



# ASSCT

Australian Society of Sugar Cane Technologists

**Proceedings  
of the  
Australian  
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of  
Sugar Cane  
Technologists**

**2024**

**TOWNSVILLE  
45th Conference**

**Program and Abstracts**

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# Conference Program

AUSTRALIAN SOCIETY OF SUGAR CANE TECHNOLOGISTS



**45TH ANNUAL CONFERENCE**

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16 - 19 April 2024

Townsville Entertainment & Convention Centre

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<b>Tuesday 16th</b>	
0800-1630	Agriculture field tour
1830-2000	Welcome function & official opening
<b>Wednesday 17th</b>	
	Palm room
	President's welcome
	Guest presentations
	Hamel – Ark Energy's journey to date
	Harris, Roberts - Technology pathways supporting adaptable and sustainable sugar industry transitions
1000-1030	Break and viewing Equipment Exhibition
1030-1100	O'Sullivan - Are biofuels a sweet deal for the Australian sugar industry? Opportunities and barriers
1100-1130	Schroeder - Will the Australian sugarcane industry's current agricultural R&D enable the next 'step change'?
1130-1200	Broadfoot - Potential major changes in process control of Australian sugar factories
1200-1230	Lochner, Quirk - Pricing impacts and rationale for transitions in sugarcane farming in northern New South Wales and Queensland: a conversation starter
1230-1330	Lunch and viewing Equipment Exhibition

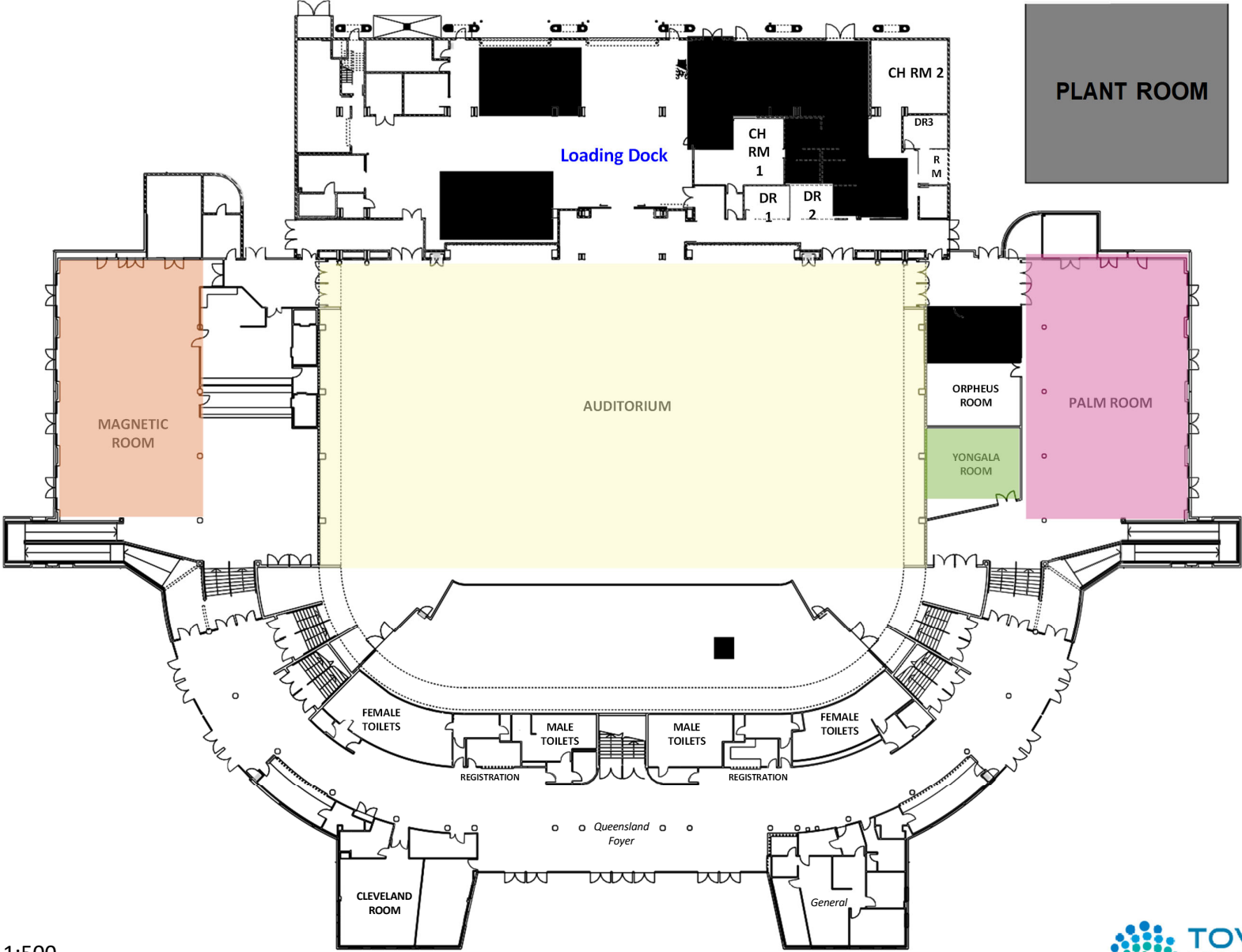
1230-1330	<b>Lunch and viewing Equipment Exhibition</b>		
	<b>Palm room</b>	<b>Yongala room</b>	<b>Magnetic room</b>
1330-1400	<b>Renouf et al</b> - Life-cycle assessment of greenhouse-gas emissions from changes in cane-growing practices	<b>Bhuiyan</b> - Temporal development of smut, yield loss, and integrated management strategies using a fungicide and varietal resistance	<b>Southern, Plaza</b> - Modelling the harvester's front end to reduce billet and stool damage: the behaviour of leaves
1400-1430	<b>Headon et al</b> - Growers reduce uncertainty around adjusting nitrogen rates following legume cover crops in the Murray district	<b>Waters et al</b> - Detection of ratoon stunting disease with freely available satellite-based multispectral imaging and machine learning	<b>Kent et al</b> - Automating the handling of soft canes through the factory
1430-1500	<b>Skocaj et al</b> - Impact of nitrogen fertiliser application timing and interaction with harvest time on crop performance	<b>Milla, Magarey</b> - Extension and RSD management in the Burdekin: challenges and successes	<b>Bakir et al</b> - Evaluation of a pilot-scale system for removing bagacillo from juice
1500-1530	<b>Break and viewing Equipment Exhibition</b>		
1530-1600	<b>Schroeder et al</b> - Are urea-based enhanced-efficiency fertilisers widely appropriate for reducing nitrogen application rates in sugarcane production?	<b>Li et al</b> - Carbon nanodots as novel fungicides for driving disease prevention in sugarcane <b>Zia et al</b> - Toxicity of carbon dots to sugarcane and human cells	<b>Matsueda et al</b> - Modelling the integration of bagasse pyrolysis into sugar mill energy systems
1600-1630	<b>Larsen et al</b> - Nutrient content after the application of mill by-products and implications for nutrient management	<b>Fillols</b> - Post-emergent control of balsam pear	<b>Attard et al</b> - Using activated bio-char to reduce colour during juice clarification in a raw sugar mill
1630-1700		<b>Rahimi Azghadi et al</b> - Precise robotic spot-spraying of weeds for improved environmental and economic outcomes in the sugarcane industry	<b>Shepherd et al</b> - Heat transfer surface film impact on heat transfer rate in evaporators
1730-1830	<b>Happy hour</b>		

<b>Thursday 18<sup>th</sup></b>	<b>Palm room</b>	<b>Yongala room</b>	<b>Magnetic room</b>
0800-0830	<b>Bradshaw, Scardamaglia</b> - Working together to achieve a sustainable outcome for the sugar industry and environment		<b>Wilson, Burke</b> - Introduction of a new Laboratory Information Management System (LIMS)
0830-0900	<b>Almeida et al</b> - ESG analysis on-farm: a practical framework to support Australian producers		<b>Thaval, Dowling</b> - Performance of the bagasse diffuser at Invicta Sugar Mill
0900-0930	<b>Wang et al</b> - Enhancing efficiency and profitability: the impact of smart irrigation scheduling in sugarcane production systems	<b>Chung, Jardine</b> - Cane railway track inspection methodology and best practices	<b>Wallace et al</b> - Challenging convention to improve chemistry management of sugar-mill boiler stations
0930-1000	<b>Schembri et al</b> - Nutrients and pesticides in end-of-paddock run-off water for farming practices in the Central region	<b>Marcelo et al</b> - Revised design of signal poles used at active level crossings of cane railways	<b>Mann, Broadfoot</b> - Effect of factory reliability on bagasse usage and surplus
1000-1030	<b>Break and viewing Equipment Exhibition</b>		
1030-1100	<b>Emtia et al</b> - Review of soldier flies in sugarcane and identification of some key research gaps <b>Bawa et al</b> - Using novel screening methods for evaluating insecticides against canegrubs		<b>Qureshi, Ghazanfar</b> - The journey towards sustainable business through technological advancement and diversification into the downstream industry: a role model in the Pakistan

1100-1130	<p><b>Green et al</b> - Removal of carbon dioxide via enhanced weathering of sugarcane mill ash under different soil conditions</p> <p><b>Holden et al</b> - Removal of carbon dioxide through enhanced weathering of basalt in acidic soils under sugarcane</p>		<p>Supplier's presentation</p> <p><b>Rózsa, Rukavina</b> - Supersaturation-based control of sugar crystallization</p> <p>Posters</p> <p><b>Matthews</b> - Using hydrotreated vegetable oil (HVO) as a renewable fuel in the Wilmar locomotive fleet</p> <p><b>Philp</b> - Retrofitting versus replacement for obsolete remote shunting unit (RSU) systems</p>
1130-1200	<p>Posters</p> <p><b>Robertson et al</b> - Implications for sugarcane nutrient management following a green-manure crop of sunn hemp</p> <p><b>Leekar et al</b> - Potential of UAV imagery and Learning Techniques for determining gaps in sugarcane rows</p> <p><b>Park</b> - Effect of application of Moddus® on yield of stand-over sugarcane in the Herbert River District in 2023</p>		<p>Posters</p> <p><b>Badger, Kelly</b> - Towards zero effluent in Wilmar's Proserpine mill</p> <p><b>Jennings</b> - Analysis of diffuser juice application at Inkerman Mill</p> <p><b>Nilon, Richter</b> - A suspected Maillard reaction in a continuous C Massecuite pan - findings and outcomes</p> <p><b>Biggs, McLean</b> - Pan condenser performance versus modelled performance</p>
1200-1230	<b>Agriculture section meeting</b>		<b>Manufacturing section meeting</b>
1230-1330	<b>Lunch and viewing Posters and Equipment Exhibition</b>		
1330-1400	<b>Magarey</b> - The BSES yield decline program: foundational research into soil factors affecting root health in the Australian sugarcane industry		<b>Broadfoot, Fraga</b> - Guidelines for cost-effectively improving sugar recovery from C massecuite cooling crystallisers
1400-1430	<b>Halpin et al</b> - The 'best' legume rotation for southern cane growers		<b>Jenssen, Broadfoot</b> - Measured and predicted consistency values for C massecuite
1430-1500	<b>Halpin et al</b> - Soybean and peanut rotations benefit sugarcane production in the Burdekin		<b>Fraga et al</b> - Use of dry substance as the process variable to control massecuite concentration during pan boiling
1500-1530	<b>Break</b>		
1530-1600	<b>Salter</b> - Impact of long-term trash blanketing and tillage prior to planting on soil carbon and sugarcane production		<b>Bankie</b> - Supplementary compressed air ploughing system for batch centrifugals trialed at Racecourse mill
1600-1630	<b>Green et al</b> - Long-term effects of gypsum on the chemistry of sodic soils under sugarcane		<b>Gilberd et al</b> - A clarifier scraper design to minimise nuisance lifting
1630-1730	<b>Annual general meeting</b>		
1830-2300	<b>Gala dinner at Museum of Tropical Queensland</b>		
<b>Friday 19th</b>			
0715-1300	<b>Manufacturing field tour</b>		

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# Opening addresses

## Ark Energy's journey to date

**Daniel Hamel**

*Ark Energy*, daniel.hamel@arkenergy.com.au

## Technology pathways supporting adaptable and sustainable sugar industry transitions

**David Harris and Daniel Roberts**

*CSIRO Energy*

## Are biofuels a sweet deal for the Australian sugar industry? Opportunities and barriers

**Cathryn O'Sullivan**

*CSIRO Agriculture and Food*

# Papers

*Almeida et al.*

## ESG analysis on-farm: a practical framework to support Australian producers

**Ana Carla Leite de Almeida<sup>1</sup>, Rachel Hay<sup>1</sup>, Allan Dale<sup>1</sup>, Stewart Lockie<sup>2</sup> and Yvette Everingham<sup>3</sup>**

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Increased pressures for a more sustainable agricultural development model has seen interest in ESG (Environmental, Social and Governance) grow rapidly. ESG frameworks and standards were designed to support industry and organisations to assess and report their ESG impacts, creating economic, environmental, and social benefit for society. However, these frameworks are not necessarily easily applied by farmers or agricultural producers. In principle, the lack of a simpler and specific framework focused on assisting farmers to continuously improve sustainability on-farm could be a limiting factor in them adopting ESG approaches and standards. With the aim of raising awareness and supporting Australian producers to self-assess and report ESG impacts on farm, and thus contributing to enhanced sustainability performance, we developed an ESG on-farm framework. We also developed a preliminary trial to investigate a) how readily the ESG on-farm framework can be applied by sugarcane farmers; and b) whether the framework can support sugarcane producers to measure sustainability-related risks and opportunities (sustainability baseline) and develop an ESG strategy. The ESG on-farm framework comprises five steps based on a blended format informed by the Global Reporting Initiative (GRI) framework and other current and relevant ESG standards. The ESG on-farm framework is a self-assessment of ESG readiness designed to be practical and to enable farmers to start their ESG analysis. Preliminary results suggest that the ESG on-farm framework could streamline the process for sugarcane farmers to develop materiality assessments, establish sustainability baselines, and inform ESG strategy.

**Attard et al.**

## **Using activated bio-char to reduce colour during juice clarification in a raw sugar mill**

**J Attard<sup>1</sup>, M Sheehan<sup>1</sup> and J Gilbert<sup>2</sup>**

<sup>1</sup>*College of Science and Engineering, James Cook University, Townsville, Queensland; jennaattard@outlook.com; madoc.sheehan@jcu.edu.au*

<sup>2</sup>*Wilmar Sugar Australia Ltd; jonathon.gilberd@au.wilmar-intl.com*

Biochar derived from sugarcane bagasse promises to be a suitable alternative to coal-based activated carbon, which is currently used to decolourise sugar in refineries. Decolourisation during the clarification stage in raw sugar milling was explored. Adsorption experiments replicating the conditions of the clarification stage in milling were undertaken using activated carbon (AC) from coal and activated wood biochar (AWB) (used as a substitute for activated bagasse biochar (ABB)). Both first express juice (FEJ) and synthetic sugar juice were used. The general pore structures, elemental composition, and specific surface area and pore volumes of coal AC, AWB, and ABB samples were compared, using SEM analysis and BET analysis. Specific surface areas of ABB, AWB, and coal AC were 793 m<sup>2</sup>/g, 830 m<sup>2</sup>/g, and 137 m<sup>2</sup>/g, respectively. Maximum colour removal from FEJ by coal AC and AWB were 75% and 67%, respectively, both at a dose of 10 g adsorbent per 100 mL solution. Colour removal from synthetic solutions was enhanced compared to FEJ (AWB at a dose of 5 g /100 mL solution led to 85% colour reduction).

**Bakir et al.**

## **Evaluation of a pilot-scale system for removing bagacillo from juice**

**H Bakir, F Plaza and R Broadfoot**

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Conventional use of rotary vacuum filters in the Australian sugar industry to remove pol from the clarifier mud has dictated that some bagacillo is allowed to flow through juice screens to mixed juice, to ensure an adequately porous mud cake is formed on the rotary vacuum filter screens. At some factories, particularly at times of high soil loading in the cane supply, additional bagacillo, such as supplied using a pneumatic separator, is added at the mud mingler. Bagacillo has detrimental effects on the juice processing stages such as increasing the mud volume in the clarifier, absorbing juice at many times its own mass, occasionally carrying over into the clear juice resulting in fugal screen blockages as well as reduced raw sugar quality. The quantity of mud cake transported back to the cane farms is also greatly increased due to the bagacillo loading in the mud cakes. Pilot-scale trials on the development of a modified process, where most bagacillo is removed from juice prior to the clarification stage and re-routed directly to the mud mingler in a more controlled and reliable manner, are described. Improved regulation of the fibre content in the feed to the mud filters would provide greater consistency and improved operation of the mud filters. Such a modified process also provides options for the use of alternative filter station technologies resulting in reduced pol loss, reduced mud cake return to the fields, and reduced supervision by operators.

**Bankie**

## **A supplementary compressed-air ploughing system for batch centrifugals trialled at Racecourse Mill**

**Oscar F Bankie**

*Mackay Sugar Limited, PO Box 5720 Mackay MC, QLD 4741; O.Bankie@mkysugar.com.au*

Many sugar mills in Australia process A and B massecuites using batch centrifugals that are of considerable age. This presents problems with the ability of this equipment to complete its duty effectively. Achieving close tolerances with plough adjustment is difficult, and due to this, often large amounts of sugar remain on the basket after plough-out, reducing fugal performance and increasing recycling of sugar. To improve performance of these fugals and prolong the usable life of these assets a supplementary ploughing system was tested at Racecourse Mill. The Air Plough System was designed to use compressed air to blow off the remaining sugar that the existing plough was unable to remove. The system consists of nozzles attached to the existing plough which, as the plough completes its duty, discharge compressed air aimed directly at

the basket. Laboratory analysis and visual inspection were used to assess and verify the improvements made by the system. In all trials, the system made a sizeable improvement in increasing sugar removal during plough-out. This concept can yield significant benefits for millers and is worthy of further research and development.

**Bawa et al.**

## **Using novel screening methods for evaluating insecticides against canegrubs**

**SA Bawa<sup>1</sup>, C Emtia<sup>1</sup>, H Farnan<sup>1</sup> and KS Powell<sup>2</sup>**

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Canegrub larvae, which include 20 species of endemic melolonthine scarab beetles, are among the most significant insect pests of sugarcane in Australia. Canegrubs feed on the sugarcane root system, causing extensive damage. The resultant damage lowers crop yield and sugar content, resulting in significant economic losses with an estimated cost of over \$50 million annually. For decades, the most effective management approach for canegrubs has been chemical insecticides, which effectively lower the pest population, thus avoiding economic loss. Currently, the neonicotinoid imidacloprid is the industry standard approved insecticide used in the management of canegrubs larvae in Australia. However, the neonicotinoid insecticide group is currently under review by the Australian Pesticides and Veterinary Medicines Authority (APVMA), which could potentially lead to either restricted future use or the eventual withdrawal of neonicotinoids from the Australian agrochemical market. Thus, there is an urgent need for an alternative insecticide product for the control of canegrubs. The efficient evaluation of insecticides for the control of canegrub infestations is a critical aspect of sustainable sugarcane production. This synopsis highlights a range of innovative bioassay methods (pot trial, artificial diet and carrot diet) developed and currently being evaluated by Sugar Research Australia for the screening of both conventional and novel insecticide products, including both chemical and biorational formulations, against laboratory reared canegrubs. Preliminary results on the effects of the tested products on mortality, weight gain/loss and effect on pupae using a carrot diet bioassay are presented. Further studies on alternatives to imidacloprid are currently being conducted.

**Bhuiyan**

## **Temporal development of smut, yield loss, and integrated management strategies using a fungicide and varietal resistance (Extended abstract)**

**SA Bhuiyan**

*Sugar Research Australia Limited, 90 Old Cove Road, Woodford, Qld 4514, Australia; sbhuiyan@sugarresearch.com.au*

**Bradshaw and Scardamaglia**

## **Working together to achieve a sustainable outcome for the sugar industry and environment**

**Carola Bradshaw and Frank Scardamaglia**

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Changes in the agriculture sector can be challenging to achieve, especially with changing regulations and requirements. Finding the balance between environmental sustainability and maintaining a profitable industry is the key to achieving collaboration to ensure lasting change. The Lower Herbert Water Quality Program (LHWQP) has proven that farming practices and improved land management are positively affecting growers' bottom lines, the local economy and are having a significant impact on the end of catchment pollution load. This paper outlines the correlation of trusting relationships between industry experts, peer-to-peer groups and growers to achieve sustainable practice changes in the sugar industry in the Lower Herbert and the impact the LHWQP has had on the region.



**Broadfoot**

## **Potential major changes in process control of Australian sugar factories**

**R Broadfoot**

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While Australian sugar factories operate with high levels of automation and have fewer supervisory and operational staff than most overseas cane factories, it is anticipated that substantial changes in the configuration of control systems will be implemented in Australian factories over the next decade that will further reduce operational staff numbers. Factors driving these changes include the current high turnover of operational staff, the need for increased reliability in factory operations, and the increased complexity of operations when factories substantially reduce their process steam consumption. Several factories are discussing changing from the current DCS control operated at local stations, to a centralised control operation. In order to support this change, new measurement systems of the hard and soft type are required to provide improved consistency in achieving the standard operating conditions and to support reduced input from operators. The changes also extend to using supervisory control systems to recommend process decisions to supervisors and to input set points for control loops. Substantially increased data analyses of process operations are likely to be implemented to support the small production management team in reviewing the efficiencies of current operations and identifying areas for improved process settings. Changes to the current training of operational staff will be required. This paper considers the changes needed in the process stations of the factory to support a successful adoption of centralised control. The overall aim is to substantially improve the productivity, recovery and sugar quality, reduce lost time resulting from operator error, and assist the adoption of substantially increased steam efficiency to support diversified production.

**Broadfoot, Fraga**

## **Guidelines for cost-effectively improving sugar recovery from C massecuite cooling crystallisers**

**R Broadfoot and G Fraga**

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The cooling crystalliser station is often a neglected area for capital investment even though a modest reduction in molasses purity from pan drop to final molasses of 5 units increases sugar recovery for the factory by more than 2%. Presently, for some factories, major investments in upgrading crystalliser stations may be considered to be high risk due to uncertainties whether the stations may become redundant should B molasses be used for alcohol production. This paper reviews the influence of the main process conditions on exhaustion performance in cooling crystallisers through the application of an upgraded SRI model of cooling crystallisation. The main findings are the importance of producing C massecuites in the purity range 62 to 68 purity, achieving strong exhaustion in the pan drop massecuite and applying higher shear rate in the first 8 h or so of cooling crystallisation. Cooling of C massecuites is essential to limit sucrose loss (and loss of fermentables) through the Maillard reaction. For factories having only short residence times in the cooling crystallisers, the sugar recovery is strongly dependent on the pan drop composition and the process conditions in the cooling crystallisers. The use of higher rotational speeds in the early stages of cooling crystallisation provides a strong benefit to sugar recovery through improved exhaustion and reduced sucrose losses through faster cooling and reduced impact of the Maillard reaction.

**Chung, Jardine**

## **Cane railway track: inspection methodology and best practice**

**David Chung and John Jardine**

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Wilmar Sugar, as a part of its standardisation efforts, investigated the methods and practices used to inspect cane railway track. These have evolved over the last ~10 years aiming at industry best practice

across the eight individual cane railway networks that Wilmar owns and maintains. The experiences and lessons learnt over the last ~10 years regarding the methodology adopted in executing track inspections are presented. Condition scoring thresholds were developed to standardise ratings among the rail networks. The ASMC Guideline for Track and Civil Infrastructure Design and Maintenance Practices provides an adequate foundation for identifying defects and developing/accepting priority thresholds. Walking inspections provide an adequate level of detail to report on the health of the cane railway. A condition heat map is a suitable tool to understand at a high level, the overall performance of the track. Track condition is divided into seven categories (rail, joints, sleepers, fasteners, ballast, track profile, and geometry), each of which is assigned a condition score by a suitably trained track inspector. Identifying and prioritising track defects occur concurrently with the condition inspection and the process is an adequate way ensuring operational security and safety.

**Emtia et al.**

## **Review of soldier flies in sugarcane and identification of some key research gaps**

**C Emtia<sup>1</sup>, SA Bawa<sup>1</sup>, H Farnan<sup>1</sup> and KS Powell<sup>2</sup>**

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Soldier flies (*Inopus* spp.) (Diptera: Stratiomyidae) feed on the root system of sugarcane and in some cane-growing regions of Australia, especially Central and Southern Queensland, are considered an economic pest complex. Past studies and some current research gaps for sugarcane soldier flies are presented. Low numbers of soldier fly larvae can cause significant damage to sugarcane due to their ability to cause poor ratooning that ultimately leads to poor growth and reduced yield. Soldier flies have a complex life cycle of up to 2 years, unpredictable outbreaks, relatively uncharacterised varietal choice, and patchy distribution. These factors make research activities and management options challenging. Most studies on the biology, ecology and control approaches for soldier fly have focused on a single species *I. rubriceps*, even though a further species *I. flavus* is also known to attack sugarcane. These studies are reviewed here. However, there are at least five major genetic groups of soldier fly in Queensland cane fields and at least a further four uncharacterised species. Their geographical distribution and relative economic significance in terms of crop damage across regions have not been determined. This diversity of soldier flies highlights the need to further improve knowledge on the biology, genetic diversity, and ecology of these insect pests, and insufficient baseline information on the soldier fly complex is a potential barrier for development of targeted control methods. Currently, only cultural practices for control of soldier flies are recommended, and reports of infested localities are increasing. Hence, new approaches to research are required. One new approach is the development of an *in vitro* rearing method using an artificial diet for sugarcane soldier fly larvae to compare the nutritional requirements of species, which would inform varietal selection. Development of a rearing methods is also a prerequisite to establish rapid screening of pesticides, including chemical and biorational options, against healthy soldier fly larvae in the laboratory prior to field trials and varietal screening. A new research approach, focusing on the development of an artificial diet and characterising species distribution, is outlined.

**Fillols**

## **Post-emergent control of balsam pear**

**EF Fillols**

*Sugar Research Australia Limited, Meringa, Qld; efillols@sugarresearch.com.au*

Balsam pear (*Momordica charianta*) is an invasive climbing vine found in sugarcane fields from Daintree to Mackay. It is particularly effective at smothering the cane, competing for sunlight and lodging the crop. Growers have been using different combinations of synthetic auxin mixtures to try and control it with variable success. Three pot trials were established to identify which synthetic auxins and mixtures are the most effective as a post-emergent control. Replicated comparisons of up to 25 mixtures showed that:

- A mixture of fluroxypyr at 260 g a.i./ha and dicamba was an effective control method that achieved 83% plant mortality. This mixture, not currently subject to buffer zone restrictions, can be boom applied from the ground or by air.
- The addition of picloram to the previous mixture seemed to enhance the control of balsam pear, but mixtures with picloram require 2,4-D as an obligatory mixing partner, and sicklepod presence in the

sprayed cane block is necessary as picloram is only registered in cane for the specific control of sicklepod.

- A mixture of fluroxypyr at 260 g a.i./ha and Dropzone also resulted in 83% mortality of balsam pear and full control of red and pink convolvulus vines. This mixture can be boom applied from the ground or by air, but it is subject to mandatory downwind buffer zones.

Effective auxin mixtures for the control of balsam pear were identified and specific label requirements associated with each mixture are highlighted.

**Fraga et al.**

## **Use of dry substance as the process variable to control massecuite concentration during pan boiling**

**G Fraga<sup>1</sup>, B Lavarack<sup>2</sup>, R Broadfoot<sup>1</sup> and A White<sup>2</sup>**

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Australian sugar factories almost universally use the measurement of massecuite conductivity to characterise the concentration of massecuite during sugar boiling. While the conductivity method is cheap and effective, the signal is adversely affected by the conductance of the impurities present in the mother molasses. Ideally, an effective, more absolute measurement system could be used which would be subject to less variation with cane quality and would be suitable for tighter control of pan boiling operations. A MicroPolar Brix LB 565 (microwave) transducer (Berthold, Germany) was installed in Pan 9 at Farleigh Mill. Pan 9 is a stirred pan (194 t) with a new honeycomb calandria and processes high grade seed and A massecuites. The microwave transducer determines the concentration of water in the massecuite and was calibrated with respect to dry substance (by atmospheric oven drying), the usual method employed at Farleigh. Relationships among refractometer brix, dry substance by atmospheric oven drying and dry substance by vacuum oven drying were developed. The analyses indicate that the instrument is simple to calibrate and use. The investigations focused on assessing: (i) the accuracy of the calibrated transducer against massecuite samples collected from a sampler installed adjacent to it, (ii) the sensitivity of measurements with respect to changes in the process conditions, and (iii) the suitability of the signal to replace conductivity to control the massecuite concentration in pans.

**Gilberd et al.**

## **A clarifier scraper design to minimise nuisance lifting**

**J Gilberd<sup>1</sup>, P Birch<sup>1</sup> and H Bakir<sup>2</sup>**

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<sup>2</sup>Queensland University of Technology; hakan.bakir@qut.edu.au

A new Short Retention Time (SRT) juice clarifier was installed and commissioned in the 2023 season. The mud scrapers on this type of clarifier have been reported to lift in previous installations while under normal mud loading and conditions. Mud scraper lifting under normal conditions can result in several performance issues including mud holding up and 'rat-holing' of juice through the mud outlet. Reports on previous instances of scraper lift resulted in failure of the scraper support hanger due to the change in forces exerted on the hangers when the scraper is in a more horizontal position. As part of the design of this new clarifier, an approach to design the scrapers to prevent lifting was developed. The approach involves understanding previous installations and developing heuristics based on these as well as developing a method of calculating the resulting force exerted on the scraper face by the mud. This approach complements existing scraper design methods which are typically based on mud volume movement caused by the scrapers moving mud towards the outlet of the clarifier. This work provides heuristics that can be used to better design mud scrapers for SRT juice clarifiers.

**Green et al.**

## **Long-term effects of gypsum on the chemistry of sodic soils under sugarcane (Extended abstract)**

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**Green et al.**

## **Removal of carbon dioxide via enhanced weathering of sugarcane mill ash under different soil conditions (Extended abstract)**

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**Halpin et al.**

## **Soybean and peanut rotations benefit sugarcane production in the Burdekin**

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The inclusion of complimentary rotational cash crops in the sugarcane production system offers an opportunity to improve soil health, productivity and profitability. This has been successfully demonstrated in the Bundaberg region. However, in the Burdekin region, there are concerns that growing a soybean or peanut crop in the traditional fallow period may adversely impact sugarcane productivity and profitability due to delays in planting the following sugarcane plant crop. To better understand the impact of soybean and peanut rotations on soil health, sugarcane productivity and gross margins in the Burdekin, a replicated and randomised strip trial comprising three different fallow management treatments (bare, soybeans, peanuts) was established in the Delta area after harvesting the final ratoon crop in 2019. Three nitrogen (N) rate treatments were then applied to the sugarcane plant crop in 2020 to the corresponding soybean (60, 115, 170 kg N/ha) and peanut (40, 105, 170 kg N/ha) treatment areas. Soybean and peanut rotations improved key soil health indicators and sugarcane root-system parameters compared to a bare fallow. The soybean and peanut rotations also contributed to higher gross margins, suggesting that soybean and peanut rotations could be a valuable addition to the sugarcane production system in the Burdekin region.

**Halpin et al.**

## **The 'best' legume rotation for southern cane growers**

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Grain legume rotations on sugarcane farms have become well established in the Bundaberg/Isis/Maryborough cane supply districts, as a result of RDE efforts of the Sugar Yield Decline Joint Venture. However, sugarcane growers wanted information on what was the "best" legume to grow in rotation with sugarcane. Two separate projects with funding support from both the Grains and Sugar industry with a grower/advisor steering committee implemented a field trial to evaluate the performance of different varieties of peanut, soybean and mungbean along with pigeon pea, traditional cowpea and bare fallow options. These rotation options were then assessed to determine the effect on the productivity of the subsequent sugarcane crop. A cane monoculture treatment was also maintained to provide a reference. The data from this experiment demonstrated that soybean and peanuts were valuable rotation options that boosted grower profitability and productivity of the subsequent sugarcane crop. The trial also highlighted the potential of pigeon pea as a rotation option. Red Caloona cowpea was the 'best' legume in terms of nitrogen contribution, but this did not translate into the best productivity of the subsequent sugarcane crop. Whilst the peanut rotation provided the 'best' profitability, by the end of the first ratoon, A6785 soybean rotation provided the 'best' cumulative cane yield. All legume rotations significantly reduced root lesion nematode populations when measured 6 months after cane establishment. The poor performance of sugarcane grown after Onyx mungbean was probably reflective of the high numbers of root knot nematodes that proliferated on that crop. A sugarcane monoculture had the lowest productivity and the lowest gross margin in the plant-cane phase. Data collected from this experiment suggests that growers would benefit from a legume decision support tool to better assist growers in making profitable farming system decisions.

**Headon et al.**

## **Growers reduce uncertainty around adjusting nitrogen rates following legume cover crops in the Murray district**

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The SIX EASY STEPS® Toolbox provides guidelines for estimating the amount of nitrogen (N) contained in legume cover crops and refining plant-cane N rates after a legume break crop. However, grower uncertainty remains regarding the appropriate adjustment to make to plant-cane fertiliser N rates. Six growers from the Murray subdistrict of the Tully mill area measured changes in soil mineral N across seven sites over the 2022/2023 growing season to better understand how plant-cane N rates could be adjusted following a legume cover crop without adversely affecting productivity. Sites varied by location, soil type, legume cover crop species, planting date and the amount of N fertiliser applied at planting. Most sites had a plant-cane N requirement of 120 kg N/ha (for a bare fallow) according to SIX EASY STEPS® guidelines for the Wet Tropics region. The amount of N applied at planting ranged from 24 to 61 kg N/ha. The mean values of total soil mineral N ranged from 10 to 365 kg N/ha in the row shoulder over the season. Sharing the mineral N results with the participating growers gave them confidence to not to apply additional N fertiliser at top-dressing. Crop N uptake was not restricted during the growing season because of this decision. Third-leaf samples collected from all sites confirmed N concentrations (% dry matter) were above the critical value and indicated the crops were not N deficient.

**Holden et al.**

## **Removal of carbon dioxide through enhanced weathering of basalt in acidic soils under sugarcane**

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Enhanced weathering (EW) of silicate rocks like basalt offers a potential negative emissions or carbon dioxide removal (CDR) technology in society's efforts to combat climate change. Modelling suggests that significant CDR via EW, but this requires field verification. This study aimed to quantify CDR through EW of basalt applied to sugarcane and determine co-benefits. The experimental site had received five basalt applications of 0 or 50 t ha<sup>-1</sup>y<sup>-1</sup> since 2018 and a 0 or 2.5 t ha<sup>-1</sup> lime application in 2022, creating a split-plot design for this study. Drainage fluxmeters (DFMs) were installed beneath the root zone to capture leachate during the 2022/23 wet season, and leachate bicarbonate (HCO<sub>3</sub><sup>-</sup>) flux was measured to quantify CDR. Cumulative HCO<sub>3</sub><sup>-</sup> flux was not significantly influenced by basalt ( $F(1, 12) = 0.713$ ,  $p = 0.415$ ) or lime ( $F(1, 12) = 0.505$ ,  $p = 0.491$ ) or their interaction. All CDR values were small compared to potential HCO<sub>3</sub><sup>-</sup> generation from carbonic acid weathering of the basalt. The discrepancy was attributed to preferential weathering by stronger acids, and consumption of HCO<sub>3</sub><sup>-</sup> in this acidic soil. There was elevated production of nitric and organic acids in the row, where cumulative HCO<sub>3</sub><sup>-</sup> was significantly lower than in the inter-row ( $p < 0.026$ ). This relationship was consistent with fertiliser application (and associated nitrification), and microbial activity and plant root exudation beneath sugarcane in the row. Results suggest pH of acidic soils may need to be raised to achieve CDR through EW. There was no significant effect of basalt on cane yield, but commercial cane sugar content increased slightly. Although basalt application did not lead to significant CDR in the field, the neutralising effect of basalt in acidic soils, and increased nutrient availability are beneficial.

**Jenssen, Broadfoot**

## **Measured and predicted consistency values for C massecuite**

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Wilmar considered replacing the non-functioning crystalliser and reheater station at Kalamia Mill with a single BMA Oscillating Vertical Crystalliser (OVC) as part of the 2023 capital program. This OVC would be the first one in Australia. Modelling, consistency measurements and predictions of exhaustion performance were carried out in the 2022 crushing season to determine the relevant functional specifications to aid with the design of a new station. The rheology of C massecuites has a strong influence on the practical exhaustion that can be achieved and on the mechanical design requirements for the equipment and pipework. It was intended to utilise correlations from literature for determining the expected consistencies of the OVC feed and discharge. To verify the suitability of using these correlations, the consistencies of pan drop massecuites and fugal feed massecuites were measured and compared to the predicted values obtained from the correlations. The assessments were compared against two correlations. One correlation provided a reasonable match, with an average agreement to the measured values of -12%. The other correlation provided larger and more variable differences between the measured and predicted consistencies. Further work to upgrade the correlations for low grade massecuite consistency would be beneficial for all investigations related to C massecuite processing.

**Kent et al.**

## **Automating the handling of soft canes through the factory**

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In recent years, concerns have been raised that many cane 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 content causing subsequent combustion issues and low steam pressure at the boiler station. Experiments were carried out at Isis Central Mill to understand and improve the processing of existing soft cane varieties, including the characterisation of the physical properties of prepared cane using a pilot sized shredder (2019), factory milling train experiments (2020) adjusting shredder speed, added water temperature and added water rate, followed in 2021 by additions to the milling train control system to provide automated soft cane processing as well as the installation of an electro-mechanical shredder grid door actuator. This paper describes results obtained during the 2022 crushing season in which the automated control strategy to manage the processing of soft canes was introduced. The control strategy involving adjustments to three parameters: shredder speed, shredder grid door position and maceration water flow rate. An experiment comparing the results of the automated system to the manual alternative concluded that the operation of the automated soft cane control system assisted in the processing of the soft cane varieties although the relatively small amount of soft cane in the cane supply was not sufficient to provide definitive results.

**Larsen et al.**

## **Nutrient content after the application of mill by-products and implications for nutrient management**

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Mill by-products such as Mud, Ash and Mud/Ash mixtures are known to increase cane yield and sugar yield. Australian growers broadcast and band these by-products in the fallow at rates greater than 150 t/ha and less than 100 t/ha, respectively. Eight commercial-size replicated, randomised strip trials were established in bare fallows between Ingham and Proserpine to investigate the impact of by-products banded between 35-100 t/ha and broadcast between 140-200 t/ha on crop nutrient uptake and accumulation compared to standard grower fallow practices. The trials were harvested each year over the crop cycle using a commercial harvester. Plant material was collected from the harvested cane supply and analysed for nutrient content. The application of Mud, Mud/Ash and Ash resulted in the luxurious accumulation of nitrogen (N), phosphorus (P), potassium (K), sulphur (S), calcium (Ca) and magnesium (Mg) in the cane supply. The application of Mud, Mud/Ash and Ash increased N, Ca and Mg in the crop with Mud > Mud/Ash >> Ash. Similarly, P increased in the crop with Mud >= Mud/Ash >> Ash. Crop K and S also increased after the application of mill by-products, however Ash > Mud/Ash >> Mud. The results from this study should be used to revise the SIX EASY STEPS® nutrient management program guidelines for reducing macronutrient fertiliser rates after the application of mill by-products, to ensure excess nutrients are not applied to sugarcane crops that might have both agronomic and economic consequences for growers.

Li *et al.*

## **Carbon nanodots as novel fungicides for driving disease prevention in sugarcane (Extended abstract)**

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Lochner and Quirk

## **Pricing impacts and rationale for transitions in sugarcane farming in northern New South Wales and Queensland: a conversation starter**

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On-farm diversification is often used as a risk mitigation strategy for agricultural producers, offering opportunities for increased soil fertility, engagement in new markets and decreasing risk related to crop loss. The correlation between price data and on-farm crop diversification in Mackay, Queensland and Northern New South Wales regions is analysed. Interview data are used to better understand how diversification to macadamia orchards interacts with sugarcane farming, and to investigate other constraints that might drive farmers to diversify. While there appears to be low statistical correlation between sugar and macadamia farming, there remains strong anecdotal evidence to suggest diversification. By analysing the relationship between price data and opportunities for diversification in these regions, insights are generated into factors driving agricultural industry transitions and futures for the sugar industry, prompting discussion for how the cane industry will respond to other opportunities in the future.

Mann, Broadfoot

## **Effect of factory reliability on bagasse usage and surplus**

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Poor factory reliability increases season length, reduces sugar production and reduces the supply of bagasse available for cogeneration and the production of by-products. The financial justification for capital expenditure, maintenance and control system upgrades usually account for the extended season length and lost sugar production associated with stoppages. However, the extra bagasse use due to stoppages is often harder to quantify, and, therefore, the resulting financial consequences are often not considered. This work attempts to quantify the effects of stoppages on bagasse use in factories so that the true costs of factory stoppages can be more accurately determined. Factory data have been used to predict the effects of long and short factory stops on bagasse consumption and surpluses. Calculations were carried out for a factory data set with a relatively small number of short stops and a factory data set with a large number of short stops. For both data sets, far more bagasse was lost due to short stops than long stops, and the quantity of bagasse consumed due to short stops represents a significant loss of revenue. Stops disrupt and increase the bagasse consumption of the boiler station in ways that are difficult to model, so it is likely that the calculations in this work underestimate the bagasse consumption and, therefore, revenue lost due to stops.



**Magarey**

## **The BSES yield decline program: foundational research into soil factors affecting root health in the Australian sugarcane industry**

**RC Magarey**

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The loss of productivity associated with continuous sugarcane monoculture has long been recognised in the Australian sugarcane industry, but a lack of industry focus meant that little work was undertaken in earlier days to explore the causal factors. This situation changed with the development of a major root rot complex in far-north Queensland associated with the widespread cultivation of the productive variety Q90. Widespread stool tipping, poor yields, associated poor root growth with pronounced rotting of the primary roots led to a sharp industry response. Resources were mobilised, external experts engaged and a research program developed seeking to identify the most important factors involved. This paper outlines the research conducted by BSES and the main industry outcomes resulting.

**Marcelo et al.**

## **Revised design of signal poles used at active level crossings of cane railways**

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Wilmar Sugar recently initiated an engineering review process that led to a revised design of the poles used at their active level crossings signals. This review was instigated after a few recent premature failures of poles at their maintenance hinge. The review's objectives were to understand the failure mechanism of these observed failures as well as use the opportunity to obtain an independent mechanical and structural review of Wilmar's standard documented pole design, a legacy design that had been modified over time. These targeted objectives of the review were achieved. The review highlighted a number of non-compliance issues with the current standards and resultantly the design was revisited. By engaging with maintainers during the redesign process, opportunities to improve maintainer safety, productivity and roadway availability were identified and considered within the new design developed. The key features of the re-designed pole include a change in the construction material, the relocation of the maintenance hinge to a more optimized location, and the addition of facilities for the use of a chain block as a mechanical aid to assist maintainers with lifting and lowering the pole safely. The new pole design is ready for prototyping and validation. Once the final construction details have been validated with the prototype, the new design will be installed at two of Proserpine Sugar Mill's level crossings along two main highways. This will see the realization of the achieved improvements at two high-risk active level crossings from the 2024 sugarcane processing season onwards.

**Matsueda et al.**

## **Modelling the integration of bagasse pyrolysis into sugar mill energy systems**

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Pyrolysis degrades biomass under low oxygen conditions to produce an energy-rich gas, bio-oil, and carbon-dense biochar. The resulting bio-oil and gas can be combusted for high energy production while biochar is a high value product with potential as a fertiliser and soil amendment product. However, there have been very few studies on integrating pyrolysis into the sugar mill energy system. This study aimed to model the integration of bagasse pyrolysis into an energy system based on Victoria Mill. The model was well-validated from previous literature on bagasse pyrolysis and mill system data. The pyrolysis unit's operating conditions were optimised for steam production, carbon emission reduction and product value,

resulting in 20% less steam production, but 16% reduced CO<sub>2</sub> emissions and 76% higher economic profit compared to current operations. Full steam production could be maintained by bypassing 30% of the bagasse to the pyrolysis unit and 70% directly to the boiler. This configuration led to 12% reduced CO<sub>2</sub> emissions and 32% greater economic profits when compared to the current process. Overall, this research showed that the integration of bagasse pyrolysis into sugar mill energy systems has potentially substantial benefits and its adoption into sugar milling deserves careful analysis.

**Milla, Magarey**

## **Extension and RSD management in the Burdekin: challenges and successes**

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Historically, the Burdekin sugar industry has had low levels of Ratoon Stunting Disease (RSD). However, from 2019 RSD levels started to increase on farms and then was detected on approved seed cane plots. Burdekin Productivity Services (BPS) staff, along with support from Sugar Research Australia (SRA) pathology staff, investigated the scale of the issue along with factors affecting transmission of RSD. Following this, a strategic plan was developed and implemented to manage the increase in RSD. This paper discusses the actions undertaken and results achieved. In 2023, no positive results to RSD on approved seed cane plots were found after extensive sampling, and there has been an apparent decrease of RSD on farms across the region.

**Qureshi, Ghazanfar**

## **The journey towards sustainable business through technological advancement and diversification into the downstream industry: a role model in the Pakistan sugar industry**

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Pakistan's sugar industry is going through a difficult time of survival due to the high price of sugarcane, low sugar content in cane, low price of sugar, strict control by the government, and environmental regulations. This situation has forced Sheikhoo Sugar Mills to adopt new technology, to increase efficiency, reduce the cost of production, and diversify into an allied industry using the advantage of the core business and increase revenues/net profits. The processing technology was changed by incorporating IPRO (Industrieprojekt) GmbH Germany designs and recommendations and replacing existing evaporators with falling-film evaporator (FFE) technology. Full automation based on a distributed control system (DCS) at the raw and refinery pans reduced water consumption, thereby providing steam and bagasse savings. Improvements in sugar quality, Eaton filters, and a new pharma-grade refined sugar line were also added. The old boilers and turbogenerators were replaced with a high-pressure system and a downstream steel plant was installed. High sucrose, high-yielding varieties were cultivated. Sugar recovery increased; the cost of production was reduced, and 70% of the production was premium grade. Steam on cane was reduced to 35%, and bagasse savings of around 191,000 t allowed the operation of the steel plant for 300 days. Efficient CMD gears and VFDs resulted in power savings of around 30%. High efficiency, high-pressure boilers, and turbogenerators vastly improved the economics of the steel plant operation. This not only saved bagasse due to the high efficiency of boilers but provided surplus power of 21 MW for steel production for 300 days.

Rahimi Azghadi *et al.*

## Precise robotic spot-spraying of weeds for improved environmental and economic outcomes in the sugarcane industry

**Mostafa Rahimi Azghadi<sup>1,2</sup>, Alex Olsen<sup>3</sup>, Alzayat Saleh<sup>1,2</sup>, Jake Wood<sup>3</sup>, Terry Granshaw<sup>4</sup>, Emilie Fillols<sup>4</sup> and Bronson Philippa<sup>1,2</sup>**

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The outcomes of an innovative project, funded by the partnership between the Australian Government's Reef Trust and the Great Barrier Reef Foundation, aimed at enhancing water quality in reef catchments and reducing input costs for sugarcane farmers, are presented. Our robotic spot spraying tool, AutoWeed, utilises artificial intelligence and computer vision technology to significantly decrease herbicide usage on sugarcane farms. Field trials comparing AutoWeed to industry standard broadcast spraying demonstrate its effectiveness, with a 97% efficacy and a 35% reduction in herbicide use, proportional to weed density, on 25 ha across six trials. Moreover, AutoWeed spot spraying shows a 39% reduction in herbicide concentration and a 54% reduction in herbicide load in irrigation runoff 3-6 days after spraying compared to broadcast spraying. These findings highlight the potential of AutoWeed to curtail herbicide use on sugarcane farms while maintaining effective weed control and fostering sustained water-quality benefits.

Renouf *et al.*

## Life cycle assessment of greenhouse gas emissions from changes in cane-growing practices

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The most effective practice changes for reducing life cycle greenhouse gas (GHG) emissions from sugarcane growing in Queensland were identified. GHG emission intensity per tonne harvested cane in three regions (Central, Burdekin and Wet Tropics) were calculated using the CaneLCA tool for a range of practice change scenarios relative to a current base case. As expected, more efficient use of nitrogen (N) was the biggest emissions saver, potentially increased further by enhanced efficiency fertilisers (EEF) if any associated reductions in N rates do not compromise yields. In cases where water application rates or pumping head pressures are high, improved irrigation efficiency could be a similarly significant source of emission savings. Modest reductions can confidently be achieved from the adoption of wider row spacings (which reduces both tractor and harvester fuel use) and reduced tillage (which reduces tractor fuel use). Varying the amounts of herbicides applied had little impact on GHG emissions. The scale of potential emissions reductions was considered relative to those that have already occurred. A retrospective analysis (for the Wet Tropics region) showed that emissions intensity has already declined by about 30% as side effect of best management practice adoption to date for water quality protection, which is likely reflected across the state. This study suggests that if all the assessed tried and tested practice changes were adopted to a conservative extent (not including N rate reduction with use of EEF) further emission reductions of 13-16% may be possible relative to current practices.

**Salter**

## **Impact of long-term trash blanketing and tillage prior to planting on soil carbon and sugarcane production**

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Green cane trash blanketing (GCTB) has been widely adopted in the Australian industry for more than 30 years. Trash contributes significant quantities of dry matter and carbon to the soil and this organic input is expected to improve sugarcane soil condition over the longer term. Understanding whether this has occurred is important as sequestering carbon in the soil is part of the Australian Government's plan to achieve net zero greenhouse gas emissions by 2050 and soil carbon is a key component of a healthy soil. A new sugarcane crop cycle was established at the long-term trash blanketing trial site at Mackay. Two minimum tillage treatments, bed renovation plus wavy disc (BRWD) and wavy disc only (WD), were imposed in order to evaluate their effect on productivity and soil C dynamics. Soil total C and total N, organic C (Walkey Black), total organic C (Heanes) and potassium permanganate oxidisable C (PPOC), were all measured prior to crop establishment and during the crop cycle. Soil C concentrations and stocks, apart from PPOC in the top two centimetres of soil, were either unchanged or higher in the burnt than the GCTB system. Sugarcane and sugar yield were significantly higher in the GCTB system in the first-ratoon crop, but not in the plant and second-ratoon crops. The BRWD tillage treatment produced significantly higher yields than WD. Soil in the WD system remained hard and compacted from the previous crop cycle. The lack of soil C accumulation under GCTB after three decades at the Mackay long-term site suggests that new approaches to trash management should be investigated.

**Schembri *et al.***

## **Nutrients and pesticides in end-of-paddock run-off water for farming practices in the Central region**

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Results from end-of-paddock run-off water quality monitoring conducted in the Central region are presented. By measuring nutrient and pesticide concentrations in run-off leaving the paddocks, we aimed to identify farming practices with reduced environmental footprints. This knowledge can be used by growers and advisors to select farming practices that are less harmful for the environment, specifically local waterways and the Great Barrier Reef lagoon. Three trial sites were implemented in the 2022/2023 growing season. Each trial was designed as a strip trial, with treatments replicated two or three times. At each site, nutrient and pesticide concentrations in run-off were monitored over the wet season. Side dress application of liquid imidacloprid in ratoons appeared to reduce imidacloprid load leaving the paddock as compared to stool split application. Liquid imidacloprid and granular slow release imidacloprid applied at fill-in stage of a plant cane crop showed similar imidacloprid losses in run-off water leaving the paddock. DIN run-off losses for an Enhanced Efficiency Fertiliser (EEF) compared to a sub-surface applied liquid fertiliser were lower at the first run-off event, but higher at subsequent run-off events. Banded mill mud increased the run-off of isoxaflutole and amicarbazone compared to where no mill mud had been applied, where the herbicides had been applied above the banded mill mud. Placing the herbicides beneath the banded mill mud appeared to further increase the run-off losses of the two residual herbicides.

Schroeder

## Will the Australian sugarcane industry's current agricultural R&D enable the next 'step change'?

**BL Schroeder**

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Making progress is dependent on continued improvement in skills. This is particularly relevant in the agricultural research and development (R&D) that are prerequisites for ensuing ongoing advances in industries such as the sugarcane in Australia. This paper provides a viewpoint on: (i) how agricultural R&D activities have changed within the Australian sugar industry over the past century, and (ii) how well-placed agricultural R&D is to support a future step-change in Australian sugarcane. Information was obtained from historical sources and the *Proceedings of the Queensland/Australian Society of Sugar Cane Technologists (Q/ASSCT)* to determine progress in sugarcane agriculture RD&E from 1930 to 2023. An analysis of trends enabled conclusions to be drawn about the scope and process of agricultural R&D to date. Agricultural R&D activities, as represented by the numbers of papers delivered at Q/ASSCT conferences, have declined markedly during the recent past. This is despite evidence that progress in sugarcane production, supported by R&D, is still occurring internationally. Based on the evidence provided here, it appears unlikely that the Australian sugarcane industry's current agricultural R&D will be able to support the next 'step change' in sugarcane agriculture. There is a need to reinvigorate the tenacity and commitment of the early industry and develop industry-focused researchers that are dedicated to contributing to a bold and bright future for our crop

**Schroeder et al.**

## Are urea-based enhanced-efficiency fertilisers widely appropriate for reducing nitrogen application rates in sugarcane production?

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Possible reductions in nitrogen (N) application rates using urea-based enhanced-efficiency fertilisers (EEFs) have recently been highlighted within the Queensland sugar industry. It was suggested that these commercially available products provide growers with an ability to reduce their N inputs and improve N-use efficiency (NUE) without negatively affecting on-farm productivity and/or profitability. This paper reports on the results of an investigation conducted in the Herbert district during the period 2015–2020. The aim was to assess the efficacy of two EEFs and standard urea on N-uptake, and cane and sugar yields over a crop cycle. The plant crop was harvested in 2016 and the four ensuing ratoons were harvested in 2017–2020. The EEF formulations were urea coated with a nitrification inhibitor 3,4-dimethylpyrazole phosphate (DMPP-urea) and poly-coated urea (PC-urea). The trial site was located on a clay soil with a soil organic carbon (Org C) content of 2.15% in a poorly-drained position subject to seasonally high water-tables and/or persistently wet conditions. Such conditions had previously been identified as particularly appropriate for EEFs to enhance NUE and productivity when denitrification losses could be expected. Seasonal climatic conditions varied markedly during the trial period contributing to overall yield differences among the ratoons. In the relatively dry 2017/18 season, the highest mean yield was 113 t cane/ha. In contrast only 63 t cane/ha (determined as biomass) was achieved in 2018/19 which was a particularly wet season. The SIX EASY STEPS N guideline (110 kg N/ha) for ratoon cane grown on a soil with 2.0-2.4% Org C was confirmed as generally applicable per season. Despite significant N-uptake and yield responses to applied N in the ratoon crops, use of EEFs did not contribute to improved yields compared to each other or standard urea at the same rate. At the site, reducing N rates below the SIX EASY STEPS guideline, irrespective of the N-formulation used, would adversely affect yield within seasons and across the crop cycle. Although EEFs may provide an opportunity for improved environmental stewardship through improved NUE in some circumstances, they should not be considered an appropriate mechanism for systematically reducing the amount of N applied. Such uses of EEFs could put the industry at risk of possible losses in on-farm productivity and/or profitability, cane supply, and mill throughput and viability.

**Shephard *et al.***

## **Impact of heat-transfer surface film on heat-transfer rate in evaporators**

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The sugar industry is constantly examining methods to improve the efficiency of the sugar manufacturing process, particularly in the evaporation phase due to its particularly high demand for thermal energy. This phase uses multi-effect Robert-Type Evaporators that are vertical tube-bundle crossflow heat exchangers that condense steam on the heat-transfer tubes and transfer heat into the sugar juice. This paper presents results obtained from a single-tube apparatus scaled down from a Robert-Type Evaporator. The effect of applying three different chemical films (NALCO-2857, Powerfilm 10000, and Powerfilm 15000) on heat-transfer tubes to produce improvements on the heat transfer efficiency was investigated. The results were compared with a control tube to determine the magnitude these chemical applications have on the condensation heat transfer over a set range of conditions and compared with theoretical calculations at the same conditions.

**Skocaj *et al.***

## **Impact on crop performance of application timing of nitrogen fertiliser and interaction with harvest time**

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In the Wet Tropics, fertilisation of early-harvested crops is often delayed as ratoons are slower growing and growers focus on land preparation, sugarcane planting operations and early crop establishment. However, as the harvest season progresses and the risk of experiencing high rainfall increases, fertilisation often occurs immediately behind the harvester. A trial was established on a clay loam soil at Tully to explore the impact of nitrogen (N) fertiliser application timing on a range of crop traits including N uptake, yield, and nitrogen-use efficiency (NUE). Treatments included three different application times (3-, 6- and 8-weeks post-harvest) and four N application rates (0, 80, 130 and 180 kg N/ha). An additional treatment (harvest time) was established in the second-ratoon crop. This allowed the effect of fertiliser application time to be assessed for ratoon crops established at different times of the harvest season (e.g. early versus late). There were statistically significant differences in crop traits associated with N rate and the timing of fertiliser application. For the early-harvested crop, there were no adverse effects on yields or NUE from delaying N fertiliser application up to 8 weeks after harvest. There was no statistically significant difference in yield or crop N uptake for fertiliser application timing in the late-harvested crop. The outcome of this research supports existing grower practices in the Wet Tropics region whereby fertiliser application is often delayed to crops harvested early in the season but applied immediately after harvesting crops ratooned late in the season.

**Southern, Plaza**

## **Modelling the harvester's front end to reduce billet and stool damage: the behaviour of leaves**

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The interactions between harvester front-end components and the cane plant have previously been identified to cause significant damage to the harvested stalk and the remaining stool. Damage to the stool

causes reduced yield in the next return. A simulation of the front-end components of a sugarcane harvester interacting with stalks and leaves was previously developed using the finite element model (FEM) software LS-DYNA. As well as providing visual detail on what is happening in the process, the simulation can predict the forces, stresses, strains and deformations experienced by both the plant and harvester components. Better understanding of these is likely to lead to improved geometry and interactions between the components, leading to improved harvester design and operation. This paper reports on expanding and improving the model's capabilities. In particular, the sugarcane leaves were modified by changing material properties to align with updated published research alongside adjustments to the leaf thickness. The model now describes the behaviour of sugarcane leaves without predicting unrealistic early failure and without a large increase in computational resources. In addition, the cane stalks, including leaves, were made to interact with the crop dividers by adding extra stalks at different degrees of lodging to a revised soil geometry.

**Thaval, Dowling**

## **Performance of the bagasse diffuser at Invicta Sugar Mill**

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The BMA bagasse diffuser installed at Invicta Sugar Mill, Australia has been in operation since 1995. Recently, the performance of the diffuser was assessed and optimised using measured juice percolation velocity for each stage. While percolation velocity is an important parameter in diffuser operation, there are other parameters and factors affecting the performance of the diffuser. An improved model of the diffuser extraction process was developed, which defines the process of the diffuser in three phases. New non-dimensionless performance indicators were developed, namely mixing factor, percolation factor and diffusion factor. These indicators describe and quantify the different phases of the diffuser extraction process. Using the new model for the diffuser and linking the diffuser extraction model to a mill extraction model, the performance of the entire extraction station was assessed.

**Wallace *et al.***

## **Challenging convention to improve chemistry management of sugar-mill boiler stations**

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Monitoring boiler-system water chemistry is important to maintain boiler assets and protect them from corrosion and scaling. Some traditional techniques developed for standard industrial or power station boilers are not effective for monitoring in sugar mills where process condensates are used as make-up. The process condensate contains a variety of contaminants including ammonia, alcohols, organic acids and occasionally sugar that interfere with some of the commonly used instruments that provide early warning of potentially damaging contamination events. This paper describes the instrumentation installed at Wilmar Sugar Invicta Mill to improve the monitoring of the boiler station chemistry and provide additional insights into potential performance issues, such as boiler carryover in real time.

**Wang et al.**

## **Enhancing efficiency and profitability: the impact of smart irrigation scheduling in sugarcane production systems**

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Reducing excess water for sugarcane irrigation can deliver both economic and environmental benefits. Technologies such as automation can, if used properly, help farmers transition to more efficient irrigation systems, while keeping productivity high and environmental impacts low. We simulated the impacts of technology adoption on irrigation and crop productivity by looking at four irrigation approaches: 1) current practice with no technology assistance; 2) low-level technology using crop modelling for scheduling; 3) medium-level technology using crop modelling for scheduling with some automation, and 4) high-level technology using a fully automated closed-loop irrigation system with sensors for adaptable irrigation. Our findings indicate that incremental technology adoption correlates with significant improvements in resource efficiencies without compromising yield. Notably, the adoption of high-level technology strategies culminates in substantial economic advantages, reaching an estimated \$3,461 /ha in cumulative benefits in 5 years for the simulated farm.

**Waters et al.**

## **Detection of ratoon stunting disease with freely available satellite-based multispectral imaging and machine learning (Extended abstract)**

**Ethan Waters<sup>1,2</sup>, C Chen<sup>1,2</sup>, LP Di Bella<sup>3</sup>, R Nielson<sup>4</sup>, R Harragon<sup>4</sup> and MR Azghadi<sup>1,2</sup>**

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**Wilson, Burke**

## **Introduction of a new Laboratory Information Management System (LIMS)**

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Wilmar Sugar has been capturing laboratory data with paper records and subsequent terminal entry into a server running VMS operating system for the last 30+ years. However, the ability to support and enhance the system has diminished over time due to the age of the hardware and availability of people familiar with these systems. Thus, design and implementation of a new laboratory information management system (LIMS) was proposed. Several off-the-shelf products were assessed, but none was found to be fully fit for purpose. A bespoke system was developed through a collaboration of internal resources and two external software development companies. In addition to replacing existing functionality, the new LIMS provided the following key features: data entry through portable devices; automated workflow and data validation; and data read directly from instruments where possible. This allowed the move towards a paperless laboratory while also avoiding transcription and manual calculation errors. This new system has been implemented and deployed to seven of the eight Wilmar Sugar mills during the 2023 crushing season for cane-payment analyses. Deployment at the final site is planned for the start of the 2024 crushing season with extension of the system to cover factory control analyses to follow.



Zia et al.

## Toxicity of carbon dots to sugarcane and human cells

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Sugarcane is Australia's second largest export crop and generates an annual revenue over \$4 billion. A perennial crop grown along the eastern coast of Queensland and in northeast New South Wales, sugarcane cultivation is impacted by biotic and abiotic stresses. The use of nanomaterials to mitigate these stresses has attracted attention in recent years as they have the potential to provide more sustainable solutions. 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 nanocarrier and nutraceutical material for sugarcane farming. Therefore, evaluation of their toxicity towards sugarcane setts, human cell lines and other agriculture-relevant animals such as bees is imperative for assessing their suitability for agricultural applications. In this study, carbon dots (CD) were synthesized in-house, and different concentrations were applied to sugarcane setts at 10 min dipping times to evaluate their impact on germination, plant height, and biomass four weeks after planting (WAP). Cytotoxicity evaluation using normal human dermal fibroblast (NHDF) cells and MDA-MB-231 breast cancer cells exposed to CD showed no change in cell viability. Overall, the CDs did not exhibit phytotoxicity and cytotoxicity indicating their feasibility for use in sugarcane cultivation.

## Poster papers

### Towards zero effluent in Wilmar's Proserpine mill

TM Badger and DM Kelly

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### Pan condenser performance versus modelled performance

Katja Biggs and Colin McLean

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### Analysis of diffuser juice application at Inkerman Mill

Donald Jennings

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### Potential of UAV imagery and Learning Techniques for determining gaps in sugarcane rows

S Leekar<sup>1,2</sup>, TA Jensen<sup>1</sup>, A Chumpia<sup>1,3</sup> and BL Schroeder<sup>1</sup>

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## **Using hydrotreated vegetable oil (HVO) as a renewable fuel in the Wilmar locomotive fleet**

**Jeshua Mathews**

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## **A suspected Maillard reaction in a continuous C Masecuite pan - findings and outcomes**

**Georgia Nilon and Matthew Richter**

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## **Effect of application of Moddus® on yield of stand-over sugarcane in the Herbert River District in 2023**

**Glen Park**

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## **Retrofitting versus replacement for obsolete remote shunting unit (RSU) systems**

**Alex Philp**

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## **Implications for sugarcane nutrient management following a green-manure crop of sunn hemp**

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## **Supplier's case study**

### **Supersaturation-based control of sugar crystallization**

**Jakab Rózsa and Matej Rukavina**

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