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Australian Society of Sugar Cane Technologists

**Proceedings
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MACKAY

43rd Conference

Program and Abstracts

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43rd Annual Conference

Futureproofing a Resilient Industry

Mackay Entertainment and Convention Centre
Tuesday 19th April - Friday 22nd April 2022



Conference Program

TUESDAY 19TH APRIL 2022

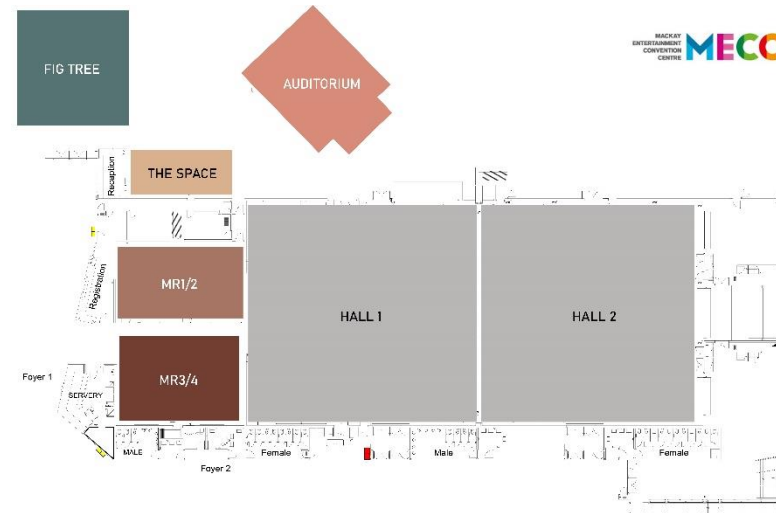
TIME	VENUE	AGENDA
17:30-19:30	Fig Tree	Welcome Drinks

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WEDNESDAY 20TH APRIL 2022

TIME	AUDITORIUM	MR1/2	THE SPACE
09:00-10:30	Opening Ceremony: Jannik Olejas, CEO, MSL & Graham Bonnett, CSIRO		
10:30-11:00	Break		
11:00-11:30	Emerging opportunities for Australian sugar using blockchain technology – Kealley et al.		
11:30-12:00	Maximising the benefits of NIR rapid analysis for sugarcane mill laboratories – Simpson, Staunton		
12:00-12:30	Managing the impacts of the Maillard reaction on the pan and crystallizer stations – Broadfoot		
12:30-13:30	Lunch		
13:30-14:00		Australian Sugar Industry Scholarship and bursary program – King	
14:00-14:30		Characterisation of physical properties of prepared cane from soft-cane varieties – Plaza et al.	
14:30-15:00		Automation parameters for milling adjustments during processing of soft canes – Kent et al.	
15:00-15:30	Break		
15:30-16:00		Posters (5 minutes each): <ul style="list-style-type: none"> West – Functional Safety Auld – Vigilance and man-down protection review for locomotives Auld – Locomotive Alarming Strategy and HMI development Greenberg – Migration to a digital voice radio network for the cane rail network Johnston – Standardisation in Wilmar Sugar 	Profitability and environmental implications of practice changes driven by soil health in Central and Northern Queensland – Connolly et al.
16:00-16:30		Posters (5 minutes each): <ul style="list-style-type: none"> Kenny – Managing Legacy Control Systems Hickey – Managing the risk of project equipment deliveries in the EIC area Babu et al. – Brix control for high-grade pan operations Harrison et al. – Dosing with ferrous chloride to control effluent odour Gilbert – Qualitative assessment of the occurrence of included crystal colour 	Comparative efficacy and environmental profile of the newly registered herbicide Palmero TX - Fillols
16:30-17:00		Opportunities for young professionals	
17:30-18:30	Happy Hour		

THURSDAY 21 ST APRIL 2022			
TIME	MR1/2	MR3/4	THE SPACE
08:00-08:30	Assessment of increased tube life in boiler convection banks through commercially available tube coatings – Plaza et al.	Forward osmosis for the concentration of sugarcane juice – Rackemann et al.	Crop response to fertilizer nitrogen on a sodic soil in the Central Region – Salter et al.
08:30-09:00	Upgrade of the boiler station at South Johnstone Mill – O'Brien et al.	Experiences with pre-evaporators at Racecourse Mill – Lavarack et al.	Refining nitrogen management under different conditions: economic results from preliminary grower-demonstration trials – Pfumayaramba et al.
09:00-09:30	Wilmar's experience with hexavalent chromium – Masotti	Configuring quintuple evaporator stations to provide high levels of steam efficiency in Australian factories – Broadfoot	Evaluation on enhanced-efficiency fertilisers in Queensland sugarcane – Connellan
09:30-10:00	A factory trial to evaluate different designs of shredder-hammer tips – Di Mauro	Assessing the suitability of quadruple, quintuple and sextuple Robert evaporator sets for high levels of steam efficiency in Australian factories – Broadfoot	Stoller in sugarcane plant root development – Steer (Exhibitor)
10:00-10:30	Break		
10:30-11:00	Exhibitors (10 minutes each): <ul style="list-style-type: none"> Conveyor skirting and transfer – Storer Can I improve the efficiency of my batch centrifuge when it is time to replace the basket? – Schofield 		Improving delivery from SRA Plant Breeding – Eglinton et al.
11:00-11:30	Design of an automated electro-mechanical shredder-grid-door positioner for online setting adjustments – Plaza et al.	Heat-transfer performance of batch vacuum pans in the Australian sugar industry – Broadfoot, Ashtiani Abdi	Opticane: An irrigation and weather support tool – Sexton et al.
11:30-12:00	Designing a device to assist shredder hammer-grid bar clearance tuning – Graham, Rozis	Assessing the suitability of operating high grade batch pans in Australian factories on low pressure vapour – Broadfoot, Ashtiani Abdi	Preliminary evaluation of real-time sensing of harvester losses by machine vision – McCarthy
12:00-12:30	Manufacturing section meeting	Administration section meeting	Agricultural section meeting
12:30-13:30	Lunch and Posters Viewing		
13:30-14:00	Exhibitors (10 minutes each): <ul style="list-style-type: none"> The growing need for automation in the sugar industry – Gulinelli Australian Sugar Industry Training Learning Management System – King Expertise and industry experience from the SRI/QUT team - Green 	Investigation of the corrosivity of final evaporator condensate at four Australian sugar factories – Arzaghi et al.	Sentinels without borders: How a global pandemic inspired the diversification of iMapPESTS's mobile surveillance suite – Johnson et al.
14:00-14:30	The next-generation cane-fibre analyser – Kent et al.	Assessment of pH control strategies to minimise sucrose losses during juice evaporation in raw sugar manufacture – Marasinghege et al	Modernising sugarcane diagnostics – Thompson
14:30-15:00	Reducing boiler maintenance costs with improved materials for air-heater tubes – Mann et al	Preliminary study of the impacts of constituents of sugarcane juice on sucrose degradation and pH drop during evaporation – Marasinghege et al.	Driving productivity and disease prevention in sugarcane growth with carbon nanodots – Li et al.
15:00-15:30	Break		
15:30-16:00	Efficacy of FDA-approved biocides to inhibit microbial degradation of sucrose – Shi et al	Modelling the impact of a falling-film evaporator in final-effect position on factory operation and performance – Thaval	Survey of plant-parasitic and free-living nematodes in New South Wales cane-growing areas – Bhuiyan et al.
16:00-16:30	Navigating the mist surrounding water usage in sugar factories – Lavarack		Tully Variety Management Group update – Shannon et al.
16:30-17:30	Annual General Meeting		
18:00-21:00	Gourmet BBQ Dinner @ Fig Tree		

Venue
Legends:

FIG TREE

AUDITORIUM

MR1/2

MR3/4

THE SPACE

IEE HALLS 1&2

Note: Each activity is colored according to the venue they are being held.

Corrosivity of final evaporator condensates at four Australian sugar factories

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Recent studies of steam-efficient evaporator stations in Australian factories show that sucrose degradation and the subsequent formation of acids in the juice produces final evaporator condensates of low pH (sometimes less than 5). Using corrosion coupons, the corrosivity of final condensates was investigated at four factories for four materials commonly used in the construction of evaporators and the ancillary pipework. On-line measurements of pH and instantaneous corrosion rates were also made. The two steam-efficient factories had very high corrosion rates for the carbon-steel coupons (pipework and tube-plate materials), while the factory with no vapour bleed (low steam-efficiency configuration) had much lower corrosion rates for these materials. One factory with a relatively low pH of condensate, but with low pH not as a consequence of sucrose degradation, showed intermediate corrosion rates. For all four factories, 304 stainless-steel coupons showed extremely low corrosion rates. The results demonstrate the need for steam efficient factories to determine appropriate solutions to extend the service lives of the evaporator vessels. Such solutions may include operational changes, design changes to evaporators and/or the use of alternative materials such as 304 stainless steel for vessel construction.

Survey of plant-parasitic and free-living nematodes in New South Wales cane-growing areas

Shamsul A Bhuiyan, Sebastien Garcia-Cuenca, Kylie Garlick and Jason Eglinton

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Plant-parasitic nematodes are important pests of sugarcane worldwide, causing more than \$80 million loss in productivity per year in Australia. A second group of nematodes are known as 'free-living' and feed on bacteria, fungi or on other nematodes. Free-living nematodes are vital contributors to soil health through their involvement in mobilisation of nitrogen and carbon and are important indicators of soil health. The objectives of this study were to determine the extent of plant-parasitic nematodes and their potential impact on sugarcane production in three mill areas in New South Wales, and the use of nematode community analysis to determine the soil health of the surveyed sugarcane farms. Soil samples were collected from 43 locations from three mill areas, Broadwater, Condong, and Harwood. Sixteen farms (37%) surveyed had medium (>300 nematodes/200 g soil) and 19 farms (44%) had high (>800 nematodes/200 g soil) numbers of root-lesion nematodes. Spiral nematodes were the only other abundant species and occurred in all farms surveyed. A nematode hazard index (HI) was developed by adding the weighted number of plant-parasitic nematodes. Approximately 93% of surveyed farms had medium (>300) to high (>800) HI values, an indication of moderate (5% to 20%) to high (>20%) potential yield loss. Soil food-web indices and metabolic-footprint indices also indicated perturbation of sugarcane soil and a farming system dominated by herbivorous nematodes. This survey demonstrated that plant-parasitic nematodes are prevalent in New South Wales cane-growing areas and are probably causing yield loss.

Configuring quintuple evaporator stations to provide high levels of steam efficiency in Australian factories

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Australian sugar factories typically use Robert evaporators in quintuple sets for juice evaporation and large, unstirred batch pans for crystal sugar production. These two equipment arrangements present several challenges for Australian factories to implement large reductions in process steam consumption, for example, by operating the pans on low pressure vapour, such as vapour from the second or third effect of the evaporator station. This paper considers the impact on the quintuple evaporator station of the variable vapour demand of the batch pans and investigates the changes needed to ameliorate the adverse impacts and to increase the pressure of the vapour supply to the pan stage. The solutions consider the flashing of vapour from condensate, the use of bleed vapour and condensate for juice heating, replacing some Robert evaporators with falling-film tube evaporators, measures to better control the evaporator set, and ways to limit the extent of sucrose degradation in the evaporators.

Assessing the suitability of quadruple, quintuple and sextuple Robert evaporator sets for high levels of steam efficiency in Australian factories

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Australian factories typically have quintuple sets of Robert evaporators and pan stages that generally comprise large, unstirred batch pans. The vapour consumption of the pan-stage cycles through large variations about the mean value as the batch pans move through their schedules. When bleed vapour from the evaporators is used on the pan stage, for example, in order to improve the steam economy of the factory, the variable vapour withdrawal to the pans causes large variations in vapour flows in the evaporators and alters the vapour pressures. This paper examines the use of quadruple, quintuple and sextuple evaporator sets to determine how each configuration accommodates the variable vapour demand of the pan stage.

Managing the impacts of the Maillard reaction on the C massecuite pan and crystalliser stations

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The Maillard reaction is known to occur in each stage of pan stage operations and during the storage of massecuites such as in receivers and crystallisers. The rate of reaction is faster in C massecuite processing than for the higher purity massecuites owing to the higher concentration of impurities, higher brix and generally higher boiling temperatures. The reaction is known to occur predominantly between glucose and amino compounds and produces organic acids, heat and carbon dioxide. Hydrolysis of sucrose is also known to occur. For the most part, sugar factories avoid the serious adverse effects of the Maillard reaction, albeit with some loss of sucrose and reducing sugars, and without great obvious impact on processing. The paper reports on factory studies that determined the change in compositions of A, B and C molasses and, using data in the literature from laboratory trials with pan drop C massecuites, formulates a model for estimating the impact of the Maillard reaction in C massecuite processing on sucrose recovery and factory revenue. Measures that reduce the impact of the Maillard reaction are discussed.

Heat-transfer performance of batch vacuum pans in the Australian sugar industry

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For Australian sugar factories where most pan stages comprise large, unstirred batch pans, the ability to reduce the process steam consumption of the factory by operating the pans on low-pressure bleed vapour from the evaporators, such as vapour from the third effect of the evaporator station, is not currently possible. In order to define the ability of batch pans to operate effectively on low-pressure vapour, the heat-transfer performance of several pans in Australian factories has been investigated for both the run-up and heavy-up phases. This paper describes the results of the heat-transfer measurements for 14 batch pans, with the study covering all massecuite production duties. Data for two continuous pans are also presented. A correlation for heat-transfer coefficients during run-up for natural circulation high-grade batch pans as a function of steam rate, massecuite height above the calandria and mother molasses consistency is presented. This correlation can be used to determine the suitability of batch pans in the industry to use bleed vapour from the evaporators.

Assessing the suitability of operating high-grade batch pans in Australian factories on low-pressure vapour

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For Australian sugar factories to achieve substantial reductions in process steam consumption will require that the pan stages use bleed vapour from the evaporators, and preferably vapour 2 or vapour 3. However, most Australian pan stages comprise large, unstirred batch pans for the high-grade boiling duties, which make it difficult to use lower pressure vapour than the currently used exhaust steam or vapour 1, without experiencing a reduction in productivity of the pan stage. A recent study of the heat-transfer performance of several pans in the Australian industry provides heat-transfer performance data and correlations for the run-up and heavy-up operations. This investigation applies those correlations to determine the suitability of using vapour 2 or vapour 3 for the run-up of the high-grade batch pans. More recently installed batch pans in the industry are able to run-up to pan full using vapour 2, but using vapour 3 is not feasible. Several recommendations are made to allow the batch pans to operate more effectively on low-pressure vapour.

Evaluation of enhanced-efficiency fertilisers in Queensland sugarcane

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Enhanced-Efficiency Fertilisers (EEFs) are purported to reduce nitrogen (N) losses by better matching N supply to crop demand over the growing season. The EEF60 project was designed to evaluate EEF performance across regions, rainfall conditions, soil types and fertiliser application times. EEFs were tested on 74 sugarcane farms, located between Mossman and Bundaberg, with the lifespan of trial sites ranging from one to three ratoons. Four treatments, including two urea and two EEF treatments, were tested. One urea treatment had N applied at the SIX EASY STEPS Step 4 (6ES) recommended rate (Urea 6ES), while the three other treatments applied 20% less N. Applying urea at 20% less N decreased cane yield in medium and high rainfall conditions but improved profitability in low rainfall conditions. Urea treated with

nitrification inhibitor (NI) and blends of 20% controlled release fertilisers (CRF) with 80% urea applied with 20% less N maintained similar productivity and profitability to urea applied at 6ES. Blends with high proportions of CRF applied at 20% less N also maintained productivity but cost more, which generally made them less profitable to apply. Nitrogen-use efficiency indicators, such as crop-N content, partial factor productivity of applied N and N-uptake efficiency, were improved when EEFs were applied at 20% less N. These findings indicate that NI-urea and blends of 20% CRF with 80% urea at N rates 20% less than 6ES can be applied at any time during the season without loss of productivity or profitability in comparison to Urea 6ES. EEFs appeared to obtain higher yields than Urea 6ES in some situations under high rainfall conditions, which corresponds to past EEF research. These findings suggest that the EEF option could be endorsed as a recommended nutrient management strategy, particularly when high rainfall is expected.

Profitability and environmental implications of practice changes driven by soil health in Central and Northern Queensland

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This work explores the economic and environmental benefits of adopting practice changes aimed at managing soil health by examining a wider scope of practice changes related to soil health occurring in the Herbert, Burdekin and Mackay regions. It expands on previous evaluations that considered Smartcane Best Management Practice changes in the Wet Tropics. Economic, biophysical and farm management data before and after the practice changes were supplied by three growers from these regions. The Farm Economic Analysis Tool and Cane Life Cycle Assessment tool were used to quantify the farm profitability and environmental implications of the changes. Despite the different strategies of the farms, the economic benefit (Annualized Equivalent Benefit) was positive for all farms, ranging from \$42 to \$131 per hectare per year, suggesting that the suites of changes adopted were profitable. Environmental improvements were also demonstrated with reduced fossil-fuel use, reduced greenhouse-gas emissions, and reduced potential for water pollution. These case studies captured a longer history of practice change (over 10-35 years) to reveal larger environmental improvements than the previous case studies that were focused on Smartcane BMP changes over 6-12 years. For one farm, the reduction in greenhouse-gas emissions were predicted to be equivalent to taking 172 cars off the road. Some economic and environmental aspects were sensitive to changes in cane yield, and these thresholds were quantified in each case study. The case studies provide further evidence of the joint economic and environmental benefits of cane-growing innovations being adopted by the Australian sugarcane industry. They provide examples for growers considering practice changes and add to a growing positive narrative to the wider community about the industry's efforts to improve sustainability. They highlighted the need to add soil-health indicators in future life cycle assessments of practice change.

A factory trial to evaluate different designs of shredder-hammer tips

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Sugarcane preparation is achieved with a hammer mill termed a shredder. The disintegration of the structure of the cane billet enables the subsequent milling process to separate some of the dissolved sucrose by a combination of further mechanical preparation, squeezing and washing. Better preparation leads to increased sugar extraction, measured as (Pol %) bagasse and lower quantities of final moisture in bagasse. Previous reports indicate that existing shredders produce high levels of preparation but require greater power/energy usage and incur high maintenance expenditures. Two factory trials, each spanning 3 weeks, were conducted at Macknade Mill during the 2021 production season to evaluate the effect of the design of the shredder-hammer tip on shredder performance. The two shredder-tip designs investigated were wedge tips (conventional) and flat tips (alternative). The key objective for this trial was to determine which tip type performs better under a range of different shredder parameters including first-stage

pressures, feeding, first-mill extraction, POC performance, turbine and rotor speeds, and power efficiencies. The conventional wedge tips performed the best.

Improving delivery from SRA Plant Breeding

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Crossing was changed to make fewer cross combinations and generate larger populations from the highest value crosses. A long-term introgression program was established to exploit novel variation from wild relatives of sugarcane. Molecular markers for smut resistance were developed, validated and are now a routine part of early generation selection. The structure of Progeny Assessment Trials was changed to reduce the resources required for cross evaluation, and early generation selection pressure for smut resistance was applied. A range of fast-track breeding strategies were developed to shorten the time from cross to release, including a novel system using tissue culture, which is three years faster than the standard approach. Investment was made to double the scale of pachymetra-resistance screening allowing selection to be done at an earlier stage in the selection program, and a range of changes were made to improve the precision of Final Assessment Trials. The timing and quantity of clean seed transfer of new varieties was changed with several productivity service organisations improving availability to growers. Significant further technologies are in advanced stages of development, including molecular markers for pachymetra resistance, implementation of genomic selection, and incorporation of drone-based phenotypic data into selection decisions and the description of new variety performance.

Comparative efficacy and environmental profile of the newly registered herbicide Palmero®TX

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Promoting weed control strategies that help reduce the movement of herbicides off site has been a priority for the sugar industry for the last decade. Pre-emergent herbicides are a very useful farming tool as they prevent weeds from germinating for weeks, but this long-desired persistence has a drawback as active ingredients can be transported by runoff into water bodies of the Great Barrier Reef catchment. A new pre-emergent herbicide Palmero®TX (isoxaflutole 150 g/ha, terbuthylazine 1500 g/ha), recently registered for use in sugarcane in Australia, was compared to Bobcat®i-MAXX SG (imazapic 94.5 g/ha, hexazinone 472.5 g/ha), AmiTron® (amicarbazone 700g/ha) plus Balance® ((isoxaflutole 150 g/ha), and Valor® (flumioxazin 350 g/ha), in trash blanketed ratoons, monitored in 2020 in far-northern Queensland. This paper reports on the herbicide efficacies in preventing weed germination and on comparative runoff loss of the herbicidal actives and their associated aquatic risk. Efficacy trials were implemented with three replicates and adjacent untreated controls. Losses in runoff were monitored using replicated rainfall simulations. Weed control varied at each site depending on the environmental conditions and the weed species. Palmero®TX performance was either equivalent to other tested alternative products, or inferior, although the nature of its limitations needs further investigation. Runoff data highlighted relatively high runoff losses of terbuthylazine in line with its higher application rate. However, when runoff occurred 3 weeks after spraying, terbuthylazine losses in runoff were lower than expected. With an estimated protective concentration that will protect 95% of the freshwater species of 1.2 µg/kg for terbuthylazine and 0.46 µg/kg for isoxaflutole, Palmero®TX had a slightly lower impact on aquatic freshwater species compared to Bobcat®i-MAXX SG, although slightly higher than AmiTron®+ Balance® when runoff occurred 3 weeks after spraying. The faster reduction in terbuthylazine runoff loss over time makes Palmero®TX a suitable pre-emergent herbicide alternative on trash blankets.

Designing a device to assist in tuning the clearance in shredder hammer-grid bars

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The need was identified for a more efficient and safe method of adjusting the distance between the sweep of shredder hammers and stationary grid bars. The current method of adjusting the gap is inaccurate, time consuming and labour intensive. As a result, the tolerance is rarely optimised, which has the potential to affect sugar extraction. Two prototype devices are explored – one device is a “smart hammer tip” and the other magnetically connects between the disks of the shredder rotor. The devices use an infrared laser to measure the distance outwards as the shredder is turned slowly. The devices can measure the gap to all grid bars in under 2 minutes with an accuracy of ± 2.5 mm. Both devices increased the accuracy of the adjustments while reducing labour and the risk of injury. The device will continue to be developed in order to be tested at all Willmar’s Australian mills for the 2022 crush.

Sentinels without borders: how a global pandemic inspired the diversification of iMapPESTS’s mobile surveillance suite

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⁶*Department of Primary Industries and Regional Development, Perth, WA*

The Rural Research and Development for Profit program (RRD4P) boosts funding to Australia’s rural research and development corporations (RDCs) for nationally coordinated, strategic research that delivers real outcomes for Australian producers. In 2017, iMapPESTS: Sentinel Surveillance Systems for Agriculture (iMapPESTS for short) saw each of Australia’s plant RDCs join forces to change the way airborne pests and diseases are detected. Using new and emerging technologies, iMapPESTS are investigating advanced surveillance and diagnostic methods to monitor and report the presence of exotic and endemic pests that threaten major agricultural sectors across Australia, including grains, cotton, sugar, horticulture, wine and forestry industries. The project has delivered a suite of new surveillance and diagnostics tools. These tools are driven by industry needs following extensive research and development into a flexible, cost-effective system using the latest technologies. iMapPESTS has delivered a suite of seven sentinels that have been adapted to provide a range of options to meet various industry needs. The sentinels range in size, deployment method (trailer, skid, modular unit) and composition of traps. The new edition units – Sentinels 4 to 7 – are smarter, smaller, lighter, and more flexible compared with earlier sentinels, which is important in a period where movement of people and goods can change quickly, and especially important for responsiveness to biosecurity incursions.

Emerging opportunities for Australian sugar using blockchain technology

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CANEGROWERS is investigating how to use blockchain technology designed for the Queensland sugar industry to show traceability of sugarcane accredited by the Smartcane BMP program. The intent is to support market access, identify opportunities for value creation in the supply chain and deliver value back to sugarcane growers. CANEGROWERS worked with KPMG Australia to test the capabilities of the KPMG

Origins blockchain platform in real time using grower and miller data. The work followed the journey of sustainable sugar in both the Tully region for the export market and the Mackay region for the domestic market. The pilot involved collaboration among 10 organisations and captured, permissioned and shared data between participants that included growers, CANEGROWERS, mills, marketers and a bank. Four Smartcane BMP accredited farms, who sell to the participating mills and marketers, were involved. The pilot sourced data from Smartcane BMP certification, soil tests and mill data including rake information. The data was uploaded to the traceability platform, across nine different events, from the point of harvest through to the marketer receiving ownership of raw sugar. Smartcane BMP certificates and traceability information were aggregated, permissioned and shared via the KPMG Origins platform. The pilot successfully traced 27,412 t of sugarcane delivered to the mill in 231 rakes and proved the traceability, data standardisation and permissioning capability of the KPMG Origins platform. The pilot also enabled the bank to validate their ability to integrate with KPMG Origins and pilot data to scope options for sustainable financing products and future carbon markets that it could then offer to growers. Opportunities for value creation in sustainable financing, carbon and ESG were evaluated and are starting to show promise.

Automation parameters for milling adjustments during processing of soft canes

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Concerns have been raised that many sugarcane varieties in the development pipeline, particularly in the Central and Southern regions, have fibre quality classified as soft, with some soft enough to cause processing problems in the factory. The main issues have been feeding of the cane through the milling train and high bagasse moisture contents causing subsequent combustion issues and low steam pressure at the boiler station. These cane varieties are usually designated as 'soft canes'. With soft canes in a factory's cane supply, there is a need to find a way to process them reliably at a reasonable rate, to extract the sucrose and produce reasonable quality bagasse for steam generation. This paper reports on a series of experiments at Isis mill to examine the effect of varying cane preparation, added water rate and added water temperature on the operation and performance of the factory, with the objective of providing the information necessary to develop an automated control strategy for handling the processing of soft canes without manual intervention. Changes to shredder speed to adjust cane preparation and changes to added water rate and temperature affect the operation and performance of the milling train. In particular, changing shredder speed influences #1 mill torque, changing added water rate influences #2 and #5 mill torque, and changing added water temperature influences #5 mill torque. Changing shredder speed and changing added water rate are proposed as strategies to address problems caused by the processing of soft canes.

The next-generation cane-fibre analyser

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Cane-fibre analysis plays an important role in the cane-payment system in Australia. The relationship between brix in first-expressed juice and brix in cane and the relationship between pol in first-expressed juice and pol in cane are affected by the cane-fibre content. As a result, Australian raw-sugar factories conduct cane-fibre analysis each day through the crushing season. Since the early 1990s, cane-fibre analysis has been mainly undertaken using the SRI can fibre machine. Although many factories now use the NIR Cane Analysis System for online cane-fibre measurement, the SRI can fibre machine is still used daily for calibration purposes. A new can fibre analyser, labelled the CFA01, was designed to replace the SRI can fibre machine. Two prototype CFA01s were tested at Maryborough, Isis and Pioneer factories in the 2020 season. The CFA01 is a logical successor to the SRI can fibre machine, being functionally similar.

The testing program has supported a hypothesis that the measurement of mean fibre content from the CFA01 is the same as that of the can fibre machine. Method 4A of the standard laboratory manual for Australian sugar mills was explicitly developed to use the SRI can fibre machine. Changes to the method are necessary before the CFA01 can be used for cane payment. A fast-dry mode has been developed that can potentially reduce the total drying time, mainly by eliminating the need for a check-dry. Changes to method 4A are also necessary before a fast-dry method could be used for cane payment.

Navigating the mist surrounding water usage in sugar factories

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Most water entering a sugar factory in the Mackay district is present in sugarcane, with raw water supply contributing about 20% of the total. Consequently, changes in CCS levels and in crush rates have a major impact on both raw water consumption and effluent production rates. High rates of raw water consumption invariably lead to increased wastewater flows to the effluent treatment plant and to increased treated effluent flows to the environment. The water usage during factory stoppages and the measures required to reduce raw water usage are discussed. These measures are affected by the specific factory design including the ability to recover and re-use water, tank holding capacities and operator knowledge regarding the nature of the stoppage and steps to be undertaken. Knowledge of factory layouts of how water is distributed and recovered as well as compliance with operational procedures are key to reducing water usage in sugar factories. Site-specific training of production personnel is essential to improve factory performance regarding water management. The annual consumption of raw water in a sugar factory and the quality and quantity of treated effluent are subject to strict government licence conditions. Consequently, to be compliant, the daily raw water consumption volume, the flow rate of wastewater to the effluent treatment plant and the flow rates of effluent discharge to the environment are key performance indicators (KPIs). This paper reviews discussions from a workshop on water management undertaken by the Mackay Institute of Sugar Technologists (MIST) for the Mackay district mills.

Experiences with pre-evaporators at Racecourse Mill

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In the 2008 season, a new pre-evaporator vessel, called PE1A, was installed at the Racecourse Mill as a precursor to the introduction of cogeneration at the factory. PE1A and the existing pre-evaporator, called PE-north, were designed as steam-efficiency measures to provide vapour to the mill pan stage, mill heaters, co-located sugar refinery and, potentially, to other value-adding operations. Both pre-evaporator vessels are Robert type evaporators, with the PE-north vessel an older standard design and the PE1A vessel incorporating new design features. PE1A is configured to take letdown steam from the cogeneration boiler (Racecourse no.4 boiler) and to return the condensate to the boiler. PE-north takes exhaust steam from the milling turbines and turbo-alternators supplied from Racecourse no.3 boiler. The specifications for condensate supplied as boiler feedwater to the cogeneration boiler, which operates at 8,000 kPa, are more stringent than the industry typical boilers, operating at 1,700 kPa. PE1A is operated as a juice-evaporator vessel during the crush season and as a steam transformer during the non-crush season. The operation of both pre-evaporator vessels is described. Severe corrosion issues are noted for the PE1A vessel that are not prevalent for PE-north vessel despite the latter being considerably older and being used in a similar role. The causes of the high corrosion levels for PE1A are discussed and some measures to alleviate the operational conditions at Racecourse are described.

Driving productivity and disease prevention in sugarcane growth with carbon nanodots

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Carbon nanodots (C-dots) are carbogenic nanoparticles that are typically smaller than 10 nm, water dispersible, UV absorbing, highly fluorescent and biocompatible. C-dots have been identified as a potential nutraceutical material for sugarcane farming. Two types of C-dots are highlighted in this paper. In vitro bioassays were developed to study the interactions between CDs and microbial pathogens. Whole-plant studies were used to investigate the phytotoxicity, growth promotion or inhibition effects of C-dots on sugarcane. For sugarcane farming, an efficient nanofertilizer could be a plausible solution to address the problem of fertilizer in run-off water. The pathogen inhibition effect of C-dots offers a new opportunity for developing novel pesticides using a green chemistry approach. Further studies on the mechanisms of pathogen growth inhibition and biomass increase and a wider range of ecotoxicity studies are required for commercial development.

Reducing boiler maintenance costs with improved materials for air-heater tubes

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Corrosion of boiler air-heater tubes costs the industry several million dollars each year in repairs, reduced boiler steam output and reduced boiler efficiency. There have been many cases where the reduced boiler steam output caused by leaking air-heater tubes has reduced factory crushing rates and electricity export. Corrosion of air-heater tubes can in many cases be minimised by improving the gas and air flow distributions with turning vanes and ductwork redesign, but in nearly all cases, there are some tubes on the cold air side of air-heaters that are still susceptible to dew-point corrosion. Using improved tube materials in parts of boiler air-heaters that are susceptible to dew-point corrosion will significantly extend air-heater life. Available materials and coatings were reviewed and laboratory- and factory-scale trials, metal temperature measurements, dew-point calculations and a financial analysis-based ranking of commercially available tube materials were undertaken. S-TEN 1 had similar corrosion performance to SS304 stainless steel. Both the S-TEN 1 and SS304 stainless steel tubes had significantly greater resistance to dew-point corrosion than the carbon-steel tubes typically used in the air-heaters of Australian sugar factory boilers. The good performance of S-TEN 1 in this project is not consistent with the poor performance of S-TEN 1 (no better than carbon-steel) in earlier trials carried out by Isis Mill. The conditions experienced by the trial tubes in this project were not as severe as those experienced by the tubes in the earlier Isis Mill trials, and this appears to be the main reason for the current improved performance of the S-TEN 1 tubes. This requires further investigation.

Preliminary study of the impacts of constituents of sugarcane juice on sucrose degradation and pH drop during evaporation

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During sugar-manufacturing processes such as evaporation, loss of sucrose can occur due to acid-catalysed hydrolysis to glucose and fructose, a reaction that is exponential with temperature. This reaction is also affected by pH, brix and residence time, as well as the impurity composition. Sugarcane juice contains many impurities extracted from the cane plant during processing, including invert sugars, minerals, organic acids, proteins, amino acids, phenolics, flavonoids and polysaccharides. Representative chemicals reflecting these impurities were spiked into synthetic sucrose solutions to determine how specific classes of impurities impact on sucrose degradation under thermal conditions. Invert sugars, flavonoids and minerals had a catalytic effect on sucrose degradation that was accompanied by higher juice pH drop. Organic acids minimised sucrose degradation slightly due to a buffering effect. Other juice constituents showed minimal impact. Studies on the catalytic activity of minerals showed that catalytic activity increased in the order of $\text{Na}^+ < \text{K}^+ < \text{Mg}^{2+} < \text{Ca}^{2+}$. During thermal processing, juice constituents are involved in complex interactions with each other, and so further research is necessary to better elucidate these interactions.

Assessment of pH control strategies to minimise sucrose losses during juice evaporation in raw sugar manufacture

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During juice evaporation sucrose loss can occur as a result of degradation reactions that are catalysed by heat, pH and other juice components. The impacts of heat and juice quality can be controlled through process and equipment design. Potential pH control strategies for juice were assessed to minimise sucrose degradation and the subsequent impacts on downstream processing during the sugar manufacturing process. These strategies were: (1) the use of reagents to improve the buffering capacity of the juice; (2) the use of neutralising alkanolamines; and (3) on-line pH adjustment during juice evaporation to minimise pH drop. All these strategies achieved significant reductions in sucrose loss of 20-50% in both the small-scale and laboratory rig trials but some come at the expense of chemical costs and other processing implications such as scaling of the evaporators. The use of ammonia was the preferred pH control strategy, although it led to an increase in juice colour.

Wilmar's experience with hexavalent chromium

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In April 2019, Siemens, one of Wilmar's turbine suppliers, released an Urgent Technical Advisory Service Bulletin to its customers to advise that Siemens had undertaken trials in which some anti-seize pastes applied to certain steam turbine components exposed to temperatures of above 400 °C may lead to the production of a residue of hexavalent chromium (Cr (VI)) on the components. Cr (VI) is a recognised human carcinogen and a regulated waste by governmental and health authorities. Cr (VI) compounds are often brightly coloured yellow, a physical characteristic that has assisted identification. Wilmar recognised a requirement to develop procedures for safe removal of Cr (VI) as this contaminant could be uncovered when undertaking future maintenance on turbines or boilers. This paper presents the likely Cr (VI) growth mechanism, locations where Cr (VI) has been found so far at Wilmar sites, Wilmar's management

procedure for Cr (VI) identification and for decontamination, and what is being done to better manage formation of Cr (VI) residues during operation of the steam plant.

Preliminary evaluation of real-time sensing of harvester losses by machine vision

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Sugar losses during cane cleaning in mechanical harvesters are estimated to cause millions of dollars of lost income per year. Existing commercially available loss-monitoring devices do not directly sense losses from the material expelled during cane cleaning in the harvester. Development of technologies for real-time, accurate and consistent measurement of harvester losses is required to achieve improved efficiency of harvesting with reduced losses. A proof-of-concept machine-vision sensor containing cameras with visible light and non-visible light sensitivity has been developed for the purpose of real-time sensing of harvester losses. Initial trials were conducted in October 2020 in the Gordonvale region. Primary extractor fan speed was varied for the trials, and a Sugar Research Australia field team recorded losses data using the Infield Sucrose Loss Measurement System. The trials enabled machine-vision sensor data to be compared with sugar expelled from the harvester under a range of field conditions. Machine-vision analysis has indicated a coefficient of determination of between 0.72 and 0.93 for prediction of sugar loss from image data from a combination of camera sensors. Further analysis is presently being undertaken on trial data collected in 2021 under different field conditions. Machine vision has potential to detect sugar losses for the purpose of providing real-time feedback to harvester operators. Ultimately, such a sensor has potential use to automatically detect and provide recommendations for harvester settings in real-time to minimise losses.

Upgrade of the boiler station at South Johnstone Mill

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The Australian sugar industry has been challenged by serious boiler incidents occurring at several factories that have cost factories several million dollars in boiler repair costs and lost production. The South Johnstone No. 2 boiler has had explosion incidents due to the build-up and subsequent ignition of combustible gases and/or dust clouds during start-up. This paper summarises the incident investigations, conclusions from the incident investigations and follow-on changes to the boiler station at South Johnstone Mill to minimise the risk of future incidents. These changes included standardising and automating the boiler start-up and purging procedures and upgrading boiler-protection systems. In addition to significantly reducing the risk of future incidents, these changes dramatically reduced low steam events, which has increased factory uptime, increased electricity export, increased boiler station efficiency and stabilised factory processing operations.

Refining nitrogen management under different conditions: economic results from preliminary grower-demonstration trials

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Economic findings are presented on a selection of refined nitrogen (N) rate demonstration trials conducted in the Wet Tropics, Burdekin and Mackay-Whitsunday regions of Queensland. Different N rates were examined to account for nutrients supplied by break crops, mill-by-products and groundwater irrigation. Reduced N rates were also considered in final ratoons, on cane varieties with perceived higher N-use efficiency, and where nitrification-inhibiting fertilisers were applied. Approaches to refined N rates were aligned to industry-led programs such as SIX EASY STEPS™ (6ES) and the more recent 6ES Toolbox. Past research has identified that applying N rates above 6ES guidelines often reduced grower profitability. Refining N rates to account for organic sources of N and consideration of production characteristics may provide opportunity for growers to improve profitability whilst maintaining or improving production levels. Agronomists supporting Project Catalyst conducted 11 grower demonstration trials between 2018 and 2020. This program aims to reduce dissolved nutrients, sediment and pesticide loss from sugarcane farms using innovative farm practice improvements. The N treatments evaluated in these trials included standard grower rates, 6ES guideline rates (through following the full 6ES rather than simply following the regulated method) or the 6ES Toolbox to account for alternative sources of N. Yields and commercial cane sugar levels (CCS) from different treatments were analysed. Data on revenue and costs were collected to calculate gross margins and relative profitability of treatments. The largest impact on grower profitability was associated with the groundwater-N trials. Despite results showing improved or maintained gross margins for refined N rates in most trials, there were no significant differences. Although demonstration trials provide a good resource to improve practice adoption by growers, longer-term trials and increased replication across a wider variety of sites are needed to validate refined N management and improve confidence in the results.

Characterisation of physical properties of prepared cane from soft-cane varieties

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Concerns have been raised that many sugarcane varieties in the development pipeline, particularly in the Central and Southern regions, have fibre quality classified as soft, with some soft enough to cause processing problems in the factory. The main issues have been feeding of the cane through the milling train and high bagasse moisture contents causing subsequent combustion issues and low steam pressure at the boiler station. These cane varieties are usually designated as 'soft canes', and their presence had been noted for at least 60 years. An attractive trait is their relatively high sugar yield per hectare. Some other general characteristics have been noted as often (but not always) having relatively low fibre content, and being easier to prepare by the shredder, resulting in a larger number of smaller sized particles in the prepared cane. During the development of new cane varieties, Sugar Research Australia carries out tests for 'fibre quality'. Experiments were carried out at Isis Central Mill to understand and improve the processing of existing soft-cane varieties. During the 2019 crushing season, a pilot-scale shredder was used to simulate the effect of shredder settings (speed and grid setting) that are known to have effects on preparation level. Four existing soft-cane varieties (SRA1^A, SRA4^A, SRA11^A and QN04-1643) were tested, along with Q208^A that provided a reference as a middle-of-the-range variety (perceived to be neither a soft nor hard cane). The prepared cane produced was tested for fibre quality at the SRA fibre quality laboratory in Bundaberg, preparation level as measured at the factory, plus two physical properties (compression and permeability) identified as important for the milling process. All the cane varieties responded to speed and grid setting in the same way, with the soft canes being part of a continuum, not a separate subset. The overall conclusion was that adjusting shredder speed and grid setting can control preparation and potentially address feeding problems at the milling train through improved control strategies.

Design of an automated electro-mechanical shredder-grid-door positioner for online setting adjustments

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The design of an automated electro-mechanical shredder-grid-door positioner and its components, programming, installation and commissioning are presented in this paper. The positioner can be used to vary the shredder grid setting and so preparation to assist processing soft cane varieties through the milling train. A second purpose is to work with shredder drives (such as steam turbines) of limited power, in order to avoid stalling the drive, which can result in factory stops. The driver for this design has been concerns in recent years that some cane varieties in the development pipeline have a fibre quality classified as soft, with some soft enough to cause processing problems in the factory. The main issues have been feeding of the cane through the milling train and high bagasse moistures causing subsequent combustion issues and low steam pressure at the boiler station. These cane varieties are usually designated as 'soft canes', and their presence had been noted as far back as 60 years ago. Trials were carried out at Isis Central Mill to understand and improve the processing of existing soft cane varieties. The automated shredder-grid-door positioner was installed during October of the 2021 crushing season so that full factory trials could be carried out, including automated grid positioning. The positioner was made up of a master/slave configuration with two 5 t power jacks driven by servo gear motors controlled by two inverters.

Assessment of increased tube life in boiler convection banks through commercially available tube coatings

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The replacement cost of a boiler convection bank due to wear (erosion) is approximately \$1 million with a tube life of approximately 10-15 years using current protection technology (tube shields). Computational fluid dynamics (CFD) modelling has been used extensively for redesign of convection banks to reduce tube wear and to predict where tube shields should be located for new convection bank geometries. Tube coatings have been successfully applied in other industries to protect against erosion and can also be applied in areas such as the superheater loops where the higher temperatures can cause problems for tube shields. The erosion performance of commercially available coatings applied by laser and thermal spray (high velocity oxy-fuel (HVOF) and twin-wire arc spray (TWAS)) processes was compared to that of bare tubes and tube shields, in both laboratory scale tests at the CSIRO Clayton facility and factory trials at Mulgrave Mill. The testing was supported by financial analyses at each stage of the project. A WearPro 62 (tungsten carbide) coating applied by laser was the best performer, with an expected coating life of approximately 18 years. The data were extrapolated to predict the coating life for convection banks with different gas velocities. There were also significant issues with early failure of tube shields by mechanisms other than erosion. Such failures are of concern as, once installed, many shielded locations in convection banks are difficult, costly or impossible to access. Further assessment and improvement of the attachment of tube shields to tubes are required.

Forward osmosis for the concentration of sugarcane juice

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During evaporation, loss of sucrose can occur due to acid-catalysed hydrolysis to glucose and fructose, a reaction that is exponential with temperature. This paper reviews non-thermal methods for concentrating juices, particularly focusing on the developments of forward osmosis (FO) membranes for juice processing, detailing the benefits and limitations of this technology. A laboratory FO membrane was used in this preliminary study to concentrate pure sucrose solutions and clarified juice from ~10 to 45 Bx using a calcium chloride draw solution. A small amount of reverse salt flux was observed. There was little impact of the impurities in factory juices on flux performance, with the flux reducing inversely with the volumetric concentration factor. By concentrating to a limit of 45 Bx, concentration polarisation factors that can have a detrimental impact on the flux were not realised. Possible strategies were also explored for the integration into the sugar-manufacturing process.

Crop response to fertiliser nitrogen on a sodic soil in the Central Region

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The SIX EASY STEPS™ nutrient-management program encourages a process of ongoing refinement, and any change to a nutrient-management program should be based on evidence. This may include leaf testing, farm records, on-farm evaluation or the combination of these and other factors. Crop response to applied fertiliser should be one of the main factors assessed when refining a nutrient-management program. Crop response to applied nitrogen (N) may be reduced on sodic soils, associated with a reduced crop-N requirement where growth is constrained. However, the sodic conditions may also limit the crop's ability to acquire N. A trial was established in the Central Region to investigate crop response to fertiliser N on a sodic soil. N rate treatments (0, 50, 100, 150 and 200 kg N/ha as urea) were established in the first-ratoon crop and repeated for the remainder of the crop cycle. The trial contained two zones, one with low yield potential and high electrical conductivity (LYHEC) and a second zone with higher yield potential and low electrical conductivity (HYLEC). Both zones were highly sodic (ESP>15%) at depth. An N deficiency developed over the crop cycle, with the 0N and 50N treatments showing lower leaf %N, and reduced cane and sugar yield. Optimum N fertiliser rates increased from the first ratoon (18 kg N/ha) to the third ratoon (109 kg N/ha) but declined in the fourth ratoon (85 kg N/ha). Nitrogen-use efficiency declined with N application rate and the highest N uptake efficiency of fertiliser N was 27% at the 50N rate. Overall, the trial showed that a small reduction (~20 kg N/ha or 14%) from the recommended rate of 140 kg N/ha would have been appropriate at this site. The results provide support for the recently developed SIX EASY STEPS Toolbox guidance for refining nutrient inputs for specific on-farm circumstance, including sodic soils. This guidance encourages amelioration of the sodic soil condition as the grower's priority before amendment of nutrient inputs is considered.

Opticane: an irrigation and weather support tool

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Whether it is to manage resources during drought or simply to improve productivity, irrigation management is an important part of many sugarcane-growing regions in Australia. Many irrigation decision-support tools (DSTs) have been developed in the past with varying levels of success. Opticane (www.opticane.net) was developed as an Internet of Things tool that integrated current weather data, locally relevant weather forecasts and a crop model to produce weather and irrigation requirement forecasts for use in irrigation management decisions. In contrast to many DSTs, a major focus of Opticane's development has been the focus on the user experience. This paper overviews the insights and lessons learnt from the project development. By highlighting the features available to users, we hope to encourage growers to investigate irrigation DSTs. By overviewing the development process, we hope to encourage researchers to explore the possibilities of interactive web development to engage industry partners with research outputs. Consultation with industry partners has led to the expansion of Opticane beyond irrigation advice, to include rule-of-thumb advice for a range of management 'tasks' such as spraying and burning. The number of visitors to the Opticane site has continued to increase over the life of the project. The majority of visits have used the current conditions and weather forecasts tools, but few have engaged with the irrigation advice, suggesting further work is needed in this area. Preliminary feedback suggests users largely like the Opticane user interface, particularly for exploring data from weather stations. We recommend researchers and industry partners consider interactive web apps as a way of engaging with users. Effectively disseminating advice and findings in a scalable and easy to access format will improve the uptake of advice that can lead to improved industry sustainability.

Tully Variety Management Group update

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Yield and cane-quality factors are important in determining the commercial success of each variety. These are determined by the Tully Variety Management Group through intensive small-scale sub-district trials to develop a voluntary Tully Recommended Variety list and associated guide. This provides confidence for commercial planting without having to conduct larger, longer-term strip trials or full-scale commercial crops that could fail early in the crop. The commercial results show improvements in both yield and cane quality that reflect the success of TVMG through the speed of commercialisation (2-3 years instead of 4-5 years), and the commercialisation of pachymetra-resistant varieties in the higher risk areas. These improvements in yield and quality assist the milling process and its profitability.

Efficacy of FDA-approved biocides to inhibit microbial degradation of sucrose

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During the sugar-manufacturing process, undetermined sucrose loss from microbial activities especially occurs during milling train stage. Hence, good factory hygiene that limits microbial activities will improve sugar recovery. This project evaluated and compared the effectiveness of two types of FDA-approved biocides (P100 and P200) based on both laboratory- and factory-scale trials. Sucrose, glucose, fructose, mannitol, organics acids and polysaccharides contents of juices with and without biocide treatment were used as markers to determine sucrose degradation. Laboratory tests on primary mixed juice (PMJ) and secondary mixed juice (SMJ) from four mills clearly showed that P100 biocide is more effective in inhibiting sucrose degradation in PMJ than P200, while the reverse is true with SMJ. The factory trials at F2 Sugar Mill indicated that dosing P100 in the milling train station reduced the microbial sucrose degradation compared to the control, while at F4 Sugar Mill, the effectiveness of the two biocides could not be distinguished.

Maximising the benefits of NIR rapid analysis for sugarcane mill laboratories

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Obtaining, training and retaining laboratory personnel for Australian sugarcane mills is a growing concern within the industry. The test duration for some primary laboratory methods is often too long to make the required process adjustments in time, such as altering the high-grade centrifugal settings. Once established, near-infrared (NIR) laboratory instruments using mature calibrations provide many advantages that address both issues, such as ease of use, speed of analysis, multiple constituent results generated in one scan for multiple mill products, and precision and accuracy of results. However, to achieve mature calibrations, an initial “development” procedure is required followed by an ongoing “operation” procedure. This paper demonstrates how the “development” and “operation” procedures were successfully applied for two sugarcane mills. A previously generated globalised calibration, created from various mill instruments and sample populations, was used as a basis for developing a mature localised calibration specific to the mill sample sets and their respective laboratory instruments. Stored raw sugar (pol, moisture), fresh raw sugar (pol, moisture) and molasses (dry substance, sucrose, and final molasses sucrose) were the targeted products considered for the two mills. The “development” methodology used as much data as was practical to rapidly represent the mill sample populations until the equation achieved stability, i.e. the standard error of prediction (SEP) was less than the error control limit (ECL) for each product’s constituent equations. Once matured, the “operation” methodology was implemented, where only 10% of the total sample population scanned by the NIR instrument was required for validation to monitor and maintain prediction performance. Novel software tools were implemented to improve the efficiency of the validation process. Both mill instruments underwent the “development” procedure during the 2019 season. Multiple NIR calibration updates were applied to achieve SEPs that were within, or converging to, their respective ECLs. The “operation” procedure was implemented during the 2020 and 2021 seasons, where only a single-seasonal NIR calibration update was required for each mill for all product constituent equations to meet the required prediction performance criteria. Providing reliable NIR test results within such short time frames allowed near real-time decisions to be made by process operators with minimal training requirements. The two-stage NIR development/operation methodology can be employed for similar products with the appropriate data.

Modelling the impact of a falling-film evaporator in final-effect position on factory operation and performance

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For the juice evaporation station in cane sugar factories, falling-film tubular evaporators (FFE) are now an accepted “alternative technology” to the conventional Robert-type evaporators. Features of the FFE include a high heat-transfer coefficient (HTC) over a longer period, short residence-times of juice in the evaporator, and the ability to operate at lower temperature differences, all of which play a role in the adoption of the technology. The addition of a falling-film evaporator to an existing evaporator set comprising entirely of Robert types is usually limited to the front-end of the set. Robert types operating as a final effect consume a large percentage of the total temperature difference available across the entire set of evaporators. Additionally, the heat-transfer coefficient of Robert evaporators in the final-effect position is quite low and circulation of syrup across the calandria is poor, especially at lower vapour condensation coefficients (VCC). This paper describes simulations which involve replacing a Robert-type evaporator in the final-effect position with an FFE and discusses the impact on factory operation and performance.

Modernising sugarcane diagnostics

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Sugarcane disease diagnostics plays an instrumental role in biosecurity and disease management. There has been considerable investment in improving disease diagnostic tests for some exotic and established sugarcane pathogens in recent years. However, for some important pathogens, the diagnostic test development had not been upgraded for many years. This paper describes the progress in upgrading diagnostic tests for nine of these pathogens/diseases: Fiji leaf gall (Fiji disease virus), Leaf scald (*Xanthomonas albilineans*), Sugarcane mosaic virus, Maize chlorotic mottle virus, Sugarcane-infecting mastreviruses, Sugarcane yellow leaf virus, Red leaf mottle (Peanut clump virus), Ramu stunt virus, and Sugarcane-infecting phytoplasma (white leaf, grassy shoot and green grassy shoot diseases). The literature was reviewed for the most recent diagnostic tests, and new diagnostic tests were developed by Sugar Research Australia including LAMP and qPCR. Published and new diagnostic tests were compared side-by-side with the existing diagnostic test. In order for a test to be suitable as a replacement it must be shown to be more sensitive, as specific, be able to detect known variants, easy to carry out, have potential for field application, and suitable for use in the SRA quarantine laboratory. In most cases this was possible, and the chosen upgraded diagnostic tests are to be trialled in 2022.

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