



Sugar Research
Australia®

SUGAR RESEARCH AUSTRALIA LIMITED

PERFORMANCE REPORT

2017/18



(Below) SRA Chairman Dr Ron Swindells and CEO Mr Neil Fisher and Commonwealth Government representatives viewing a rainfall simulation in the Wet Tropics.



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Australian Government
Department of Agriculture
and Water Resources



Queensland
Government

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INTRODUCTION

Sugar Research Australia Limited (SRA) is a sugarcane grower and miller owned company and the declared Industry Services Body for the Australian sugarcane industry under the *Sugar Research and Development Services Act 2013* (Cth). As the declared Industry Services Body, SRA is required to provide and manage research, development and adoption (RD&A) activities, for the benefit of the sugarcane industry and for the wider public good.

SRA invested \$37.7 million in RD&A activity in 2017/18, which was made possible through sugarcane grower and miller levy contributions; Commonwealth and Queensland Government co-investment; and collaborative funding partnerships with other research organisations, industry organisations and agri-businesses.

This investment was guided by SRA's 2013/14 – 2017/18 Strategic Plan and the 2017/18 Annual Operational Plan, that set the key focus areas (KFAs), intended outcomes and performance measures that SRA worked towards during the past year. This Performance Report provides an overview of SRA's performance in delivering on these plans.

The Performance Report is by no means exhaustive but rather provides a selection of SRA's research highlights and performance. This report is a companion document to SRA's 2017/18 Annual Report where significant initiatives, collaborations and corporate governance overviews are provided. In addition, SRA's website and periodical publications, such as *CaneConnection*, *MillingMatters* and electronic newsletters, provide further information on SRA's research portfolio and the impact this research is having on the Australian sugarcane industry.

The Performance Report is presented for the interest of SRA's industry and government investors, our research collaborators and broader stakeholders.

(Right) SRA locations across Northern New South Wales and Queensland



SRA IN 2017/18 SNAPSHOT

88



USERS ENROLLED IN THE NEW LEARNING MANAGEMENT SYSTEM (LMS) FOR SUGAR MILLING OPERATIONS PROVIDING 312 TRAINING COURSES TO DEVELOP MILL OPERATIONS CAPABILITY AND SKILL



\$9.42
MILLION

NET PRESENT VALUE OF THE ECONOMIC BENEFITS TO BE ACCRUED FROM R&D INVESTMENT INTO CHLOROTIC STREAK DISEASE



2.9:1.0

AGGREGATED
RETURN ON RD&A
INVESTMENT



6.8:1.0

RETURN ON INVESTMENT FROM RESEARCH OPTIMISING PRODUCTIVITY THROUGH ANALYSIS OF MILL DATA



43%

OF GROWERS WHO REPORTED PRACTICE IMPROVEMENTS IN 2018 ATTRIBUTE SRA AS AN IMPORTANT SOURCE OF INFORMATION FOR PROMPTING CHANGES

6



NEW VARIETIES RELEASED:
SRA11[Ⓢ], SRA12[Ⓢ], SRA13[Ⓢ],
SRA14[Ⓢ], SRA15[Ⓢ], SRA16[Ⓢ]



92%

SRA'S SCORE IN THE ANNUAL EXTERNAL AUDIT OF THE WORKPLACE HEALTH AND SAFETY (WHS) MANAGEMENT SYSTEM REFLECTING EXCELLENT WHS PRACTICES



24

HARVESTER FEED TRAINS WERE OPTIMISED, REDUCING SUGAR LOSS FOR OPERATORS BY \$70 PER HECTARE



11,400

HECTARES OF CANE LAND MANAGEMENT CHANGED IN ACCORDANCE WITH CHEMICAL BEST MANAGEMENT PRACTICE IN THE WET TROPICS REGION FOLLOWING INVOLVEMENT IN SRA'S ADOPTION PROJECT 2016/002



7

BENCHTOP NEAR INFRARED (NIR) SPECTROSCOPY INSTRUMENTS HAVE BEEN INSTALLED IN AUSTRALIAN SUGAR MILLS AND REFINERIES IMPROVING MILL EFFICIENCY AND PROFITABILITY



72%

OF SURVEYED GROWERS RATED SRA'S PERFORMANCE 'HIGH' TO 'VERY HIGH'

STATE OF THE INDUSTRY 2017/18

The Australian sugarcane industry stretches the eastern seaboard from Northern New South Wales (NSW) to Mossman in North Queensland, comprising approximately 4,100 growers and 24 mills. In 2017/18, the industry produced 33.3 million tonnes of cane, a reduction from the 2016 crop of 36.5 million tonnes due in part to the impact of Cyclone Debbie affecting much of the industry in the early months of the year. The industry continued to face other local challenges of industry exit, land competition from other agricultural industries and rising input prices.

Entering the second year of world market surplus, the global market experienced substantially low world sugar prices, adversely affecting the Australian industry. 55 percent of Australian growers reported profits to be below that of the five-year average coupled with industry confidence falling due to the sustained low sugar prices, overseas competition and the pervasive negative sugar nutrition media debate (Grower Survey, 2018).

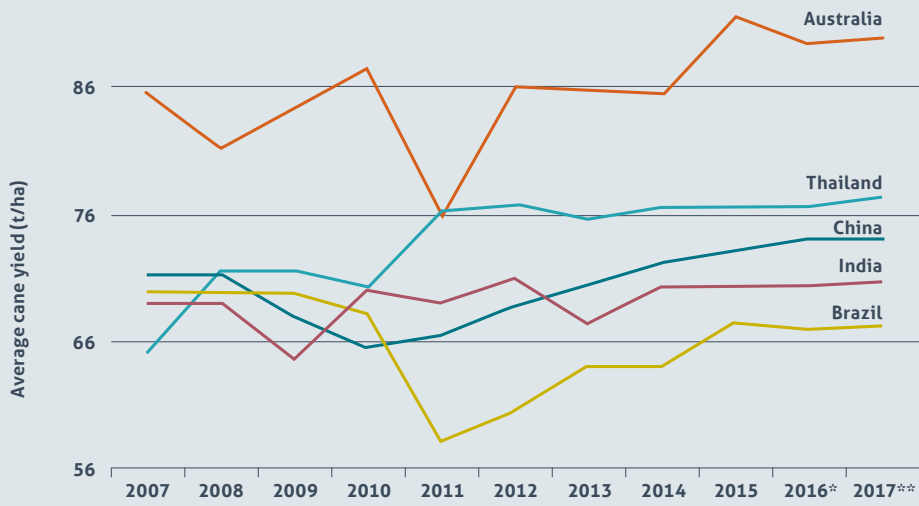
In spite of local, price and climatic challenges, the industry exported 3.7 million tonnes of raw sugar in 2017, maintaining Australia's place as the third largest exporter in the world. To strengthen Australia's export position and potentially increase the volume of industry exports, some advancements were made in trade policy and market access, including the securing of duty-free provisions for Australian sugar into Peru through the Peru-Australia Free Trade Agreement (PAFTA).

Australia continues to lead the world as the highest producer of cane yield per hectare, maintaining a substantial margin above that of Thailand, which has seen considerable industry growth in recent years.

Looking forward, SRA will continue to grow the profitability, sustainability and capability of the Australian sugarcane industry. Through appropriate and effective research and development solutions that are translated into timely on-the-ground outcomes, SRA will enable our growers and miller investors to respond to opportunities and buffer the impact of the abovementioned challenges.



AVERAGE GLOBAL SUGARCANE YIELDS (T/HA)



*OECD-FAO estimate
 **OECD-FAO provisional estimate
 Source: <http://stats.oecd.org/>



SRA PERFORMANCE SUMMARY 2017/18

PERFORMANCE RATING

72%

72% of surveyed growers rated SRA's performance 'high' to 'very high'.

67%

67% of surveyed millers rated SRA 'high' to 'very high'.
(Note small sample size).

ANNUAL OPERATIONAL PLAN KEY PERFORMANCE INDICATORS (KPIs) SUMMARY

● **ACHIEVED**

52%

● **ON TRACK**

48%

● **NOT ACHIEVED**

0%

52% of the performance measures for 2017/18 were achieved, 48% of measures are on track or require further activity to be met. Full list of measures reported in Appendix 1.

RETURN ON INVESTMENT

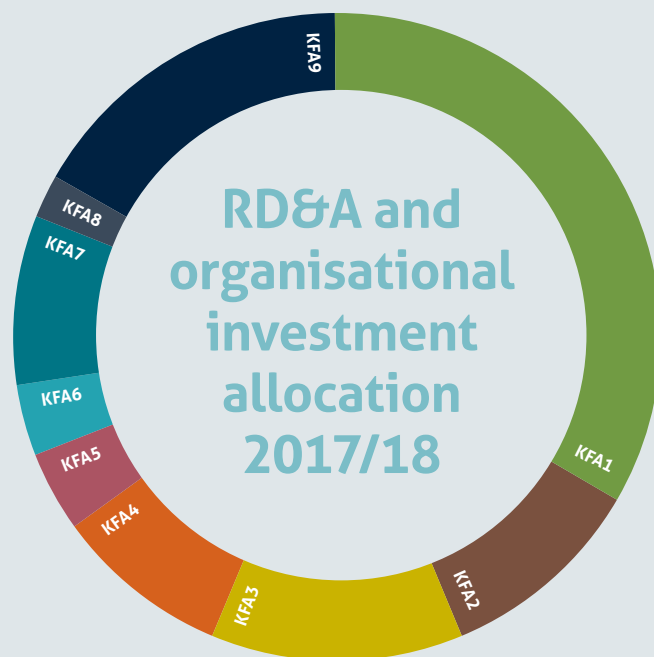
2.9

SRA's 2017/18 external evaluation program revealed a 2.9:1.0 average aggregated return on investment across nine investments. SRA acknowledges Queensland Department of Agriculture and Fisheries (QDAF) co-investment in many of these projects.










PROJECT CODE	RD&A INVESTMENT	BENEFIT COST RATIO ¹
2011/343	Maximising genetic gain from family selection	2.0:1.0
2013/357	Innovative approaches to identifying the cause of chlorotic streak and new management strategies	3.6:1.0
2013/358	Developing cytogenetic and molecular tools to improve selection for soil borne pathogen resistance in wild hybrids	2.7:1.0
2014/024	Modelling extreme yields in the Wet Tropics to improve nitrogen use efficiency	0.0:1.0 ²
2014/045	Optimising productivity and variety recommendation through analysis of mill data	6.8:1.0
2014/053	Advancing yield, disease resistance and ratooning by exploiting new sources of genetic variability from wild relatives of sugarcane	2.1:1.0
2015/070	Spatially explicit estimation of Achievable Yield Potential – An improved basis for fertiliser management	3.9:1.0
2015/077	Cropping solutions for the sugarcane farming systems of the Burdekin – extension of 2011/922	3.2:1.0
2015/081	Assessment of new soft cane varieties	1.8:1.0

¹ All Benefit Cost Ratios reported in this report are calculated on a 30 year horizon at a discount rate of 5%.

² Benefit Cost Ratio is zero because follow up research has identified project findings cannot be used with confidence to lower nitrogen applications as originally hypothesised.



SRA RD&A INVESTMENT AND ORGANISATIONAL EXPENDITURE

KFA	MILLION*
 KFA1 / OPTIMALLY-ADAPTED VARIETIES, PLANT BREEDING AND RELEASE	\$15.1M
 KFA2 / SOIL HEALTH, NUTRIENT MANAGEMENT AND ENVIRONMENTAL SUSTAINABILITY	\$4.7M
 KFA3 / PEST, DISEASE AND WEED MANAGEMENT	\$5.7M
 KFA4 / FARMING SYSTEMS AND HARVESTING	\$4M
 KFA5 / MILLING EFFICIENCY AND TECHNOLOGY	\$1.8M
 KFA6 / PRODUCT DIVERSIFICATION AND VALUE ADDITION	\$1.6M
 KFA7 / KNOWLEDGE AND TECHNOLOGY TRANSFER AND ADOPTION	\$3.9M
 KFA8 / COLLABORATION AND CAPABILITY DEVELOPMENT	\$1M
RD&A expenditure	\$37.7M
 KFA9 / ORGANISATIONAL EFFECTIVENESS	\$7.6M
Total expenditure	\$45.3M

*Numbers are rounded.



KFA 1: OPTIMALLY-ADAPTED VARIETIES, PLANT BREEDING AND RELEASE

Key Focus Area 1 includes SRA's core sugarcane plant-breeding program for the production of new and improved sugarcane varieties and their release and distribution for commercial production. In addition, KFA1's contestable investment portfolio is aimed at developing tools, technologies and platforms to enable the breeding program to develop those varieties including the exploration and creation of new genetic diversity and improved genome and trait knowledge.

INPUTS

Number of investments	41
Total investment 2017/18 ²	\$15.1M
Lead R&D providers	Sugar Research Australia, Commonwealth Scientific and Industrial Research Organisation (CSIRO), University of Queensland, Sunshine Sugar, University of Southern Queensland, Queensland University of Technology

OUTPUTS AND RD&A HIGHLIGHTS

- The first draft genome sequences of a cultivated sugarcane variety R570 and of *S. Spontaneum* were produced through an international effort co-funded by SRA as part of an International Consortium for Sugarcane Biotechnology. The sequence and annotation data is now available on the Sugarcane genome hub website. The genome is a starting point to understand the impacts of variation in different genotypes on sugarcane phenotypes.
- Improved methods were developed for isolating and amplification of single chromosomes, leading to better results for sequencing and hence for marker development.
- Diversity of sugarcane root architecture was evaluated, demonstrating that the rate of branching as well as the length of the branches are factors determining the plant's strategy for mining of soil resources, especially when resources are limited. A specific, calibrated and efficient method for the quantification of live sugarcane root mass in soil samples was developed for inclusion as a diagnostic tool in the soil health toolbox.
- Study of stool architecture traits that may contribute to ratoon performance showed genetic variation in all measured traits amongst current commercial lines. This provides methods that are more rigorous for researchers comparing genotypes for stool architecture traits.
- Stalk height and stalk number were found to be the most biomass-predictive traits in young cane plants, especially under nitrogen-limiting conditions and large genetic variability for biomass production was observed in the test population under low and high nitrogen supply.
- New progeny were created from crosses between Indonesian *Erianthus* and Chinese hybrids with successful seed germination and assessment of field populations showing *Pachymetra* resistance.
- Gene markers have been identified that are associated with *Pachymetra* and smut resistance and a mini single nucleotide polymorphic (SNP) marker chip platform for high throughput and faster screening for resistant varieties is undergoing validation testing.
- Markers linked to Commercial Cane Sugar (CCS) and yield were converted to a high throughput marker platform and can now be validated for genetic linkage with the target traits and tested for cost effectiveness in routine application.
- Knowledge about effects of locations, crop class and maturity on fibre quality measurements was generated by reviewing historical data and conducting a designed experiment. Fibre quality traits exhibited a high correlation with one another and shear strength was identified as the measurement that remains most consistent across the season (cane age).
- 1,044 advanced clones have been genotyped with the 44K Axiom sugarcane array. The clones have high quality phenotypic data for tonnes of cane per hectare (TCH), CCS and disease resistance with field performance data from all major production areas. The genotype and phenotype information is the basis for a reference population that will allow testing of genomic selection in SRA plant breeding.
- Drone based methods of measuring plant growth vigour and canopy characteristics were developed to provide a way of assessing the large number of clones in early generations. Clones selected using this system will be sown in Final Assessment Trials (FATs) to compare drone phenotyping with conventional selection.
- Over 1kg of smut spores were collected in 2017 to inoculate a Clonal Assessment Trial (CAT) propagation trial at Meringa in 2018. Identifying susceptible clones earlier in the

² SRA acknowledges the Queensland Department of Agriculture and Fisheries co-investment contribution in KFA 1.

- breeding process will improve the commercial merit of clones tested at the final assessment stage. Implementation of smut inoculation in early generation trials at other breeding centres will proceed if the pilot test is successful.
- A revised crossing strategy was developed for the Photoperiod Facility with a 45% reduction in the number of parents and a focus on generating larger quantities of seed from the highest value crosses. The strategy was successful with a record 261 commissioned cross combinations achieved and 588 combinations made in total.
 - DNA based testing for variety identification was redesigned to provide a lower cost tool. This has allowed an expansion of testing for quality control in tissue culture production, plant breeding and commercial seed plots.
 - A pilot Near Infrared (NIR) calibration for moisture developed for the Meringa SpectraCane unit is being used to investigate the relationships between cane maturity, CCS and fibre characteristics. Implementation at all sites is planned to support future variety selection.
 - The potential for targeted gene manipulation for sucrose improvement in established sugarcane varieties was evaluated and the transgenic technology was applied to varieties, Q208^ϕ and Q240^ϕ. Some improvement was recorded for seven lines, out of 365 tested under field conditions but it was not significant enough to justify continued investment.
 - Digital soil mapping is being conducted in all Final Assessment Trials to improve selection accuracy by accounting for soil variation within blocks.
 - Two introgression clones selected for the two year, temperate cane growing conditions of NSW were promoted to the accelerated stage for possible release in 2020.
 - Fast-track breeding schemes have been developed to reduce the time from cross to release for selected germplasm without compromising the level of performance information available to inform commercialisation.
 - Six new varieties were released; SRA11^ϕ in NSW and the Southern Region, SRA12^ϕ and SRA13^ϕ in the Central Region, SRA14^ϕ in the Herbert, and SRA15^ϕ and SRA16^ϕ in the Northern Region.

OUTCOMES

Tracking against KFA1's five-year year Strategic Plan outcomes.

KFA1 STRATEGIC OUTCOMES 2017/18 – 2021/22		PROGRESS COMMENTS
1	Highly streamlined and efficient core breeding program delivering commercially desirable, high-performing varieties.	The SRA Board approved the 16 recommendations from the major review of plant breeding conducted in 2017. The planned changes to plant breeding range from cost neutral technical changes through to new initiatives such as a core introgression pipeline to broaden the genetic base, and establishment of molecular selection capability.
2	Improvement in the genetic gain in Final Assessment Trail clones from the current level towards the target of 2% gain per annum.	Metrics to quantify underlying genetic gain are established and reporting systems to the SRA Executive and Board implemented. The 16 work packages recommended from the plant breeding review are being adopted to increase genetic gain including increased early generation selection pressure, improved field trial precision, exploiting non-additive genetic variance, and establishing fast-track breeding schemes.
3	Introduction of the first phase of molecular markers in early stage selection trials.	A range of activities are underway to validate the genetic linkage between molecular markers and target traits identified in previous genetic analysis projects. The application of genomic selection in sugarcane is being tested and an elite bi-parental mapping population is under development to produce new information on the genetic control of commercial traits.
4	Proof of concept to use high throughput phenotyping to enhance selection and develop molecular markers.	Drone based systems to rapidly measure sugarcane growth rates, plant architecture and canopy characteristics have been developed and calibrated against ground based measures. Drone phenotyping used to select clones and field trials will be established to compare them with clones from conventional selection to validate routine application in plant breeding.

LOOKING FORWARD

In 2017/18 the Board approved new investment to implement DNA based selection technology in plant breeding. Initial activity focussed on establishing work flows and validating molecular markers linked to smut resistance with the aim of using these in clone selection for the first time in 2019.

PATHWAY TO IMPACT – CASE STUDY

Project 2014/054: Optimising productivity and variety recommendations through analysis of mill data

THE CHALLENGE:

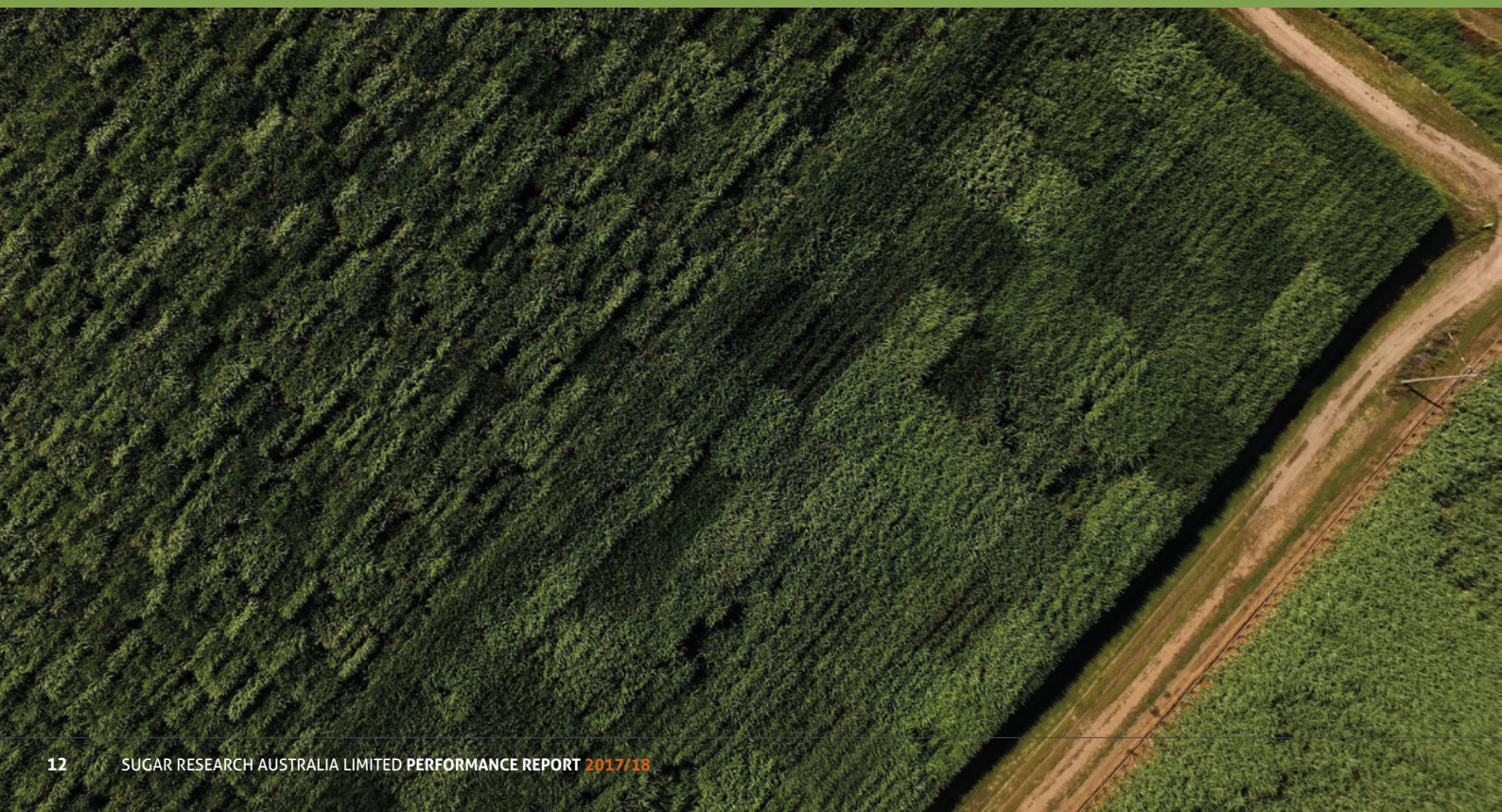
Production in the Herbert River mills peaked in 2005 at 5.5Mt. However, the area has since suffered a substantial decline in productivity. Although some regional variation can be explained by extreme weather conditions or localised disease incursions, SRA researchers identified a need to understand the management and varietal selection factors affecting productivity and profitability in the region. Substantial amounts of data are captured annually by Wilmar Sugar Australia and Herbert Cane Productivity Services Limited (HCP SL), providing an opportunity to analyse the data to identify some of the key drivers affecting on-farm productivity. This project was funded by SRA and the Queensland Department of Agriculture and Fisheries and received in-kind support from HCP SL, Wilmar Sugar Australia and many Herbert region growers and harvesting contractors.

THE RESEARCH:

SRA researchers employed innovative statistical methods to analyse and summarise mill data to identify groups of farms of similar size with similar productivity over time. Information was collected in a standardised format from mill data and analysed by soil type, crop class, sub-district and productivity zone, and grouped to demonstrate relationships between grower production systems and mill data characteristics. A major finding of the study was that those growers who have adopted new farming systems had significantly higher productivity than those who use traditional practices. Similarly, the researchers determined that, for small sized farms, higher performing farms were adopting new, more productive varieties to a greater extent than lower performing farms. The major output of the project was the development of decision-support reports residing in QCANESelect® that allow Herbert River growers and advisors to base their variety selections or recommendations on the best available data in a fast and accessible format.

THE PATHWAY TO IMPACT:

These outputs allowed HCP SL to design targeted extension strategies to improve varietal choices in the region with a focus on productivity. Assuming that 10% of the Herbert canegrowing area makes improved management and varietal decisions, external analysts conservatively valued the net present value of the economic benefits (improved productivity and profitability) at **\$4.75 million**, translating into a **6.79:1.0** return on investment. While not valued in this evaluation, the project developed a model of data collection and analysis that could be duplicated elsewhere and lead to positive impacts in other regions. Since completion, similar research is being conducted in a new investment to extend the methodology to further milling areas, representing 91% of the industry, due for completion in early 2021. The investment by SRA and QDAF has instigated the use of targeted extension strategies for productivity based on timely and, until now, under-utilised data sets.



KFA2: SOIL HEALTH, NUTRIENT MANAGEMENT AND ENVIRONMENTAL SUSTAINABILITY

Key Focus Area 2 contains SRA's RD&A investments concerned with improving soil health, management of nutrients and chemical inputs, capability to predict and adapt to variable climatic conditions and the industry's environmental sustainability and social license to farm. The focus area houses SRA's dedicated Soil Health Program, charged with the coordination and delivery of the long-term investment needed to research and develop solutions to the industry's soil-based constraints.

INPUTS

Number of investments	15
Total investment 2017/18 ³	\$4.7M
Lead R&D providers	Sugar Research Australia, University of Southern Queensland, Biological Crop Protection, James Cook University, CSIRO, Queensland Department of Science Information Technology and Innovation, Australian Pork, Cotton Research and Development Corporation

OUTPUTS AND RD&A HIGHLIGHTS

- Collaborative work between SRA and the South Australian Research and Development Institute (SARDI) proved the concept of using PREDICTA root disease DNA diagnostic technology for *Pachymetra* and two nematode pests. A strategy was implemented for extending the results to the sugarcane industry and new SRA research to further develop the range of diagnostic tests available using the PREDICTA platform commenced.
- SRA, in collaboration with Farmacist, facilitated customised Burdekin SIX EASY STEPS[®] workshops for all growers participating in the Queensland Department of Environment and Science's Complete Nutrient Planning for Cane Farming project (RP161), the successor to the award-winning RP20 Burdekin Nitrogen Trials project.
- 56 enhanced efficiency fertiliser (EEF) strip trials were established and biomass sampled at 6-9 months crop age to determine crop nitrogen (N) uptake. Preliminary analysis showed potential reductions in leaching losses at lower N rates and only small differences in productivity based on early harvest results. These extensive field trials continue in 2018/19 and will ultimately contribute to EEF decision support tools.
- Spatial distribution of major soils with crop growth and N responsiveness constraints were developed in the Herbert region, informing potential management practices to improve nutrient use efficiency. This new knowledge complements whole-of-farm nutrient management planning activities for these regions and will inform the development of SIX EASY STEPS[®] Tool Box.
- Analysis of mill records revealed marked spatial yield variability in the Herbert River district across seasons and crop class, suggesting more granular methods of determining yield potential could improve N use efficiency. This will inform a measure of how N management would be different under fertiliser application based at either the district, farm, block or management zone level and inform industry of the opportunities presented by location-specific estimates of yield potential.
- A direct relationship between optimum N fertiliser rates and crop size was identified and advanced crop modelling was used to successfully simulate crop yields for field trials in Tully. This informed development of a prototype delivery tool, the OptimN App, which integrates seasonal climate forecasting information to predict likely crop fertiliser recommendations for the forthcoming season. Such a decision support tool will add value to whole farm nutrient management planning when developed for commercial use.
- Translation of the relative benefits of different types of EEFs and blends in different circumstances into a decision support tool for growers commenced. This builds on previous SRA investment into the performance of control release fertilisers and potentially provides a pathway for reducing off-farm nitrogen losses.
- Three distinct sub-regions within the Herbert with similar climatological attributes were statistically identified. These results will be investigated further through expert opinion and comparison to sub-regional rainfall data to better inform improved nutrient use efficiency with respect to climatological zone.
- Guidelines for the better management of legume crop N were developed to mitigate N loss pathways and preserve it for the following sugarcane crop. The trial data sets will be of significant value in refining the current nutrient management tools and the development of a module in the SIX EASY STEPS[®] ToolBox for legume N residue management.

³ SRA acknowledges the Queensland Department of Agriculture and Fisheries co-investment contribution in KFA 2 and investment by the Queensland Department of Environment and Science (DES), the University of Queensland and CANEGROWERS.

OUTCOMES

Tracking against KFA2's five-year Strategic Plan outcomes.

KFA2 STRATEGIC OUTCOMES 2017/18 – 2021/22		PROGRESS COMMENTS
1	Chronic problems and drivers of poor soil health alleviated through development and promotion of improved soil management practices.	In early 2018, SRA's Soil Health Program was launched to coordinate the long-term investment needed to research and develop solutions to soil-based constraints. The program maps out 10 years of coordinated R&D necessary to deliver outcomes in sugarcane industry soil health. In 2017/18, the Soil Health Program coordinator and Soil Health Officers were appointed and short-term demonstration and long-term paired sites established. The sites, established in the Burdekin and Herbert regions, compare the soil health implications of 'improved' and conventional farming systems and initial soil, nematode and <i>Pachymetra</i> sampling took place. Development of the Soil Health website commenced and electronic tools to capture and record grower and advisor feedback at industry events were developed.
2	Industry equipped with practice and cost-effective solutions to meet practice standards and regulatory targets for nutrient management, irrigation practices and water quality that deliver off-farm improvements in water quality.	Enhancement of the SIX EASY STEPS® nutrient management guidelines continues through ongoing R&D to ensure the industry is equipped with a suitable guide to nutrient management. In 2017/18, the SIX EASY STEPS® short course was updated and the new SIX EASY STEPS® Advisory Committee (SESAC) was formed as a mechanism to review new data and knowledge to update the guidelines in a timely manner. This work is complemented by a portfolio of R&D investigating the incorporation of enhanced efficiency fertilisers and incorporation of climate forecasting into on-field decision making to optimise farm nutrient management and minimise off-farm impacts.
3	Integration of climate seasonal forecasting information into strategic and tactical on-farm decision making.	A prototype decision-support tool, OptimN App, was developed which integrates seasonal climate forecasting information to predict likely crop fertiliser recommendations for the forthcoming season. Further development of the App is required to bring it to commercial use. Similarly, in Round 3 of the Commonwealth Government's Rural R&D for Profit Program, SRA is a contributor to a \$10M+ Australian-wide investment to develop new forecasting products of climate extremes for all Australian agricultural industries. A sugarcane reference panel has been established to ensure products applicable to the sugarcane industry are developed.

LOOKING FORWARD

In 2017/18, three new contestable research projects were funded to further research and development in KFA2. CSIRO will continue existing research trials to further understand the impact of stool architecture on ratooning and Queensland University of Technology will develop strategies for increasing Nitrogen Use Efficiency (NUE) and reducing environmental pollution through quantification of the relationship between NUE, greenhouse gas emissions and denitrification losses in sugarcane soils. SRA researchers will further existing research outputs through applying recently developed DNA-based assays to sugarcane soil health projects to introduce routine delivery of the new assays and develop further molecular assays for the industry.

PATHWAY TO IMPACT – CASE STUDY

Project 2011/062: Climate forecasting to improve sugarcane nitrogen management in the wet tropics

THE CHALLENGE

The Wet Tropics sugarcane industry experiences one of the highest levels of inter-annual climate variability in the world. While many factors affect productivity, the climatic conditions experienced during the growing season have a significant impact on cane yield. This makes the task of applying the right amount of N fertiliser to optimise profitability and minimise environmental losses challenging. Given the extreme variability in climate and yields experienced in the Wet Tropics N guidelines may be different for 'wet' and 'dry' years. However, current methods for determining N guidelines use a constant yield target or yield of the previous crop. SRA researcher Dr Danielle Skocaj investigated the utility of seasonal climate forecasting indices based on sea surface temperature anomalies in the central equatorial Pacific Ocean, to predict N requirements of the forthcoming crop. This research formed her doctoral thesis, supported by SRA and Queensland Department of Agriculture and Fisheries.

THE RESEARCH

Danielle's thesis successfully developed a proof-of-concept that at least in some Wet Tropics areas, N fertiliser rates could

be reduced without impacting cane yield. Three small-plot N rate response trials, maintained for three crops (1st – 3rd ratoon) were conducted to parametrise the Agricultural Productions Systems Simulator (APSIM) crop model, validate simulated cane yield responses to different N rates and assess plant uptake of N over successive ratoon crops. The resulting simulation study identified N fertiliser requirements are lower in wet years for ratoon crops growing on the Bulgun series soil and the June to August Oceanic Niño Index can be used to predict N requirements. Danielle concluded that growers should consider reducing N rates on ratoon crops growing on Bulgun series soils when the June to August Oceanic Niño index is in the EL Niño phase. This may help improve N use efficiency in wet years. While Bulgun series soils account for only 8% of the Tully mill area, it is likely these results could also apply to other poorly drained alluvial soil types throughout the Wet Tropics region.

THE PATHWAY TO IMPACT

Should the project lead to refinements of N management in the region based on the application of seasonal climate forecasting indices, there are a number of potential economic, environmental

and social benefits. Tailoring N fertiliser inputs to seasonal requirements may lead to more profitable use of N fertiliser and greater N use efficiency without reducing productivity. Environmental impacts may be realised through reducing N fertiliser applications in some years leading to reduced off farm water quality impacts via reduced N losses in surface runoff and deep drainage. Capability benefits are achieved through increased sugarcane research and scientific capacity through the development of a highly skilled, PhD-trained researcher.

Independent analysts valued the economic benefits of the project at \$2 million, translating into a **4.8:1 return on investment** to SRA and QDAF. This analysis trusts that the necessary R&D to convert the proof-of-concept into industry outcomes occurs. Since this investment, SRA and the Queensland Department of Environment and Science (DES) through the NUE co-investment program have continued the necessary R&D leading to development of a prototype delivery tool, the OptimN App, which integrates seasonal climate forecasting information to predict likely crop fertiliser recommendations for the forth-coming season. Field validation of this prototype tool is required prior to commercial use.



(Left) SRA Senior Researcher Dr Darvey Olsen inspects a Soil Health Program trial site.

KFA3: PEST, DISEASE AND WEED MANAGEMENT

Key Focus Area 3 houses SRA's internal pathological and entomological expertise and capability to diagnose and manage domestic and international biotic threats to the Australian sugarcane industry. The focus area also comprises the portfolio of contestable research and development investment delivering improvements in pest, disease and weed management and SRA's Yellow Canopy Syndrome (YCS) research portfolio.

INPUTS

Number of investments	37
Total investment 2017/18⁴	\$5.7M
Lead R&D providers	Sugar Research Australia, University of Southern Queensland, Western Sydney University, University of Queensland, Horticulture Innovation Australia

OUTPUTS AND RD&A HIGHLIGHTS

- Research identified four different taxa of the pathogen causing downy mildew (*Peronosclerospora* spp.) where only two had previously been thought to be present; three may be new species. Pathogen variation was also identified in the tenuivirus causing Ramu stunt. This knowledge contributed to the development of improved diagnostic techniques for Ramu stunt and downy mildew and are available for screening in SRA's post entry quarantine facility.
- A two-step phytotoxicity screening program was developed to screen herbicides for damage to susceptible cane varieties and has been incorporated into SRA's core breeding program.
- A range of integrated management strategies that efficiently control troublesome grass weeds in North Queensland were identified and communicated to industry through updating of the SRA weed manual. Across the life of the project, almost 300 attendees participated in 15 grower field days at trial sites.
- Using SRA's rainfall simulator, four runoff field trials comparing the runoff losses of 16 herbicides showed that runoff losses of pre-emergent herbicides were largely driven by their application rate, with the exception of pendimethalin and flumioxazin.
- A prototype precision weed identification sensor was developed and a commercial partner engaged to commercialise it. Trialling is underway in far north Queensland to develop market entry algorithms for sugarcane.
- In recent trials, several insecticides that are possible alternatives to imidacloprid reduced numbers of greyback and Childers canegrubs in field trials.
- The use of molecular techniques has identified greater diversity and successful species identification of important exotic moth borers that pose a biosecurity threat to the industry. The molecular data forms the basis of rapid diagnostic protocols and was integrated with new and revised morphological traits that will be used to revise and update SRA dossiers and species distribution maps. Updated and improved incursion management plans were also prepared to minimise losses in the event of an incursion.
- SRA named the organism responsible for chlorotic streak disease (CSD) in sugarcane as *Phytocercomonas venanatanas* and two papers on CSD and its cause were published in the journal *Phytopathology*, one of the premier international journals for plant diseases. A novel, rapid and reliable resistance screening method is being developed and feasibility testing of a diagnostic service is in the final stages.
- Field trials and testing of ratoon stunting disease (RSD) detection technologies commenced and preliminary analysis underway in order to make recommendation on the optimal RSD assay for the Australian sugarcane industry.
- SRA researchers made modifications to the Sugarcane Streak Mosaic Virus molecular diagnostic tools to ensure the assays detect the virus under all circumstances, based on research showing significant variation in the pathogen between countries in South East Asia.
- Species composition work on soldier fly has identified that at least five genetic groups of soldier fly are responsible for the damage observed in the industry. This finding has potential implications in terms of management, especially if the behaviour and ecology of these species differs between these groups.
- Strategic basic research has identified that when feeding on sugarcane roots, soldier fly larvae produce "venom" like proteins. These proteins may be responsible for the damage observed to sugarcane when it is attacked by soldier fly, informing future research to develop management strategies to combat the pest.

⁴ SRA acknowledges the Queensland Department of Agriculture and Fisheries co-investment contribution in KFA 3 and investment by the Australian Centre for International Agricultural Research (ACIAR), the Queensland Department of Environment and Science and Horticulture Innovation Australia.

- Data has been collected that supports the hypothesis that Fiji Leaf Gall has been eradicated from the Central region. This work is being subjected to international peer review to ensure that appropriate conclusions have been drawn before a final decision is made which could ultimately lead to the removal of the Fiji Leaf Gall rating in the central region.
- YCS research progressed in 2017/18 such that it can now be diagnosed with a high degree of certainty. Researchers ruled out magnesium deficiency as a cause and experimental work focused on identifying the numerous factors that need to be present for YCS to be expressed.
- An indicator tool kit for productivity organisations and industry advisors to identify YCS reached an advanced stage of development while a chemical option is under investigation, which suppresses YCS symptom expression under experimental conditions. Both these avenues are important precursors to the development of effective YCS management strategies.

OUTCOMES

Tracking against KFA 3's five-year year Strategic Plan outcomes.

KFA 3 STRATEGIC OUTCOMES 2017/18 – 2021/22		PROGRESS COMMENTS
1	Enhanced preparedness for the management of high-risk biosecurity threats to the Australian sugarcane industry.	A number of ongoing and recently completed research investments have improved understanding of exotic threats and enabled improvements to molecular detection tools (Sugarcane Streak Mosaic Virus and exotic moth borers) and post-entry variety quarantine diagnostic techniques (Ramu stunt and downy mildew). Further funding to explore the management of exotic moth borer threats common throughout Papua New Guinea and Indonesia using a range of systemic insecticides was secured and all biosecurity management incursion plans were reviewed and updated.
2	Enhanced capability to diagnose biotic threats (pests, weeds, diseases and rodents) to productivity and recommend management strategies to reduce their impact in a sustainable manner.	Capability to diagnose biotic threats and recommend management strategies is progressing through a number of investments including: <ul style="list-style-type: none"> • Field testing of RSD technologies in order to make a recommendation on the most appropriate diagnostic tool for the Australian industry; • The chlorotic streak disease diagnostic test is in the final stages of feasibility testing before extension to industry; • Identification of promising insecticides that have the potential to provide alternatives to imidacloprid to manage canegrubs; and • Greater understanding of how solider fly larvae damage sugarcane root systems.
3	Reduced industry reliance on chemical interventions that have detrimental environmental impacts.	Grower feedback surveys report that practice change has occurred across 11,400 hectares of cane land in accordance with best management practices for chemical use in the Wet Tropics region as a result of adoption activities undertaken in project 2016/002 ⁵ . The changes reported include improved timing of herbicide application, reductions in the use of residual herbicides, increased utilisation of modern chemistry with better water quality attributes and targeted application of imidacloprid based products as opposed to prophylactic approaches. A further 8,000 hectares of managed land is under consideration for best management practice implementation.

LOOKING FORWARD

In 2017/18, the SRA Board approved a new investment into the management of exotic moth borers, a major biosecurity threat to the industry following on from the recent success of moth borer research which will enhance the capability of SRA to respond and minimise impact of an exotic moth borer incursion.

PATHWAY TO IMPACT – CASE STUDY

Project 2013/357: Innovative approaches to identifying the cause of chlorotic streak and new management strategies

THE CHALLENGE

Chlorotic streak disease, characterised by white streaks and internal stalk reddening, is one of the major diseases affecting the Australian sugarcane industry. Occurring predominately in areas of high rainfall and poorly drained fields, the disease reduces germination, ratooning, stalk numbers and weight. This causes yield losses of up to 40 percent in susceptible varieties, costing the industry between \$7-10 million annually. First recognised as a disease in 1929 and with the causal agent still unknown as of 2013, SRA and the Queensland Department of Agriculture and Fisheries invested in research to improve understanding of the causal agent biology. It was reasoned that improved understanding would foster development of new methods of control.

THE RESEARCH

The project, led by pathologists at SRA, trialled a range of innovative molecular and traditional pathological techniques to identify the cause. This investigation was accompanied by epidemiological study of disease spread in the field and hydroponic transmission

studies. Ultimately, the causal agent of chlorotic streak was successfully identified through high throughput sequencing and traditional techniques as a novel biflagellated cercozoan, *Phytocercomonas venantans*. Previously unknown to science, the pathogen can now be grown in culture, overcoming previous challenges which had hampered research efforts to develop a varietal screening technique.

Identification of the causal agent enabled development of an improved diagnostic test to screen soil, plants and water and the trialling of several rapid glasshouse resistance screening methods. This research continues in the follow-up SRA project 2017/010 'Delivering solutions for chlorotic streak disease'. The project was communicated through SRA biosecurity roadshows across the industry in late 2016, additional specific CSD industry events, various shed meetings, laboratory tours and conference presentations. The project's success also garnered substantial media attention through television, radio and print media.

THE PATHWAY TO IMPACT

Impact of this research discovery is derived firstly through the future reduced costs to industry due to the distribution of seed free of chlorotic streak by productivity service organisations thanks to diagnostic screening and, secondly, through future varietal resistance ratings identifying susceptible varieties. Based on conservative assumptions, external analysts valued the net present value of these economic benefits at \$9.42 million, translating into a 3.6:1 return on investment¹. Analysts also identified (but did not value) positive social impacts through the significant contribution to science and growth in Australian sugarcane research capacity that may be leveraged for future research outcomes. The investment has safeguarded and increased future industry profitability through reduced or avoided losses from CSD and investment to develop and extend the practical diagnostic test and variety screening method continues at SRA.

¹ Analysis includes estimate of impact value of the follow-on project. Attributed benefits reported here are based on 73% attribution factor for project 2013/357.

(Below) SRA chlorotic streak disease researcher Dr Chuong Ngo.



KFA4: FARMING SYSTEMS AND HARVESTING

Key Focus Area 4 houses SRA's research and development activities dedicated to optimisation of sugarcane farming and harvesting systems. The portfolio may encompass precision agriculture, water management, cropping management and on-farm energy efficiency research. KFA4 contains SRA's flagship harvesting best practices (HBP) program, which continued to drive improvements in harvester design and practices with promising industry outcomes emerging from the participating harvesting groups in the 2017 season demonstration trials.

INPUTS

Number of investments	15
Total investment 2017/18⁶	\$4M
Lead R&D providers	Sugar Research Australia, Queensland University of Technology, University of Southern Queensland, MSF Sugar Limited, AgResearch New Zealand, University of New England, Norris Energy Crop Technology, Queensland Department of Agriculture and Fisheries, University of New South Wales

OUTPUTS AND RD&A HIGHLIGHTS

- 43 HBP demonstration trials were conducted investigating the effect of four different harvesting practices on a range of performance criteria. Most trials revealed the HBP recommended practice gave economic gains to the grower and an increase in harvested tonnes to the contractor relative to current practices. The results indicate that the industry has the potential to obtain a 5.5 percent increase in harvested tonnes with no cane land increase and \$74m increase in shared industry revenue if operating at harvesting best practice recommendations.
- SRA's chopper test rig was recommissioned and enhanced for the 2017 and 2018 seasons. The rig allows testing of different chopper drums to assess billet damage and sugar loss without a harvester and is the only one of its kind available in the industry.
- As part of development of the harvesting decision-support tool *SCHLOT Live*, sensors installed on a harvester were connected to an on-board computer that is able to estimate cane loss in real time and transmit this to a remote user interface in close-to-real time, allowing rapid adjustments for optimised harvesting.
- Several harvesters were modified to link the rotational speed of the basecutters and forward feed components to groundspeed. Despite this modification, severe damage to cane stools has been measured in trials, indicating that there are major flaws in the design of the current harvester front end. This informs ongoing R&D effort to optimise harvesters.
- The Harvesting Optimisation Week (HOW) trial held in the Herbert region revealed gross revenue will increase by up to \$2.56/tonne or \$217/ha when optimising harvest operations in the Herbert. This equates to an additional \$11 million in industry value to the Herbert region alone if operating in accordance with harvesting best practice. The HOW week was a collaborative effort between SRA, HCPSL, Wilmar Sugar, Sugar Research Institute (SRI) and Herbert River Canegrowers.
- After a series of preliminary trials in southern Queensland, the cleaning chamber of the mobile post-harvest cane cleaner was modified during the off season to improve its performance. The unit has been relocated to the Tableland where large-scale trials began in June 2018. The research will deliver a cost benefit analysis of cane cleaning as a strategy to mitigate harvest losses.
- Preliminary analysis of three case studies investigating opportunities for energy innovation in sugar irrigation systems were completed in Bundaberg, Mackay and Ayr. Results so far suggest that high returns can be achieved by installing solar where the pumping load is under 30 kW (on a 3-phase connection) and a feed-in tariff is eligible. This work will increase the knowledge, confidence and capability of the industry to apply renewable energy technology on farm for improved productivity.
- Automation of furrow irrigation in the Burdekin produced annual benefits of \$8,600, \$12,700, and \$20,000 for three different case study farms. Significant reductions in energy, water, labour and travel costs associated with irrigation management were seen across all three sites.
- An evaluation of irrigation scheduling tools was completed and revealed unexploited opportunities for the industry to combine soil moisture field sensors, crop based sensors and

⁶ SRA acknowledges the Queensland Department of Agriculture and Fisheries co-investment contribution in KFA 4.

weather forecasts to improve value and reliability of the tool IrrigWeb to achieve greater water productivity.

- Computer code to automate the processing of satellite imagery to classify cane fields according to crop vigour and yield was developed. This code has generated maps for all sugarcane growing regions participating in the project for the 2018 season and yield estimates are currently used by mills to manage the 2018 harvest. Ultimately, the intention is to enable growers to access their individual farm maps to

identify crop variability at the field and within-field level to tailor their crop management accordingly.

- Innovative research with future commercial potential continued the assessment of the microbiome of sugarcane in elite cultivars and wild relatives. Commercial varieties of sugarcane have less complex microbial communities than wild relatives indicating a loss of potentially important microbes to support sugarcane resilience. The application of some of the isolated endophytes (microbes) in tissue

culture plantlet trials revealed bioactivity of selected fungal endophytes against two sugarcane diseases and major pest species. This suggests that endophyte-assisted varieties have the potential to have enhanced resistance against major pests and pathogens.

OUTCOMES

Tracking against KFA4's five-year Strategic Plan outcomes.

KFA4 STRATEGIC OUTCOMES 2017/18 – 2021/22		PROGRESS COMMENTS
1	Enhanced skill capability and improved adoption of validated and improved precision agriculture technologies, water management and sugarcane farming systems.	SRA's grower survey reported a moderation in the previous upward trend in adoption of new practice changes (overall, 54% reported making a change in both 2016 and 2017), though the rate varies across demographics and regions. Growers indicated key barriers to change being financial constraints (55% reported profits below the five-year average due to low world sugar prices) and satisfaction with current practices. SRA's newly implemented industry-led adoption strategy commenced in late 2017/18 and supports the uptake of new and existing technologies in the coming years through collaboratively developed regional investment strategies and delivery.
2	Greater returns across the value chain due to improved cane harvesting operational procedures and equipment.	A follow up survey of the 43 harvesting groups involved in 2017 HBP demonstration trials indicated: <ul style="list-style-type: none"> • 15 EHS Maxi chop chopper drums have been installed reducing sugar loss by a minimum of \$50/ha; • 24 harvester feed trains have been optimised, reducing sugar loss by \$70/ha; • 85% of the groups are utilising decision support tools (SCHLOT demonstration version or SRA Online Pour Rate Ready Reckoner); and • Six groups indicate intention to switch to an incentive-based payment system for the 2018 season and 19 groups are already under negotiation. These tangible outcomes demonstrate substantial progress towards achieving greater returns across the Australian sugarcane value chain through harvesting best practice RD&A.

LOOKING FORWARD

Recognising the need for greater irrigation selection and operation capacity across the industry, a new investment was approved in 2017/18 to develop irrigation innovation hubs, whole-of-system case study site assessments and irrigation training weeks.

PATHWAY TO IMPACT – CASE STUDY

Project 2014/079: Modernisation of Furrow Irrigation in the Sugar Industry

THE CHALLENGE

Irrigation is an essential part of sugarcane production in many of the sugarcane regions of Australia, especially in the Burdekin region where the entire crop is irrigated and 95% is labour intensive manual furrow irrigation. With both energy and water prices significantly increasing and threatening farm productivity and profitability, researchers at the University of Southern Queensland (USQ) foresaw that furrow irrigation, often viewed as wasteful and inefficient, had the potential to be efficient on many soil types if designed and managed appropriately. Through funding provided by SRA in 2014, Malcom Gillies and his colleagues set out to ground-truth the economic impact of automated furrow irrigation on three representative farm case studies in the Burdekin.

THE RESEARCH

Following a review of the commercially available hardware and sensors, three farms representing different but common types of irrigation infrastructure in the Burdekin were selected and 160 hectares of automated furrow irrigation was successfully installed. All three growers experienced economic benefits of automated furrow irrigation through

savings in energy, water, vehicle and labour costs. A cost benefit analysis demonstrated annual benefits of \$8,600, \$12,700 and \$20,000 at each of the sites across different capital payback periods. In addition to the economic benefits, the growers experienced improvements in quality of life through more time for family and improved sleeping habits and identified the potential for environmental impacts through better records of irrigation performance and compliance with SmartCane BMP. Project results were communicated extensively through industry presentations, 11 demonstration site field walks coordinated by SRA and Burdekin Productivity Services, trial site growers hosting visits from individual interested growers on occasion and three SRA YouTube CaneClips, shared throughout the industry.

THE PATHWAY TO IMPACT

Considerable interest has emerged from both within the Burdekin and further afield. Co-investigator, Stephen Attard from AgriTech Solutions received enquiries from growers wishing to have designs and quotes drawn up for their own farms after attending the field days and Andrew Jakins from Isis Productivity Limited indicates that the

research has attracted interest in the Southern region. One Isis cane supplier is already commencing automation on his property and others in the region are also expressing interest.

Funding through NQ Dry Tropics continues the reach of the work, with six case studies commencing in the Burdekin in March 2018 with the intention to automate a further 550 hectares in the Burdekin by the end of 2018. The case studies require each grower to co-invest, three of whom are expanding automation (growers from the original project) and three new growers who were motivated by the outcomes of the original SRA project. SRA and USQ's project has led the way for the industry to explore the potential productivity benefits of automated irrigation, including the possibility of linking the automation software to an irrigation scheduling tool such as IrrigWeb, explored through funding from the Queensland Government's National Environmental Science Program (NESP) and James Cook University. SRA continues to invest in farming systems research to realise greater farm productivity and profitability through the application of innovative technologies and farming practices.

Details of the trial sites and analysis can be located on the SRA website at www.sugarresearch.com.au/growers-and-millers/farming-systems/



(Right) Burdekin grower Mr Russell Jordan with his automated furrow irrigation setup.

KFA5: MILLING EFFICIENCY AND TECHNOLOGY

Key Focus Area 5 houses SRA's investments pursuing greater milling process efficiency and utilisation, optimised cane quality and transport and improved sugar quality. The KFA includes SRA's internal NIR capability supporting Australian millers in the ongoing installation and calibration of Cane, Sugar and Bagasse Analysis Systems and adoption of laboratory and online NIR solutions. A new feature of KFA5, launched in 2017/18, is the Small Milling Research Program providing a vehicle for targeted investment in small milling investor projects that develop a product, service or process that delivers tangible outputs with almost immediate outcomes within the sugar factory.

INPUTS

Number of investments	19
Total investment 2017/18	\$1.8M
Lead R&D providers	Sugar Research Australia, Griffith University, Queensland University of Technology, Wilmar Sugar Australia, Isis Central Sugar Mill, Mackay Sugar

OUTPUTS AND RD&A HIGHLIGHTS

- A blueprint for Factory Managers and Senior Technologists to guide process improvement strategies was released and communicated to industry. The blueprint details new processing technologies and their cost-benefit relative to conventional technologies in the Australian industry.
- Final recommendations and guidelines for optimum tube dimensions in evaporators at different positions in sugar factories were completed. The use of optimum tube dimensions were shown to reduce juice residence time and offer the prospect of reduced sucrose degradation. Economic benefits are expected through savings of \$0.1-0.5 million through reduced installation capital costs when a new evaporator is installed and benefits of reduced sucrose degradation in early stage evaporators in cogeneration facilities.
- Real time scheduling software (RTSS) was upgraded to provide marshalling yard and depot support for greater rail transport efficiency.
- 'Time-of-flight technology' was installed in the Victoria mill in the 2017 crushing season to examine suitability for liquor density measurement, testing continues in the 2018 season.
- Three tube coatings for resistance to corrosion were selected from extensive laboratory testing for large scale boiler trials during the 2019 season, subject to further development of the coating process and quality assessments during 2018. The coatings are being tested in the anticipation they will reduce boiler maintenance costs and defer capital expenditure. Boiler tube wear and corrosion costs the industry approximately \$5 million annually.
- SRA and QUT co-hosted five milling research seminars to update milling investors in Broadwater, Bundaberg, Mackay, Townsville and Gordonvale on current RD&A portfolio progress. The seminars were attended by 108 people and were well received.
- SRA staff assisted in the installation of ProFoss NIR systems at five Australian sugar mills, including the installation of a Sugar Analysis System. These systems use the new ProFoss diode array Direct Light NIR instrument.
- A FOSS Mosaic Server was installed at SRA Indooroopilly to facilitate the industry uptake of laboratory NIR solutions by the SRA NIR group. The server allows the instant uptake of laboratory NIR solutions, users to remotely access calibration updates developed by the SRA NIR group and will deliver improvements in sugar quality and factory efficiency.
- A Perten DA7300 Cane Analysis System (CAS) was installed at Condong mill for evaluation as a potential cheaper alternative to Foss ProFoss instrument.
- Laboratory NIR instruments owned by Millaquin, Tully, Wilmar Sarina biorefinery and Queensland Sugar Limited had their calibrations for raw sugar, molasses, massecuite and mill mud updated and systems migrated to the new SRA Mosaic server to improve SRA support efficiency. New calibrations for boiler water analysis are currently under investigation.
- New modules were loaded into the recently developed Learning Management System (LMS) for sugar milling operations and training of all milling companies took place. As of June 2018, 88 users are enrolled and 312 training courses are available in the system which is now fully available for industry training?
- Back-end models were completed and fed into the development of a new

boiler simulator. The simulator will become a training tool for operators to familiarise themselves with boiler operation, increase confidence, reduce error and facilitate testing of boiler responses without risk to plant or personnel⁸.

OUTCOMES

Tracking against KFA5's five-year year Strategic Plan outcomes.

KFA5 STRATEGIC OUTCOMES 2017/18 – 2021/22		PROGRESS COMMENTS
1	Optimised milling production for cane quality, plant utilisation, sucrose recovery, energy optimisation and waste minimisation is supported through the identification and/or development of new or improved processes and/or technology.	In 2017/18, the release of the blueprint to guide process improvement strategies, guidelines and recommendations for optimum tube dimensions and in-mill trialling and adoption support of benchtop NIR spectroscopy systems are tangible examples of RD&A supporting optimised milling production within Australian sugar factories. Existing ongoing traditional R&D investment will be complemented by small-scale targeted milling investor projects through the Small Milling Research Program in the remainder of the current Strategic Plan.

LOOKING FORWARD

In 2017/18, a new investment was funded to deliver a cost effective means for upgrading Australian mill pan stages to operate on low-pressure vapour. In 2018/19, SRA's Small Milling Research Projects Scheme will conduct another investment round to fund short-term, targeted milling investor projects that deliver tangible outputs with almost immediate outcomes within the sugar factory.

PATHWAY TO IMPACT – CASE STUDY

Project 2014/051: Improving mill efficiency through rapid analysis methodologies

THE CHALLENGE

Sugar factories experience significant variation in cane quality across consignments, managed through optimised control of factory unit settings to minimise impact on overall efficiency. However, traditional methods involve lengthy delays to factory settings (between 4-24 hours) due to method complexity and limited resources in mill laboratories. As such, the need for rapid, low cost analytical data for production staff and process operators was identified. SRA researchers hypothesised that benchtop NIR spectroscopy instruments and analysis techniques could provide a solution if their performance could be validated under factory conditions.

THE RESEARCH

Analysis of sugar factory products by NIR spectroscopy has been previously undertaken in many cane growing countries but was often limited to single season, single mill and a small range of products. This affects the robustness and usefulness of the calibrations and adoption of laboratory NIR systems has remained low due to calibration quality

targets not being met. Project 2014/051 aimed to improve NIR spectroscopic applications through the development of molecularly targeted NIR calibrations validated on diode array NIR. Following extensive in-mill research trials and rigorous evaluation under different conditions, validation data indicated adequate accuracy and precision to make informed decisions about factory products in Australian mills, particularly for raw sugar, pan products and prepared cane. A calibration suite for key sugarcane factory products was developed to provide a turn-key or near turn-key solution. This included an information package illustrating scientifically how and why NIR analysis works for quantifying products, guidelines for users, and a standardisation protocol for the FOSS DA1650 spectroscopic instrument.

THE PATHWAY TO IMPACT

Benchtop NIR spectroscopy Instruments were shown to have the potential to improve milling efficiency, profitability and sustainability. Through the project, the SRA project team determined that greater profitability could be achieved through improved efficiency in the

cost per sample throughput in mill laboratories. Further benefits were identified through greater quality and quantity of sugar testing, accurate and timely processing of data, and frequent monitoring of the final raw sugar product which enables meeting of quality targets and increased bonus payments. In addition, minor to intermediate improvements in processing were observed and enabled greater mill sustainability through minimisation of wasted energy use, improved boiler efficiency and better coordination and optimisation of maintenance at the pan stage.

As of August 2018, seven instruments have been installed in Australian sugar mills and refineries, four instruments are currently undergoing trialling and one further mill expressing interest in a future trial. SRA's investment in the proof-of-concept and adoption support of NIR laboratory rapid analysis methodologies is leading to greater milling efficiency with further support for the adoption of the technology supplied by SRA through its internal NIR capability.

If you would like more information on benchtop NIR spectroscopy, contact SRA's Steve Staunton on (07) 4056 4502.

(Below) Dr Geoff Kent from QUT presents the Gordonvale 2018 milling research seminar update.



KFA6: PRODUCT DIVERSIFICATION AND VALUE ADDITION

Key Focus Area 6 comprises SRA's product diversification and value addition portfolio. Investment in KFA6 can encompass the identification of new opportunities and uses for sugarcane, economic and market analysis of value-add opportunities and prioritisation of future industry diversification options. The focus area invests in the development of diversification and by-product revenue streams to safeguard enduring industry profitability and sustainability.

INPUTS

Number of investments	3
Total investment 2017/18 ⁹	\$1.6M
Lead R&D providers	Queensland University of Technology, University of Queensland

OUTPUTS AND RD&A HIGHLIGHTS

- Through the Rural R&D for Profit Program project, *Biorefineries for Profit*, researchers have worked on a range of fungi grown from bagasse that could accumulate up to 70 percent of dry biomass as oil which could lead to the future development of next generation biofuels such as aviation fuel. Similarly, results indicate potential probiotic and enzyme supplements could help make bagasse into a more suitable livestock feed.
- Novel research seeking to identify the genes in controlling carbon partitioning into sucrose and fibre has progressed to field trials in the Burdekin region. 24 genotypes representing high sucrose, high fibre, low fibre and poor fibre quality have had leaf and internode tissue samples collected which will be used to identify the expressed genes. Identification of the genes controlling partitioning into sucrose and fibre allows the development of molecular markers for these traits and will assist in improving breeding and variety delivery. Gene identification is also a prerequisite for any future modern gene modification activity such as gene editing.
- A pilot-scale bagasse pulp factory demonstration was completed showing that a high quality bagasse pulp could be produced that would be competitive with imported pulps and that the process waste products may also have value.

OUTCOMES

Tracking against KFA6's five-year year Strategic Plan outcomes.

KFA6 STRATEGIC OUTCOMES 2017/18 – 2021/22		PROGRESS COMMENTS
1	Diversification and value-addition across the industry value chain is supported through the timely identification, prioritisation, assessment and communication of commercial opportunities.	In 2017/18, the SRA Board approved investment to review sugarcane product diversification options. This includes a strategic background brief summarising key technical, commercial, market and decision-making criteria required for diversification based on a literature review and industry consultation. A RD&A assessment framework will be developed to inform SRA's assessment of R&D opportunities in this space.

LOOKING FORWARD

Results and R&D strategy recommendations made through Diversification Review, due to be completed in February 2019, will inform SRA's product diversification and value addition investment in the remainder years of the current Strategic Plan.



KFA7: KNOWLEDGE AND TECHNOLOGY TRANSFER AND ADOPTION

SRA's Key Focus Area 7 concentrates on the development and implementation of knowledge transfer and adoption strategies, processes and activities to ensure transfer of research outputs and translation into on-the-ground outcomes. The focus area houses SRA's internal Adoption unit and a contestable research portfolio facilitating specific adoption activities, research to understand and improve knowledge transfer and projects to improve sugarcane farm business, risk management and decision making. KFA7 also encompasses SRA's Communication unit and industry engagement through the delivery of timely and professional publications and other communication across several mediums.

INPUTS

Number of investments	14
Total investment 2017/18 ('000)¹⁰	\$3.9M
Lead R&D providers	Sugar Research Australia, Cotton Research and Development Corporation, AgProfit, AgTrix, Queensland Department of Agriculture and Fisheries, Dairy Australia, Queensland University of Technology, Ag Econ

OUTPUTS AND RD&A HIGHLIGHTS¹¹

- 252 growers, productivity services' staff and others attended a series of Master Classes in soil health and biology across 2017 and 2018. Feedback from the participants indicated that the classes were a resounding success with feedback ranging from "excellent course: engaging and interesting", "the use of microscopes, practical application was great!" and "continue this every year!". The Master Classes upskilled participants in knowledge of soil biology and soil borne diseases and provided a holistic understanding of the management practices required to improve soil health. Most participants indicated their willingness to accept the challenge of implementing soil improvement plans.
- Six case studies determining the economic and environmental impacts of BMP adoption were finalised and results from the analyses indicate that BMP implementation in the Wet Tropics can be a win-win for both economic and environmental outcomes. The economic benefit from BMP adoption was found to range between \$25 and \$220 per hectare per year. The case study results will continue to be communicated to industry to inform widespread transition to industry BMP.
- A proof-of-concept farm business management framework was built to facilitate the business management capacity of growers in the Herbert. 60 participating growers were provided with three reports analysing their business, financial and production performance, customised for the sugarcane industry. Valuable learnings from this pilot project pave the way for future development of improved farm business management in the industry.
- SRA's Adoption Team delivered numerous professional workshops and events across the year. The annual grower updates were well attended and provided the 225 attendees latest information on potential genetic gains in the plant breeding program, sugarcane variety fibre levels, yellow canopy syndrome, farming systems, soldier fly and grub control, new technology for tillage, and future technology in agriculture.
- Harvesting forums were held across the industry and were well supported with 388 participants provided with the latest results from the Harvesting Program including: the development of an on-line tool to provide operators with real-time feedback on harvesting practices to maximise industry profitability; integration of the front end of the harvester with the feed train and choppers; commercial-scale economic evaluation of field-side cane cleaning, including the impacts of clean cane on milling; and an investigation into different sensors to measure harvesting losses and provide improved feedback to the harvester operator.
- Seven SIX EASY STEPS® workshops were held to provide the 93 participants with knowledge and information on best practice nutrient management. These workshops continue to be popular and are highly rated by attendees.
- SRA released a range of information products including: CogCalibrator™, a new online tool to enable easier fertiliser calibrations; an updated *Australian Sugarcane Nutrition Manual* which provides a practical guide and reference material on most aspects of sugarcane nutrition in all Australian cane growing regions; a range of harvesting best practice guides and fact sheets; and six sugarcane variety guides for the Northern, Herbert, Burdekin, Southern and New South

¹⁰ SRA acknowledges the Queensland Department of Agriculture and Fisheries co-investment contribution in KFA 7 and investment by the Queensland Department of Environment and Science.
¹¹ Note some KFA 7 investments have been reported in KFA's 3, 4 and 5 to align with R&D theme.

Wales regions providing current information on new and recently released cane varieties and their performance against commercially grown standard varieties.

- All of SRA's products are highly rated by growers (between 3.5 -3.9/5) with the three products most accessed being SRA Factsheets, the *CaneConnection* magazine and the monthly SRA e-newsletter.

“Survey results clearly show that SRA publications and e-newsletters are the key vehicles for creating awareness of the organisations activities...This result is a clear endorsement of the communication team's efforts to date in producing these products.”

– Down to Earth Research

OUTCOMES

Tracking against KFA7's five-year year Strategic Plan outcomes.

KFA7 STRATEGIC OUTCOMES 2017/18 – 2021/22		PROGRESS COMMENTS
1	Collaborative, coordinated and evidence-based knowledge and technology transfer that drives broader and accelerated adoption across the industry.	<p>Results from the latest Grower Survey confirm that growers continue to rely on research and information with 43 percent who made a practice change in the past two years acknowledging the importance of information and advice provided by SRA in making those changes. While the proportion of growers using SIX EASY STEPS® has remained steady, there has been a significant rise in the number of growers calculating fertiliser rates based on district yield potential and reducing this rate post mill mud/ash application or growing a break crop.</p> <p>SRA's 2017 season Harvesting Best Practice demonstration trials led to substantial practice change outcomes supporting the importance of a collaborative demonstration trial and evidenced based approach to successful knowledge and technology transfer.</p>
2	Effective, long-term working relationships and collaborations with local extension providers to optimise synergies, integrate knowledge and convert research into desired impacts.	<p>In 2017/18, SRA finalised the Strategy for Industry Led Adoption Activities in the Sugar Industry (Adoption Strategy) which aims to support the profitable and sustainable growth of the Australian sugarcane industry through accelerated application of technologies and practices which lead to targeted and measurable practice change. The Adoption Strategy relies on the collaborative development of investment strategies at the regional and industry level that focus on practice improvement needs and outcomes; the establishment of robust adoption priority setting and investment structures and processes; the establishment of two streams of investment for adoption service delivery (core funding and an Industry Adoption Fund); and the application of consistent design and evaluation approach to all strategies and projects funded through the process. In 2017/18, an Executive Manager and six Regional Coordinators were appointed to facilitate implementation of the strategy.</p>

LOOKING FORWARD

The Adoption Strategy will be rolled out in 2018/19. Industry stakeholders and service providers will have a critical role in working collaboratively with each other and SRA in the process of defining, designing and delivering adoption activities which enable clear and measurable improvement to be achieved in areas of identified need. The Adoption Strategy will be overseen by an Industry Adoption Advisory Committee (IAAC) responsible for identifying priority projects and making a recommendation to the SRA Board for funding approval once these have been fully developed. The Strategy, in conjunction with SRA's new Stakeholder Engagement Framework will provide strategic oversight to guide SRA's engagement with diverse stakeholder groups ensuring optimal relationships that promote delivery of RD&A outcomes.



KFA8:

COLLABORATION AND CAPACITY DEVELOPMENT

Key Focus Area 8 houses SRA's investment in the capacity and capability development of industry and research personnel, and cross-sectoral collaborations to leverage knowledge, resources and impact. Capability development investment covers postgraduate scholarships, research awards, travel and learning awards to enable the exchange of knowledge, ideas and experience, and the development of industry leaders. SRA contributes both domestically and internationally to collaborative RD&A efforts and both leads and participates in cross-sectoral partnerships across Australian agricultural RD&A.

INPUTS

Number of investments	11 Sugar Postgraduate Research Scholarships 15 Sugar Travel and Learning Awards 4 Sugar Industry Research Awards 1 training program development investment Various cross sectoral investments and contributions
Total investment 2017/18	\$1M

OUTPUTS AND RD&A HIGHLIGHTS¹²

- Two postgraduate scholarship recipients were awarded their PhDs. Omkar Thaval, for his research on Robert Evaporator design at QUT and Maren Westermann for her thesis on the effect of organic nutrients on sugarcane growth, microbial activity and greenhouse gas emissions at the University of Queensland (UQ).
- Minh Nguyen, a graduate engineer from James Cook University, completed a four week Sugar Research Institute (SRI)/SRA bursary work placement at Mackay Sugar's Mossman mill and intends to pursue a full time career in the industry.
- SRA was a key sponsor of the NextGen StepUp Conference in Mackay, to encourage activities and development for the next generation of young farmers, millers, researchers and industry professionals. SRA also supported a group of NSW growers to attend through a travel and learning award.
- SRA Indooroopilly site hosted two students from Guangzhou in China, sponsored by the Chinese Government, for a three-month molecular biology training placement. The students assisted SRA researchers in their work to further investigate Yellow Canopy Syndrome.
- SRA Indooroopilly also hosted Noelia Neria, a postgraduate student from UQ's School of Chemistry and Molecular Biosciences, for a six-month placement as part of UQ's Student Industry Placement and Internship Program for young scientists.
- SRA Meringa hosted two high school work experience students interested in learning more about a future career in science.
- SRA's Dr Chuong Ngo, completed a research award investigating the effect of the protozoan that causes chlorotic streak disease. His investigation complements other significant CSD work where research efforts continue at SRA to develop varietal resistance ratings for the disease.
- Through an SRA research award, Dr Johann Pierre, a postdoctoral fellow at CSIRO, in partnership with the South Australian Research and Development Institute, successfully developed a new DNA-based diagnostic tool for the accurate measurement of sugarcane root biomass from field soil samples. The DNA tool improves the industry's ability to quantify the amount of living roots in field samples, previously a laborious manual task, through physical examination. Johann worked closely with SARDI to ensure the test met their analytical service standards and Johann's research award work is now adding value to other projects underway through SRA investment.
- SRA hosted the industry *Futures Forum* in April 2018, bringing together 70 industry stakeholders to consider future scenarios and innovation drivers for the industry and work towards clarification of an industry vision. The Forum identified a number of priority actions to be implemented collaboratively between industry leaders including development of a Sugarcane Industry RD&A Employment and Capability Strategy.
- Dr Max De Antoni, a Research Fellow at QUT and Dr Terry Rose, an agronomist at the University of Southern Queensland (USQ), completed their respective research awards. Max evaluated the ability to reduce nitrate leaching and increase NUE of sugarcane in an eight-month pot experiment and Terry assessed the nitrogen benefits of soybean break crops.
- An SRA travel award was utilised to permit Dr Angelique D'Hont, a world renowned scientist and

¹² Note: KFA 8 milling operations Learning Management System highlight reported in KFA 5 due to research theme.

authority in sugarcane genomics to visit SRA. Dr D'Hont, from the French Agricultural Research and International Cooperation Organisation (CIRAD), gave a seminar and met with researchers from across the Australian sugarcane breeding program (SRA, Queensland Alliance for Agriculture and Food Innovation (QAAFI), CSIRO). Dr D'Hont provided insightful recommendations for SRA's Mackay cytogenetic lab and provided valuable feedback on SRA's introgression breeding research.

- Four small capability projects commenced as part of SRA's *Innovation Catalyst* pilot initiative. Seed funding was provided to SRA researchers to experiment with new scientific techniques or ideas without fear of failure. The program intends to foster a culture of innovative thinking with a view to discovering novel solutions or future research activity of benefit to the industry.
- Travel and Learning awards granted in 2017/18 are providing opportunities for researchers and growers to attend

and/or present at conferences, to meet and visit international peers and their research facilities and foster new collaborations and learning through inviting international experts to deliver workshops and seminars to the Australian industry.

OUTCOMES

Tracking against KFA8's five-year year Strategic Plan outcomes.

KFA8 STRATEGIC OUTCOMES 2017/18 – 2021/22		PROGRESS COMMENTS
1	Leveraged collaborations with research and industry providers to achieve synergies and extend our capacity to deliver value to our investors.	SRA leads, participates and contributes to numerous research programs within the Australian Government's Rural R&D for Profit Program. In Round 3 of the Program, launched in 2017, SRA leveraged \$692,000 of project value for sugarcane related pest management and contributes \$168,000 within a \$10M program of work that will deliver improved products for forecasting of climate extremes to all Australian primary industries. Other leveraged collaborations in 2017/18 include the Plant Biosecurity Research Initiative (PBRI), contributions to the International Consortium for Sugarcane Biotechnology (ICSB) and ongoing variety exchange agreements with eight international sugarcane research organisations.
2	Interactive collaborations with other Research and Development Corporations and Industry-Owned Companies to improve corporate performance and achieve mutual benefits.	SRA maintains vital networks with the network of 15 industry-owned companies and research and development corporations (RDCs) through regular exchange, co-operation and participation in cross-RDC working groups. This includes the CEO, R&D Managers, Business Managers, Communication Managers and Evaluation Working Groups and frequent participation in activities as required by the Council of Rural Research and Development Corporations (CRRDC). In 2017/18, SRA hosted an inaugural cross-sectoral meeting between the R&D program managers of SRA, Cotton Research and Development Corporation and Wine Australia to learn from shared challenges and successes as medium-sized crop research and development organisations.
3	A highly skilled industry and research workforce with the knowledge and capability to meet current and future needs of the industry.	In 2017/18, SRA's capability and capacity development program contributed to the up-skilling of the industry and research workforce through attainment of sugarcane industry employment by engineering students who participated in the SRA/SRI work placement bursary program, ongoing engagement of recipients of SRA research awards in sugarcane RD&A and numerous travel and learning awards used to broaden the professional networks and knowledge of sugarcane scientists and growers at domestic and international conferences.

LOOKING FORWARD

In 2018/19, SRA's new Capability Building Program to develop future industry leaders will be launched and from 2018/19 SRA's research program has been restructured as the Sugar Industry Research Awards to broaden the scheme's scope to allow any applicant, at any stage of their career, the opportunity to develop their research skills or explore new and innovative ideas.



(Above) SRA's Dr Shamsul Bhuiyan with peers at the International Congress of Plant Pathology on a Sugar Travel and Learning Award. (Below) Dr Angelique D'Hont presenting to SRA Indooroopilly staff.



KFA9: ORGANISATIONAL EFFECTIVENESS

Key Focus Area 9 comprises SRA's corporate, finance functions and operations including all facilities and farms. SRA strives to build an investor-centric and performance-driven culture, empower SRA employees and equip them for success and optimise SRA's organisational facilities, systems and processes to support delivery of the RD&A investment portfolio .

INPUTS

Total investment 2017/18 ⁹	\$7.6M
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HIGHLIGHTS

- SRA's overall Workplace Health and Safety Management system scored 92 percent in the annual external audit, up 40 percent since 2016. The auditor noted that this impressive compliance score reflects vast amounts of work completed in the last two years, which included the completion of 1,500 risk assessment recommendations made by Australian Risk Services.
- SRA's audit processes were updated to meet new clauses for matching funds audits in SRA's Statutory Funding Contract with the Commonwealth Government.
- Implementation of the Cultural Values Program continued amongst SRA staff to strengthen the organisations values throughout workplace culture. The third annual independent Cultural Values Assessment Survey showed year-on-year improvements in the SRA working environment, testament to the initiatives and activities of the program and SRA staff.
- A further two farms at the Ingham and Burdekin SRA sites were awarded their Smartcane BMP accreditation, in addition to existing accreditation of the Meringa and Mackay sites.
- SRA's farm operations invested in lateral move irrigation at the Bundaberg and Mackay sites to improve irrigation efficiency, invested in three new Case harvester fronts to improve feed of cane for trial plot assessments and made improvements to irrigation at SRA's Burdekin farm for greater pumping efficiency and supply.
- The Research Funding Acquittal Performance Internal Audit was completed to ensure SRA's research providers are appropriately utilising SRA's investment on behalf of the industry. The Audit found no cause for concern in research provider conduct and that SRA has established appropriate policies and procedures to govern the research funding program.



Our Values

INNOVATION
INVESTOR SATISFACTION
ACCOUNTABILITY
TEAMWORK

OUTCOMES

Tracking against KFA9's five-year year Strategic Plan outcomes.

KFA9 STRATEGIC OUTCOMES 2017/18 – 2021/22		PROGRESS COMMENTS
1	The right internal culture, capability, systems and facilities to deliver beneficial RD&A activities to industry and positive returns on investment.	The second year of consecutive improvement in SRA's Cultural Values Assessment Survey indicates further improvement of an internal culture in line with SRA's organisational values of investor satisfaction, accountability, teamwork and innovation. The Cultural Values Program continues into 2018/19.
2	Employees are supported, valued and recognised for performance.	SRA's employees are recognised for performance through the Reward and Recognition Program administered through the People, Performance and Remuneration Committee (PPRC).
3	SRA's workplace facilities are modern and well-maintained and workplace processes are best-practice.	In 2017/2018 SRA undertook investments in regional research stations to support RD&A. These included: completion of the Meringa Station refurbishment; commencement of construction of additional offices; machinery shed and spectracane lab at Ingham; and major building maintenance at Tully.














LOOKING FORWARD

In 2018/19, SRA will continue the roll out a new Safety Culture Program across the entire organisation, complete the redevelopment of the Bundaberg and Ingham research stations and upgrade Indooroopilly quarantine facilities. Ongoing development and investment in IT systems will continue and aim to deliver effective tools to meet the needs of all SRA users.




APPENDIX 1

KFA MEASURES


2017/18 ANNUAL OPERATIONAL PLAN MEASURES	TARGETS FOR 2017/18	STATUS	COMMENTS
🌱 KFA1: Optimally-adapted varieties, plant breeding and release			
Rate of genetic gain.	Progress towards 2% genetic gain, as measured by Final Assessment Trial test clone performance.	●	Progress towards improving genetic gain is underway through the implementation of 16 work packages to modernise SRA's breeding program..
Percent production from new varieties.	Increasing.	●	Production from new varieties held steady overall between 2016 and 2017. Increasing in the Northern, Hebert, Burdekin and Central regions and moderating in the Southern regions.
Molecular markers.	Validation of molecular markers for use in breeding program.	●	Testing of the application of genomic selection in sugarcane is underway and an elite bi-parental mapping population is under development to produce new information on the genetic control of commercial traits.
🌱 KFA2: Soil health, nutrient management and environmental sustainability			
Soil health.	Identification of key indicators of soil health.	●	Preliminary results from Hebert and Burdekin trial sites demonstrate soil health indicators can be identified which demonstrate improved soil condition in response to adoption of the 'Improved farming system'.
Adoption of SIX EASY STEPS®.	75% of growers use SIX EASY STEPS®.	●	72% of growers use SIX EASY STEPS®, an improvement on 69% in 2017.
Economic and environmental indicators to demonstrate impact from transitioning to improved farming systems.	Metrics and data collection established, with benchmarks to be set following analysis of 2017/18 performance data (in collaboration with CSIRO and Queensland Government's Paddock to Reef Programme).	●	6 case studies measuring and demonstrating economic and environmental impact of transitioning to industry BMP completed in 2017/18. Ongoing water quality testing and measurement of nutrient run-off from farm demonstrations to understand environmental impact of management for improved nutrient use efficiency practices.
🌱 KFA3: Pest, disease and weed management			
Up-to-date dossiers reflecting current knowledge for high-risk exotic threats.	Reviewed annually.	●	Updated.
Adoption of new and/or improved pest management strategies.	At least 20% of growers adopted new and/or improved pest management strategies within last five years.	●	35% of growers have made a change to weed and/or pest management in the past two years.
Pest and disease screening of clones from various stages of selection programs, parents and foreign clones.	At least 2,000 clones screened annually.	●	Screened >2,000 sugarcane clones at various stages of selection program for smut, lead scald, mosaic, red rot, Fiji leaf gall and nematodes.

 KFA4: Farming systems and harvesting			
Productivity impact from adoption of new farming practices and/or technology.	Positive input-output efficiency ratios, demonstrated through case-studies.		Project 2014/079 demonstrated productivity improvements on three case study farms through reduced energy, water, labour and vehicle inputs when installing automated furrow irrigation technology.
Adoption of new farming practices and/or technology.	At least 70% of growers producing more than 7,000 tonnes per annum adopted new practices and/or technology over two-year period.		2018 Grower survey indicates that on average 58.5% of large and extra-large growers (greater than 7,000 tonnes) have made practice change improvements in the last two-year period.
	At least 50% of growers producing less than 7,000 tonnes per annum adopted new practices and/or technology over two-year period.		2018 Grower survey indicates that on average 49.5% of small and medium size growers (less than 7,000 tonnes) have made practice change improvements in the last two-year period.
Adoption of harvesting best practices.	10% increase in harvesting best practice demonstration sites.		43 harvesting demonstration sites held in 2017 season, increase from 19 held in 2016.
 KFA5: Milling efficiency and technology			
Adoption of improved or novel milling processes and technology.	All milling groups aware of available new processes and technology.		108 attendees across five regional milling research seminars (Mackay, Townsville, Gordonvale, Broadwater, Bundaberg) held in March 2018 in partnership with QUT. 2 Milling Matters publications published.
Adoption of laboratory NIR systems.	50% of sugar mills adopted new NIR systems.		7 laboratory NIR system instruments have been installed, 4 are being trialled and 1 mill has expressed interest in conducting a trial.
Miller satisfaction with SRA milling research and services.	Average rating of at least 4 out of 5 achieved by 2022.		Average of 2.8 in inaugural baseline survey collection (Note: small sample size).
 KFA6: Product diversification and value addition			
Identification of new opportunities in product diversification and innovation.	Bio-refinery opportunities identified and prioritised.		Diversification review contracted in late 2017/18 to commence and complete in 2018/19.
 KFA7: Knowledge and technology transfer and adoption			
Productivity impact from adoption of new farming practices and/or technology.	Positive input-output efficiency ratios, demonstrated through case-studies.		6 case studies demonstrated the economic benefits of transitioning to new farming practices and technology in line with industry BMP. The economic benefit ranged between \$25 and \$220 per hectare per year.




 **KFA7: Knowledge and technology transfer and adoption (continued)**

Adoption of new farming practices and/or technology.	At least 70% of growers producing more than 7,000 tonnes per annum adopted new practices and/or technology over two-year period.		2018 Grower survey indicates that on average 58.5% of large and extra-large growers (greater than 7,000 tonnes) have made practice change improvements in the last two-year period.
	At least 50% of growers producing less than 7,000 tonnes per annum adopted new practices and/or technology over two-year period.		2018 Grower survey indicates that on average 49.5% of small and medium size growers (less than 7,000 tonnes) have made practice change improvements in the last two-year period.
Grower and miller satisfaction with SRA adoption and communication activities.	Average rating of 3.5 (or above) out of 5.		Growers surveyed rated SRA's communication products and services 3.7 on average. Millers surveyed rated SRA's communication products and services 2.9 on average in the inaugural survey. (Note: small sample size).

 **KFA8: Collaboration and capability development**

SRA participation and investment in relevant collaborative and cross-sectoral programs, including the Commonwealth's Rural R&D for Profit Programme.	Ongoing contribution and support.		Ongoing participation in numerous programs, e.g. Rural R&D for Profit projects and cross sectoral programs on managing impacts of climatic events, improving plant pest management, nutrient use efficiency, precision agriculture and value-adding through biofuels and bioenergy.
Scholarships awarded to current and future industry participants.	Minimum of 4 postgraduate scholarships and two research awards.		2 postgraduate scholarships awarded, 2 research awards.
Short-term placements of students and/or professionals in research or industry positions for industry exposure.	At least 2 placements.		2 industry placements funded through the joint SRA-SRI bursary program.

 **KFA9: Organisational effectiveness**

Investor performance rating for SRA.	Increase from 74% 'high' (2016) to 85% by 2022.		72% of surveyed growers rated SRA's performance high to very high. 67% of surveyed millers rated SRA's performance fairly highly to high. (Note: small sample size).
Economic, social and environmental returns from RD&A investments.	Aggregated research investment benefit-cost ratio of 4:1 or above by 2022.		2.9:1.0 average cost benefit ratio. Improvement on 2:1 in 2016/17.
Governance performance.	Maintain 100% compliance with statutory and contractual requirements.		Met target of 100% compliance.

APPENDIX 2

ACRONYMS

ABBREVIATION	IN FULL
BMP	Best management practice
CAS	Cane Analysis System
CAT	Clonal assessment trial
CCS	Commercial cane sugar
CEO	Chief Executive Officer
CIRAD	French Agricultural Research and International Cooperation Organisation
CRRDC	Council of Rural Research and Development Corporations
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CSD	Chlorotic Streak Disease
Cth	Commonwealth
DES	Queensland Department of Environment and Science (Queensland)
DNA	Deoxyribonucleic acid
EEF	Enhanced efficiency fertiliser
FAT	Final assessment trial
ha	Hectares
HBP	Harvesting Best Practice
HOW	Harvesting Optimisation Week
HCPSL	Herbert Cane Productivity Services Limited
IAAC	Industry Adoption Advisory Committee
ICSB	International Consortium Sugarcane Biotechnology
KFA(s)	Key focus area(s)
Kg	Kilogram
KPIs	Key Performance Indicators
kW	Kilowatt
LMS	Learning Management System
m	Million
Mt	Million tonnes
N	Nitrogen
NESP	National Environmental Science Program
NIR	Near infrared
NUE	Nutrient Use Efficiency
NQ	North Queensland
NSW	New South Wales

ABBREVIATION	IN FULL
OECD-FAO	Organisation for Economic Co-operation and Development – Food and Agriculture Organisation
PAFTA	Peru Australia Free Trade Agreement
PBR	Plant Breeder's Rights
PBRI	Plant Biosecurity Research Initiative
PhD	Doctor of Philosophy
PPRC	People, Performance and Remuneration Committee
QAAFI	Queensland Alliance for Agriculture and Food Innovation
QDAF	Queensland Department of Agriculture and Fisheries
QDES	Queensland Department of Environment and Science
QLD	Queensland
QUT	Queensland University of Technology
R&D	Research and development
RD&A	Research, development and adoption
RDC	Research and development corporation
RSD	Ratoon stunting disease
RTSS	Real time scheduling software
SARDI	South Australian Research and Development Institute
SASA	South African Sugar Association
SESAC	SIX EASY STEPS® Advisory Committee
SCHLOT	Sugarcane Harvesting Logistics Optimisation Tool
SMRP	Small Milling Research Program
SNP	Single nucleotide polymorphism
SRA	Sugar Research Australia Limited
SRI	Sugarcane Research Institute
SSMV	Sugarcane Streak Mosaic Virus
t/ha	Tonnes per hectare
TCH	Tonnes of cane per hectare
UQ	University of Queensland
USQ	University of Southern Queensland
YCS	Yellow canopy syndrome



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MILLING MATTER

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- 2 MICRO-GROS: Powering the future of irrigated sugarcane
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