# 2017/18 PROGRESS REPORT





**NEW WEBSITE LAUNCHED** 

www.sasri.org.za

## NEW MOBILE APPLICATIONS

• FertiCalc, RustCalc, Pur*Est®* update

## NEW DESKTOP DECISION SUPPORT TOOL • Stalkgro

## **CAPACITY DEVELOPMENT**

- First regional modular course initiated in 2017
- 115 students attended the Senior Certificate Course
- 107 students attended the Junior Certificate Course

## **CONTACT EVENTS**

- 1 770 Visits to growers
- 346 presentations at scientific events
- Hosted 1 102 visitors at SASRI
- 129 Grower days

## RADIO

• 80 programmes at 10 radio stations

## **3 NEW VARIETIES**

 $\left[\text{N63, N64 and N65}\right]$  with increased RV yields and improved pest and disease resistance

Successful containment of a new pest infestation (longhorn beetle) and integrated management technologies for the sustainable, long-term management of the pest





## **SRASA COMMITTEE**

Chairman: GD Stainbank (April – December 2017) S Naidoo (January 2018 – Current) Vice-Chairman: PW Russell (April – December 2017) HR Hackmann (January 2018 – Current)

## **GROWERS REPRESENTATIVES**

TB Funke TJ Murray AM Russell S Sharma GD Stainbank (January – Current) R Talmage GW Taylor KM Hurly (alternate) GDP Littley (alternate) S Mashaba (alternate) W Visser (alternate – April – August 2017) ST Naidoo (alternate – April – December 2017)

## **MILLERS REPRESENTATIVES**

EA Brüggemann J Dewar N Dlodlo FM Eggers AJ Harris SS Munsamy **RS** Ninela **DP** Rossler PW Russel (January 2018 - Current) D van Rooy JPM de Robillard (alternate) JDP Erasmus (alternate) CJ Galloway (alternate) RB Lütge (alternate) D Sutherland (alternate) AT Wynne (alternative)

## SASA REPRESENTATIVES

CM Baker M Govender P Mpofu R Stranack MK Trikam DA Watt R Mahadeo (Secretary)

## SASRI MANAGEMENT TEAM

(as at 31 March 2018)

## **EXECUTIVE COMMITTEE**

Director: CM Baker Research Manager: DA Watt Operations Manager: KA Redshaw Finance and Admin Manager: R Mahadeo Human Resources Manager: C Botes

## **PROGRAMME MANAGERS**

Variety Improvement: SJ Snyman Crop Protection: RS Rutherford Crop Performance and Management: R van Heerden Systems Design and Optimisation: R van Antwerpen

## **RESOURCE MANAGERS**

Crop Biology Resource Centre: S Buthelezi Plant and Environment Resource Centre: B Naidoo Diagnostic and Analytical Resource Unit: KA Collings Breeding and Field Resource Unit: S Ramgareeb Extension and Biosecurity: RA Stranack Knowledge Management: ML Binedell

## **CONTENTS**

Chairman's Report	1
Director's Report	3
Overview of SASRI Research	5
Variety Improvement Research	11
Crop Protection Research	15
Crop Performance and Management Research	19
Systems Design and Optimisation Research	23
Research Contracts	27
Research Collaborations and Partnerships	29
Research Grants	30
Achievements and Awards	33
Extension	35
Technology Development and Knowledge Exchange	39
Biosecurity	43
Advisory and Support Services	47
Publications and Presentations	51



## CHAIRMAN'S REPORT SURESH NAIDOO

Since the work conducted in any research organisation is guided by its strategic plan, SASA Council's approval in March 2017 of SASRI's five-year plan (devised in 2015), was welcomed.

The focus of this plan, developed in consultation with the Sugarcane Research and Sustainable Agriculture (SRASA) Committee and additional grower and miller representation, reflects a considerable shift from the previous strategic plan, and emphasises delivery and implementation of relevant technology for enhanced sugarcane productivity and sustainability. This change was emphasised by the increased number of technology development and knowledge exchange projects in the research portfolio presented for approval in early 2018.

Further, with its newly developed thematic approach to research and development (R&D), SASRI has made it abundantly clear where their efforts are directed. The delineation of seven impact areas defines where their research adds value, and reveals the manner in which the institute aspires to contribute to industry sustainability. The portfolio of projects that reflect industry requirements evidences SASRI's commitment to consultation with all stakeholders through the Research Development and Extension (RD&E) structures when developing and considering new projects. This provides useful justification for the industry investment into R&D. With the approval of GM commercialisation, SASRI once again demonstrated its resilience and determination to pioneer this technology in South African sugarcane varieties. The first year of the programme commenced with the aim of delivering an insect-resistant, herbicide tolerant cultivar for the future. This represents the culmination of two decades of preparatory research and development, and highlights the valuable experience that is resident amongst SASRI scientists.

In a year dominated by the incursion of a previously unreported pest, the longhorn beetle, the SRASA Committee successfully recommended an unprecedented course of action to SASA Council that entailed provision of R50 million towards containment of the pest. Confined to just one region in the industry, an area of 1 000 hectares was delineated as the pest containment zone, and all infested cane within that perimeter was eradicated and replaced with a two-year fallow.

## The enormity of this task as well as its achievement within a very short space of time is astonishing.

This is a tribute to SASRI's rapid responses and to those affected growers that were directly involved. While eradication of this pest is not possible, curtailment of its populations in sugarcane is the desired outcome.



It is pleasing to report that the new tissue culture facility at SASRI, under construction in the previous financial year, is now operational. The facility was designed to deliver NovaCane® plants into the bulking stage of the plant-breeding programme to enable rapid multiplication of disease-free and true-to-type material for distribution into the gazetted regions of the industry. This reflects the calibre of innovation that is embedded in the research institute. This new approach and adjustment in the breeding programme was designed to ensure that SASRI's new varieties, which are characterised by significant advances in their yield potential, become more readily available to enhance grower productivity and profitability.

Meeting the expectations of industry demands the dedication of a committed cohort of scientists and specialists, whose exclusive research focus is improving sugarcane productivity and ensuring its sustainability. The South African industry is indeed fortunate to have such a dedicated group of highly skilled people resident at SASRI. The SRASA Committee remains committed in its support of SASRI's R&D programmes, many of which are outlined in this annual report. The Committee also acknowledges the importance of ensuring that the research institute has the latitude that it requires to deliver on its strategic plan. Current challenges in the industry have resulted in sustained scrutiny of SASRI's efficiencies, and considerable pressure continues to be placed on the institute to be responsive to industry's future strategic requirements and to deliver required outcomes to all growers.

This outlook is unlikely to change in the near future. Nevertheless, I remain confident that the institute will endure these stresses and remain a vibrant source of innovation for the long-term survival of our industry.



## In a year dominated by far-reaching changes in the industry, SASRI has maintained its commitment to serving all growers and millers by conducting relevant, rigorous and robust research.

Improving and sustaining sugarcane productivity in the South African sugar industry requires continual re-evaluation of old technologies and recommendations, application of new technologies and innovations, and implementation of enhanced agricultural efficiencies. At SASRI, our emphasis on ensuring that our research delivers tangible outcomes for all of our growers and millers is embedded in the conception and development of each of our projects. This has culminated in an exciting set of findings, many of which are covered in this report.

In addition to the ongoing work in the four research programmes namely, variety improvement, crop protection, crop performance and management and systems design and optimisation, particular emphasis was placed on interrogating the plant-breeding programme. An external expert review of the programme endorsed the revised breeding strategy formulated by our plant breeders with a view to enhancing genetic gains and improving selection strategies. In particular, the proposed shift from a niche-focused strategy for variety selection towards one that recognises the value and efficiency of conducting breeding and selection in the industry's three mega environments, yielded considerable debate regarding the range of potential scenarios that were proposed. Throughout the past year, significant resources were devoted towards addressing containment of the longhorn beetle incursion in the Entumeni area. This new pest *(Cacosceles newmannii)* that appears to have transitioned from forests into sugarcane required united, collective and strategic action. This combined approach aimed to induce a dramatic decrease in populations as quickly as possible, to prevent its escape to any other region in the industry. The destructive potential of this beetle warranted implementation of extra-ordinary measures and immediate commitment towards a research programme targeted at understanding the biology, behaviour and ecology of this little known species.

# Ongoing focus on eldana control saw the implementation of a cost-effective approach to inducing sterility in wild populations of moths.

The F1 sterile insect technology (SIT) project established the efficacy of irradiating newly emerged male moths reared in proximity to the irradiator in the Western Cape, mating them with un-irradiated females and transporting their eggs back to SASRI. In the forth-coming season, the impact of the male moths emerging from these eggs will be tested in cage trials before considering scaling up to pilot field releases. Should this approach be successful, the considerable investment in eldana research over the past 45 years will have culminated in the successful compilation of a series of tools aimed towards managing the impact of this long-standing and devastating pest.



Additionally, research associated with each of the other strategic objectives in our Strategic Plan continues:

- Work towards increased RV yields and pest and disease resistance of new varieties through conventional, introgression, mutational and molecular breeding is ongoing with the aim of demonstrating that genetic gains in RV yields achieved in our plant breeding trials can be attained under commercial conditions and SASRI's better management practices.
- Provision of readily accessible and up-to-date mechanisation information to support growers in interrogating and improving their mechanisation practices is available online.
- Work towards enabling production of reliable predictions of climate change impacts on crop water use and yield for existing and potential agroclimatic zones is on track together with the identification of feasible adaptation strategies.
- Excellent progress towards optimising soil health and crop nutrition to maximise production efficiencies were made.
   This was supported with the development of guidelines for the amelioration of top and sub-surface soil acidity and detecting that reliable leaf nitrogen threshold values for improving nitrogen fertiliser recommendations would be improved with simultaneous estimation of stalk biomass.

While this work outlines only a fraction of the research conducted at SASRI, it is in addition to the host of specialist services that continue to be provided to support grower and miller agricultural operations. The growing need for all farmers to enhance their sugarcane productivity resulted in development of regional modular courses. Designed to serve as refresher courses, a pilot course presented on the north coast was very well received. This prompted preparation of two further courses for the forthcoming year. Furthermore, for the first time, SASRI collaborated with the University of Mpumalanga to provide a short learning programme on Sugarcane Production.

Diagnostic and analytical services remained in demand, and given the importance of attending to soil health, soil sample analyses increased over the previous year by 7%. While the value of taking leaf samples is undisputable, it was unfortunate that leaf analyses for growers decreased by 8%, largely because of lower submissions from growers outside South Africa.

Remaining a focus in the Extension arena, it was satisfying to record a 100% submission of SUSFARMS® Progress Trackers by growers in three mill areas, namely Eston, Noodsberg and UCL. Since this tool provides a comprehensive guide to all of SASRI's recommendations and better management practices, SUSFARMS® serves as the basis for extension support to all growers in the industry, and is in the review process to ensure relevance for both large-scale and small-scale growers alike.

## Commitment to exchanging our technologies and knowledge to all growers is evident in the extent to which our extension and knowledge management group work together to design a range of technology transfer activities intended to guide good farming practices.

Ranging from development of demonstration trials in all sectors, grower engagement sessions in the form of field days and study groups as well as grower visits, we continue to strive to understand grower needs and deliver support that is responsive, useful and informative.

SASRI's ongoing commitment to graduate skills development have resulted in five PhDs and six MScs, as well as four postdoctoral researchers. The internship programme remained vibrant and productive. The standing of SASRI scientists was evidenced in the number of honorary academic positions held at South African universities amounting to 12. These relationships enable collaboration and leverage resources where applicable.

Without the generous support and strategic direction from the industry, SASRI would be unable to deliver on its mandate and for this, we remain very grateful. However, I remain indebted to the extremely competent SASRI staff since it is their hard work, dedication and commitment that contributes to our successes. Without their co-operation, collective effort and collaboration SASRI's accomplishments would be severely diminished.

## **OVERVIEW OF SASRI RESEARCH** DEREK WATT, RESEARCH MANAGER

## **RESEARCH AGENDA 2020**

During 2017/2018, the sugar industry leadership finalised the agenda for the SASRI research programme for the period 2015-2020. Within this strategic vision for SASRI research delivery, six research impact areas are identified:

- Eldana Control
- Higher RV Yields
- Climate Change Adaptation
- Bioenergy Applications
- Crop and Soil Health
- Mechanisation Information

The biosecurity threat posed to the industry by the localised outbreak of a Longhorn Beetle in northern Zululand, resulted in a seventh critical impact area.

The research enabling these positive impacts on industry performance areas is administered within four research programme areas: Variety Improvement, Crop Protection, Crop Performance and Management and Systems Design and Optimisation.



## **RESEARCH IMPACT AREAS**

## **IMPACT AREA TARGETS**

Impact Areas are articulated to maximise the contribution of SASRI research outcomes to the profitability and sustainability of sugarcane production in South Africa.



### PROGRESS

Research progress in 2017/2018 within the seven Impact Areas.

#### 1. Longhorn beetle management

- Three insecticides with two different modes of action registered.
- Mechanical stool eradication methods developed.
- Several microbes identified as having potential as biological control agents.
- Post-doctoral Research Associates (PDRAs) and post-graduate students appointed at the universities of Pretoria and Stellenbosch to investigate the chemical ecology and agro-ecology of the beetle.

Preliminary evidence indicates that the pheromone differs markedly from those emitted by other pest longhorn beetles. Desiccation and starvation experiments reveal that the larvae are extraordinarily tolerant of resource limitations.

## 3. Increased rv yields

• Good genetic gains achieved in breeding for RV.

## 2.Eldana control

- Good progress made with F1 Sterile Insect Technique (SIT) development.
  - F1 SIT efficacy testing in cage trials to commence in Spring 2018.
- Good progress made in Bt GM pre-commercialisation research.
  - Two genetic constructs containing the Bt Cry1A and Cry2A genes synthesised and introduced into sugarcane cells.
- Good progress made in breeding for variety eldana resistance within the coastal programme.
  - Tactics implemented to spread these gains to other regional breeding programmes.
- PDRA at University of Pretoria investigating chemical ecology.
- Progress made in identification of biocides and collaboration with Wits to be established.
- Trials under way to integrate plant resistance priming with pesticide efficacy and clarify the role(s) of the fungus, fusarium, in eldana-sugarcane interactions.

BREEDING PROGRAMME	GENETIC GAINS PER ANNUM			GENETIC GAINS PER ANNL	
	CANE YIELD	RV% CANE	TONS RV		
Midlands	2.18%	0.55%	2.92%		
Coastal Long Cycle	1.97%	0.01%	1.87%		
Coastal Short Cycle	0.18%	<b>-0.67</b> %	-0.64%		
	1.32% <sup>a</sup>	0.29% <sup>a</sup>	<b>1.06</b> % <sup>a</sup>		
Irrigated	0.18%	0.68%	1.03%		

a These values are calculated over the last six breeding cycles.

The improvements reflect the turnaround breeding strategy for the coastal short cycle programme implemented in 2011.

· Good RV yield benefits demonstrated for new varieties.

GION	RV YIELD BENEFIT® TONS RV/HA	GENETIC GAINS¢ Tons RV / HA / New Variety
lidlands	12.50	0.21
linterland	8.10	0.30
Coastal	1.20	0.30
rrigated	1.20	0.13

b Derived from post-release variety trial data.

c Derived from grower managed variety trial data.

• Grower-led commercial trials demonstrated the RV benefit of ripening.

REGION	MAXIMUM RV YIELD BENEFIT	
	TONS RV / HA	
Midlands	2.1	
Coastal	1.1	
Irrigated (Pongola)	3.1	
Irrigated (Komati)	2.1	

• During 2017, knowledge exchange with growers and MCPs on RV benefits of new varieties and ripening facilitated at 20 formal contact events.

## 4. Climate change adaptation

- Refined Canegro crop model demonstrated to have improved accuracy under simulated climate change scenarios and multi-site sensitivity analyses reveal plausible simulated crop responses.
- Refined model predicts crop yields, water use and irrigation requirements for predicted mid-century climate scenarios.
- Simulations indicate agronomic adaptation options for a changed mid-century climate.

## **5.Bioenergy applications**

- On-farm energy-use calculator tool developed.
- Model developed to calculate cost of various residue collection, processing and transport options.
- Life cycle assessment conducted on primary fossil fuel energy inputs and greenhouse gas emissions for sugarcane production.
- Resource-use requirements and potential of sugarcane for bioenergy established and compared to other bioenergy crops.

• Informal research collaborations explored with Imperial College and Swiss Federal Institute of Technology.

## 6.Crop and soil health

- Total soil nitrogen (N) demonstrated to be a reliable index of soil N supply to the crop and will result in improved reliability of N recommendations when included in the FAS analytical package.
- Lime and gypsum topdressings on ratoons demonstrated as effective in ameliorating acidity on sandy and humic soils.
- Research demonstrated that establishing a universal indicator of soil health is not easily achievable, although mid-infrared spectroscopy may be used with reasonable precision to predict biological soil health indicators.

## 7. Mechanisation information

On-line database created of nationally - and - internationally available mechanical equipment.







## **VARIETY IMPROVEMENT RESEARCH**

SANDY SNYMAN, PROGRAMME MANAGER

Continual release of high-sucrose yielding varieties, through both improved sucrose content and biomass yield that are pest and disease resistant and enhance industry productivity.



## **RESEARCH HIGHLIGHTS**

## Breeding of new and improved varieties

- Varieties N66 (high altitude 18-24 month cutting cycle for humic soils), N67 (coastal 12-14 month cutting cycle on average and high potential soils) and N68 (coastal 14-18 month cutting cycle for high potential soils) gazetted for cultivation.
- Good RV yield benefits demonstrated for new varieties.
- Analysis of advanced-stage plant breeding trials in the midlands reveal promising gains for sugar yield and eldana resistance.
- Tactical revisions to breeding permit more effective selection of irrigated varieties and for eldana resistance in midlands' varieties.

## NovaCane® technology

Further evidence gained that NovaCane® technology produces true-to-type sugarcane across plant and ratoon crops.

## Introgression (Diversification) breeding

- Forty-two crosses amongst SASRI sugarcane genotypes and selected wild *Saccharum spontaneum* genotypes selected for execution in Barbados.
- Seed from each of the crosses to be re-imported into South Africa for family evaluation trials during 2019.

## Variety evaluation

Confirmation from ongoing analyses that newly released varieties continue to out-perform older varieties on a tons RV per hectare basis.

- N59 demonstrated considerable promise for cultivation on a long cutting cycle on the south coast.
- N52 demonstrated as being superior to other midlands varieties in terms of RV/ha.



## **Ratoon Longevity**

Further outcomes indicate that differences in ratoon longevity of newer and older variety releases are generally not statistically significant.

#### **GM technology**

- Bt *Cry1A* and *Cry2A* genes synthesised for the genetic engineering of sugarcane.
- Independent external review supportive of the SASRI technical strategy for the development of Bt GM sugarcane.
- Stakeholder engagement session on Bt GM sugarcane hosted at the 90th Annual Congress of the South African Sugar Technologists' Association.
- Industry communication plan on commercial Bt GM variety to be developed in conjunction with Biosafety SA.

#### Preserving valuable germplasm

Sugarcane germplasm may be stored safely for up to four years under specific laboratory conditions and indefinitely at ultra-low temperatures, which will be invaluable during the development of a Bt sugarcane variety when synchronous production of numerous genetically-modified lines will be required.

#### Sugarcane genetic analysis technology

- A novel bioinformatics pipeline developed to enable snapshot views of genes being expressed in response to particular stimuli (e.g. eldana boring), which will ultimately inform marker-assisted breeding of eldana-resistant varieties.
- Implementation of novel in-house informatics has facilitated the description of the full lignin pathway, representing the first full pathway description in sugarcane.
- All genes within the chromosome region of the sugarcane brown rust resistance gene, *Bru1*, have been assembled.

## ESSENTIAL OUTCOMES FROM COMPLETED RESEARCH VARIETY CHARACTERISATION

## Agronomic performance of NovaCane® versus conventional seed under rainfed conditions

- Tissue culture propagation by NovaCane® does not compromise the yielding ability of sugarcane over crops and propagation stages.
- This is despite the NovaCane<sup>®</sup> process affecting the phenotype (observable characteristics) of selected varieties (characterised by a higher population of thinner stalks), across crops and propagation stages.
- Hence, the multiplication of new varieties using the NovaCane<sup>®</sup> is suitable for the bulking of new varieties for release, although routine assessments of varietal responses in bulking plots is recommended.

## **PROGRESS IN ONGOING RESEARCH**

#### VARIETY CHARACTERISATION

#### **Commercial Breeding and Variety Evaluation**

- Trials conducted during 2017/2018 revealed that N62, N61, N58 and N59 have the potential to deliver benefits of up to 6 tons RV/ha in the hinterland when compared with N12.
- Grower events at the hinterland trial sites on grower collaborator farms held during the course of 2017/2018 promoted the adoption of these newer, superior releases.

#### **Ratoon Longevity**

- Data obtained during 2017/2018 continue to support the scientific contention that differences in ratoon performance of newer and older variety releases are generally not statistically significant.
- However, it has emerged that comparison of ratoon age categories (e.g. young [P, R1, R2], medium [R3, R4, R5]) may provide information more relevant to grower concerns about variety ratoon longevity.
- The economics of ratoon length and replant tactics are under investigation in a separate study that aims to assist grower decision-making in this regard.



## **INTROGRESSION BREEDING**

- During 2017/2018, forty-two crosses were made in Barbados amongst SASRI sugarcane genotypes and selected wild *Saccharum spontaneum* genotypes in the collection held by the West Indies Central Sugar Cane Breeding Station.
- The seed from each of the crosses will be planted into family evaluation trials in South Africa during 2019.

## **NOVEL AND IMPROVED TRAITS**

## **BT GM SUGARCANE COMMERCIALISATION RESEARCH**

#### **Biosafety and communication**

- SASA/SASRI has joined Excellence Through Stewardship as a means to access expert oversight of the implementation of GMO stewardship programmes and quality management systems, as well as the facilitation of independent third-party audits for verification.
- A stakeholder engagement session with growers and miller-cum-planters on GM sugarcane hosted at the 90th Annual Congress of the South African Sugar Technologists' Association was held between 15 and 17 August 2017 at the Durban International Convention Centre.
- A communication strategy on 'industry plans to develop a commercial GM variety' will be developed in conjunction with Biosafety SA.

## **TECHNICAL PROGRESS**

- Outcomes of a commissioned external review of SASRI technical strategy for the development of Bt GM sugarcane were overwhelmingly favourable.
- Following the findings of an IP audit, the Bt *Cry1A* and *Cry2A* genes have been synthesised for the genetic engineering of sugarcane.
- A biogeographical survey and phylogenetic analysis of sugarcane wild relatives in KZN and Mpumalanga have revealed that *Miscanthidium capense* (Daba dropseed grass) and *M. junceum* (Wireleaf Daba grass) are species most likely to hybridise with commercial sugarcane.
- Field assessments of pollen viability of 13 commercial sugarcane cultivars have revealed decreasing pollen viability (from 85 - 0%) from the northern (Malelane) to the south eastern (Port Shepstone) regions of the study area.
- Future research is to investigate factors that may influence potential gene flow, including cytological compatibility and introgression between sugarcane and *Miscanthidium* species.

## Development of an integrated field programme for deploying imazapyr tolerant sugarcane

 Gene sequencing and protein modelling of the consequences of a point mutation in the acetolactate synthase (ALS) gene have characterised the mechanism of imazapyr tolerance in a promising mutant N12 variety produced by mutation breeding.



#### Production of stress tolerant varieties by mutagenic breeding

- Epigenetic variants of N41 resulting from altered DNA methylation are to be generated through treatment of embryogenic calli with azacytidine and imidacloprid.
- Selection of plants with altered methylation patterns will be performed through the application of high temperature (40°C) and polyethylene glycol (PEG), with the latter mimicking drought *in vitro*.
- In addition, selection of plants with potentially desirable mutations is to be imposed through the application of a phytotoxic compounds related to stress, including Al<sup>3+</sup>, paraquat, methyl-glyoxal and toxic products from the action of reactive oxygen species (ROS) on lipids.

## **GENOMICS AND BIOINFORMATICS**

## Synteny analysis and genome mapping

- Implementation of novel in-house informatics has facilitated the description of the full lignin pathway, representing the first full pathway description in sugarcane.
- A novel transcript mapping pipeline has been developed using Exonerate, a generic tool for pairwise sequence comparison.
- All genes within the *Bru1* chromosome region from sugarcane and *S. spontaneum* have been assembled.

- Full text analysis has been integrated into the sugarcane gene assembly pipeline for the identification and assembly of sugarcane genes proven by transgenesis to be responsible for stress responses in sugarcane and closely related species.
- A new pipeline has been developed with the imaging software lcy (an open community software for bio-image informatics) to derive karyotypes for sugarcane, sugarcane ancestral species and closely related species.

## **GENETIC VARIATION AND PHYLOGENY**

- Phylogenetic analyses have revealed a surprisingly narrow genetic base in the *Saccharum spontaneum* chosen for sugarcane breeding, indicating that current collections have not sampled the true breadth of *S. spontaneum* types present in the wild.
- SASA/SASRI scientists have confirmed that there were at least two types of 'creole' cane in production in the New World prior to the introduction of *S. cultum* in the 1780s, which finally answers a question that has been debated by sugarcane historians for almost a century.
- SASA/SASRI research has shown that there is no specific *Bru1* gene for brown rust resistance, as identified by CIRAD in ICSB-funded research, but rather that the locus (chromosome region) contains two genes that work in concert to yield protection against fungal (and other) infections.

## **CROP PROTECTION RESEARCH** STUART RUTHERFORD, PROGRAMME MANAGER

Integrated management strategies that minimise the effects of pests, diseases and weeds on crop production in a sustainable manner.



## **RESEARCH HIGHLIGHTS**

New chemistries for pest, disease and weed control

## Of three new eldana control products tested, two show promise, while the third requires further preliminary screening.

These new products will add additional modes of action to eldana management, which will assist in preventing the emergence of agro-chemical resistance.

## BIOSECURITY

#### Eldana

Good progress made with F1 Sterile Insect Technique, with cage-based proof-of-concept studies to commence in Spring 2018.

## Longhorn beetle

- Preliminary recommendations developed for emergency longhorn beetle (LHB) containment.
- Three insecticides with two different modes of action registered.
- · Mechanical stool eradication methods developed.

- Dessication and starvation experiments reveal LHB larvae to be extraordinarily tolerant of resource limitations.
- Commercial traps for attracting LHB adult beetles ineffective as the indigenous insect has a pheromone profile different to that of other related LHB pest species occurring on other continents.
- Under laboratory conditions, a strain of the fungus, *Beauveria* brongniartii, demonstrated to be pathogenic to LHB adults, indicating potential as a future bio-control agent.

## Fall armyworm

- Based on the experiences of the Louisiana sugar industry, fall armyworm is unlikely to become a major sugarcane pest.
- Stakeholders advised to remain vigilant, particularly in cane established from NovaCane® plantlets and plant cane.
- As a precautionary measure, temporary emergency registration of three insecticides has been granted.



### Sugarcane resistance to pests and diseases

- Varieties N47, N51, N52 and N55 show an increase in cumulative RV yields over three crops when grown on a 6% clay soil treated with a nematicide.
- Ongoing studies reveal that varieties may not exhibit significant innate resistance to the RSD bacterium.

## ESSENTIAL OUTCOMES FROM COMPLETED RESEARCH

#### WEED MANAGEMENT

## Translocation of herbicides in problematic weeds

- *Cyperus rotundus* (rooi uintjies/purple nutsedge) is arguably the worst weed in the tropical and subtropical regions of the world.
- Plants proliferate mainly via underground tubers which rely on the translocation of photosynthate from parent to daughter plants.
- One new pre-emergence coded product with a different mode of action showed equal potential to two industry standards, Authority<sup>®</sup> and Extreme Plus<sup>®</sup>, killing 75-87% of planted parent tubers and preventing the formation of viable daughter tubers.
- A tetrazolium staining protocol was developed which tests for viability of new daughter tubers.
- This method showed that the production of new live tubers was completely inhibited by the coded product in sand and sandy loam soils, but that some daughter tubers were formed in soils of higher clay percentage.
- The same tetrazolium staining method was used to test *Cynodon dactylon* rhizome viability following seasonal applications of imazapyr (Arsenal GEN 2).
- Maximum translocation and rhizome death was found to be greatest following mid-late summer applications.

## **PROGRESS IN ONGOING RESEARCH**

#### BIOSECURITY

## Longhorn beetle infestation suppression and monitoring technologies

- Studies undertaken by an industry-funded post-doctoral research associate based at the University of Pretoria revealed that the species of longhorn beetle comprising the Entumeni outbreak might have a pheromone biology different to that of other longhorn beetle species.
- Evidence suggests that the low numbers of adult longhorn beetles emerging in Entumeni in 2018 are likely to be a result of the eradication and plough-out measures instituted in the area.
- Longhorn beetle pheromone and chemical ecology studies
  - During 2017/2018, a Post-Doctoral Fellow was appointed at the University of Pretoria (Forestry and Agricultural Biotechnology Institute [FABI]) to investigate the chemical ecology (pheromone, plant and associated microbial volatiles) of the longhorn beetle.
  - Although 3.5-dimethyldodecanoic acid (prionic acid) appears to be a common attractive component among beetle species of the tribe Prionini within the sub-family Prioninae, it appears that it is not a component of the pheromone obtained at FABI from live female *C. newmannii* beetles (tribe – Cacoscelini).
  - However, unknown components have been detected which do elicit electrophysiological responses in male *C. newmannii* antennae. These are to be identified by mass spectroscopy.



- Longhorn beetle emergence in early 2018
  - The relatively low number of adult beetle emergences in 2017/2018, and from only a few fields, suggests that the eradication and plough-out measures have largely succeeded in reducing the LHB population by exposing and killing late-instar grubs in infested fields, which would otherwise have pupated and emerged as adults.
  - The evidence so far indicates that this species has a 2-year life cycle (almost all of which is spent in the larval stage), with the adults being short-lived (3-4 weeks), non-feeding, and with females being very weak or non-fliers.

## Orange rust monitoring

 Although orange rust spores were detected in Komatipoort in early 2018, no visible symptoms have emerged on sugarcane, including on the sentinel plot of the highly susceptible Australian variety, Q124.

#### Yellow sugarcane aphid

- For several years, SASRI research into the effects of the yellow sugarcane aphid on yield and variety resistance have been confounded by the sporadic nature of feral infestations; a situation which has rendered trial-based research untenable.
- Consequently, through collaborative arrangements, the trial-based research was relocated to Zambia, where feral infestations of sugarcane are more consistent.
- In addition, at SASRI, an alternative research tactic, using aphid inoculation of pot-grown sugarcane, has been implemented.

 Recent examination of a north coast site provides further support of the notion that soil health plays a role in reducing crop stress and associated susceptibility to yellow sugarcane aphid infestations.

#### **RSD** decontamination of mechanical harvesters

 Three readily available commercial quaternary ammonium compound disinfectants were shown to be effective against *Clavibacter michiganensis*, a culturable bacterium related to *Leifsonia xyli* subsp. *xyli*, the bacterium causing RSD.

## **BIOLOGICAL CONTROL**

## Endophytic fungi for eldana control

 Two strains of the endophytic fungus, *Beauveria bassiana*, which are both antagonistic to eldana, were recently shown to promote the growth of sugarcane.

## **Sterile Insect Technique**

- In the implementation of a F1 sterility approach to determine proof-of-concept of the Sterile Insect Technique for eldana control, the first consignment of irradiated male X un-irradiated female crosses received from XSIT (Pty) Ltd progressed from the egg and larval stages of the life cycle and reached the pupation stage.
- The reduction in eldana fertility achieved at an irradiation dosage of 200 Gy at the XSIT facility is acceptable and the resultant enclosed F1 larvae have been inoculated onto diet.
- Efficacy of the F1 Sterility SIT approach is to be tested in cage release studies that are to commence in Spring 2018.

## **RESISTANCE MECHANISMS**

#### Quantification of smut colonisation

 Good progress made in 2017/2018 in the development of a DNA-based technique for quantifying the extent of smut colonisation of sugarcane.

#### Variety resistance to nematodes

 Varieties N47, N51, N52 and N55 demonstrated an increase in cumulative RV yields over three crops when grown on a 6% clay soil treated with a nematicide.

#### **DNA diagnostic tests**

- Good progress has been made in adapting commercially available DNA-based diagnostic kits for sugarcane viral pathogen (SCMV and SCYLV) detection.
- These state-of-the-art kits offer a more rapid, reliable and cost-effective alternative to the techniques currently employed at SASRI for pathogen detection in sugarcane.

## **AGROCHEMICALS**

#### New chemistries for Eldana Management

- Research has demonstrated the potential for the use of two insect growth regulator insecticides for eldana management.
- These chemistries have the potential to replace less benign products and broaden the choices available to growers and miller-cum-planters in their eldana IPM strategies.



## **CROP PERFORMANCE AND MANAGEMENT RESEARCH**

RIEKERT VAN HEERDEN, PROGRAMME MANAGER

Better Management Practices and models enabling growers and miller-cum-planters to enhance sustainable crop production.



## **RESEARCH HIGHLIGHTS**

## **CHEMICAL RIPENING**

- Efficacy of recently registered ripener, Moddus<sup>®</sup>, tested under irrigated conditions, including during periods of low rainfall and irrigation water scarcity.
- Nine industry-wide contact events, attended by over 300 stakeholders, convened throughout the industry to confirm:
   (a) the cost-benefit of using Moddus<sup>®</sup>; (b) niche situations for its use, especially late-season ripening; and (c) the correct use of the product.
- Under rainfed conditions, evidence indicates that N58 is an exceptional responder to the Ethephon®/Fusilade Forte® combination treatment.
- Estimation of gross margin returns confirmed the highly profitable nature of chemical ripening.
- Gross margin returns on the ripening of varieties N49, N53 and N57 ranged between R2 690 and R17 094 R/ha, depending on treatment.



## **CROP RESIDUE MANAGEMENT**

## The seventy-nine year-old SASRI trial (BT1) indicates that the benefits of crop residue blankets may not be fully realised in the absence of soil acidity amelioration.

## NUTRITION AND SOIL HEALTH

- Surface applications of ameliorants are effective in addressing soil profile chemical constraints and result in enhanced productivity of the crop.
- Surface applications of gypsum to an acid humic soil results in substantial movement of calcium into the subsoil within a period of two to three years.
- A positive interaction exists between gypsum and reactive lime sources in terms of soil profile amelioration and is worthy of attention by stakeholders.
- Total soil N demonstrated to be a reliable index of soil N supply to the crop, which will result in improved accuracy of FAS analytical package.
- Good progress made in the development of a model to accurately estimate the effects of biomass accumulation on leaf critical N levels for the sugarcane crop.
- Field-based trial studies initiated to determine P and S thresholds that will enable the refinement of FAS fertiliser recommendations.

## **CROP MODELLING**

The Drought Irrigation Program (DRIP) informs stakeholder farm-level irrigation decision-making during periods of drought.

# ESSENTIAL OUTCOMES FROM COMPLETED RESEARCH

## **NITROGEN NUTRITION**

Development of reliable leaf nitrogen threshold values

- This research sought to investigate the development of a leaf sampling method that would enable more accurate N fertiliser recommendations.
- The objectives of the study were to: (a) investigate variations in sugarcane leaf N concentrations associated with advancing crop age; (b) provide evidence of potential variations in critical leaf N levels with age (biomass); and (c) develop a model(s) that will accommodate the effects of age (biomass accumulation) on the variations in the critical N concentration in sugarcane leaves.

- The research achieved the following.
  - Leaf N concentrations were observed to decrease significantly with advancing crop age over the 3-7 month interval recommended for leaf sampling.
  - Critical N concentrations were established from relationships between leaf N concentrations and final stalk yields, and these relationships indicate that the critical N concentration for yield optimisation varies markedly with crop age, and may range from ~2.0% at an age of 3-4 months to ~1.7% at 7 months.
  - Critical N values established at each sampling event were also related to stalk biomass. It was found that critical N values declined exponentially with increasing biomass (R2=0.73 for the irrigated region, R2=0.77 for the rainfed and R2=0.74 for the combined data).
  - These findings point to the potential for improving the reliability of the interpretive process for leaf N through the inclusion of estimates of stalk biomass at the time of sampling. In particular, given the pivotal role of N in yield optimisation, there is a requirement to take into account decreases in the critical N concentration with increasing biomass (crop age), as has been done successfully for a range of other crops. This is the first attempt in the South African sugar industry to evaluate the merits of the Greenwood-Lemaire model for sugarcane.
  - To minimise the labour-intensive measurement of stalk biomass at the time of leaf sampling, relationships have been developed between height (cm) and crop biomass (g) for the different varieties included in this study [N37 (R2=0.88), N25 (R2=0.84) and N41 (R2=0.85)].
  - However, due to difference in stalk thicknesses and elongation for different varieties, varietal differences need further investigation for this relationship to be successfully implemented.

## **SOIL ACIDITY**

## Management practices to ameliorate top and subsoil acidity

 Surface application of gypsum and lime to ratoon crops on coastal sands and hinterland humic soils is an effective approach for addressing excessive acidity in both top and subsoils.



- Movement of calcium (Ca) from gypsum into subsoils is markedly more rapid than Ca from lime. On both a sandy and humic soil, movement of Ca from gypsum had occurred to a depth of approximately 50 to 60 cm within two to three years.
- Evidence from this study indicates that combining gypsum with a reactive lime markedly increases the effectiveness and speed of profile amelioration. On the other hand, combining gypsum with a 'conventional' dolomitic lime on a sandy soil appears to retard the movement of gypsum into the subsoil. These aspects warrant further research.
- In a season of very favourable rainfall, remarkably high yields (21.9 t sucrose/ha) were obtained in a 17 month-old plant crop on a 'weak' Cartref sand following the application of high rates (in excess of FAS recommendations) of fertiliser and organic and inorganic amendments. This provides evidence of the potential production and crop nutrient demands on these soils when growth conditions are optimised.
- On a coastal sand with very high acidity levels, yields were at a maximum in treatments which included a combination of lime and gypsum. On a humic hinterland soil, surface-applied lime and gypsum treatments did not significantly impact yields in the three crops following their application.
- On a severely acidic sand, indications are that the upper application rate of 5 t/ha for both lime and gypsum was insufficient in terms of adequately reducing subsoil acidity levels and increasing Ca supplies.
- On a humic soil low in silicon (Si), application of amendments (including Si products) in the furrow at planting had no significant effects on either crop performance or Si uptake.

## **CONDENSED MOLASSES STILLAGE**

## Long-term effects of CMS on soil quality

The objectives of the investigation were to determine: (a) the impact of long-term use of condensed molasses stillage (CMS) on soil chemical, physical and biological properties; (b) differences between nutrient levels in cane fertilised with fortified CMS or other more conventional nutrient sources, either applied on bare soil or directly onto a mulch layer; and (c) the efficiency of N utilisation following CMS application with and without added fertiliser N.

- The main findings of the study are as follows:
  - No evidence found suggesting that CMS affects the pH or acid saturation of a soil, as was determined from pot trial studies and midlands field trials conducted on two contrasting soil types in which CMS was applied to three consecutive crops.
  - Evidence obtained indicates that under both burnt and mulched management regimes: (a) N applied as either LAN or CMS (unfortified and fortified with N) is equally available to the crop; (b) leaf N concentrations are not significantly different when N is supplied at equal concentrations as LAN and N-fortified CMS; and (c) K applied as either KCI or CMS is equally available to the crop.
  - No conclusive evidence found suggested that significant amounts of N are lost when applied as N-fortified CMS, as determined in a pot trial study and confirmed by a field trial where no significant differences were detected in leaf-N concentrations.

## WATER MANAGEMENT

- Farm-level water allocation decision support programme based on crop response to deficit irrigation.
- A computer programme was developed to enable farmers to assess the likely impact of their irrigation decisions on farm profitability.
- The programme, coded in Microsoft Excel and named DRIP (Drought Irrigation Program), uses a sophisticated crop and water balance model to calculate the impact of specified irrigation strategies on crop yield and survival under assumed future water allocation and climate scenarios.
- Available irrigation water is applied according to the specified irrigation strategy for each field following specified priorities.
- Farm level gross margins for the current and next two seasons are calculated from yields, irrigation applied and production costs at field level.
- Irrigation strategies that can be explored include: (a) scheduling rules based on growth-phase specific soil water depletion thresholds; (b) reducing irrigation amounts; (c) adjusting the drying off period; and (d) abandoning low potential fields, or fields where the crop was due to die.



## **PROGRESS IN ONGOING RESEARCH**

## **CROP PHYSIOLOGY**

## Modelling world-wide GXE interactions

- During 2017/2018, SASRI hosted a workshop of the International Consortium for Sugarcane Modelling from 26 to 27 June 2017 to discuss progress and determine additional research required to enable the application of crop models to sugarcane breeding for current and predicted future climates.
- The workshop hosted 20 delegates from Australia, Brazil, France, South Africa, the United States of America and Zimbabwe.

## High-throughput phenotyping technology development

Cost-effective impetus to the development of high-throughput phenotyping technology has been achieved during the reporting period through: (a) collaboration with SA Canegrowers enabling the use of the drone and cameras owned by that association;
(b) training of a project team member at a workshop in the USA which was funded by the SA Society for Crop Production; and
(c) receipt by a team member of a three-year doctoral fellowship from the Professional Development Programme of the National Research Foundation.

## Optimal harvest age for different production regions

 Simulation studies conducted with crop models have revealed that yields generally increase with harvest age across all regions, regardless of the yield potential determined by total available moisture.

## **CROP NUTRITION**

## Field calibration of soil P (resin) and soil sulphur tests

• To develop nutrient recommendations based on soil test results, the tests require calibration against crop response to applied nutrients in field experiments.

- Of necessity, such experiments are conducted on a range of soils to represent the diverse soil types within the industry.
- The research, which commenced in April 2017, encompassed the establishment of P and S field trials on a number of sites in the northern irrigated and rainfed cane areas.
- Thresholds for resin P and S for all soils of the sugar industry are to be established and used by FAS to accurately refine fertiliser recommendations.

## **SOIL HEALTH**

## Influence of crop residue retention on water infiltration into soil

 Preliminary measurements made with a Dual-Head Infiltrometer device have revealed substantially higher rates of water infiltration into the soil under continuous mulching compared with the practice in which all crop residues are continually removed.

## **CROP RIPENING**

## Variety ripener evaluation

- Estimation of gross margin returns once again revealed the highly profitable nature of chemical ripening. For example, gross margin returns on the ripening of varieties N49, N53 and N57 ranged between R2 690 and R17 094 R/ha depending on treatment.
- Evidence obtained during 2017/2018 further confirmed the efficacy of Moddus<sup>®</sup> as a ripener under irrigated conditions, even during periods of low rainfall and irrigation water scarcity.
- Under rain-fed conditions, evidence obtained during 2017/2018 suggested that N58 might be an exceptional responder to the Ethephon®/Fusilade Forte® combination treatment.



## **SYSTEMS DESIGN AND OPTIMISATION RESEARCH** RIANTO VAN ANTWERPEN, PROGRAMME MANAGER

Innovative systems enabling growers and miller-cum-planters to optimise agricultural performance.



## **RESEARCH HIGHLIGHTS**

## Adoption of recommendations

Novel systems dynamic model permits identification and examination of key drivers of technology adoption and will enhance planning of knowledge exchange interactions with stakeholders for improved technology diffusion.

## WATER USE

- Modified Universal Soil Loss Equation (MUSLE) selected for updating of design norms for industry soil and water conservation structures as it most appropriately simulates erosion events.
- Modelling study revealed significant scope for improving water use efficiency of irrigated sugarcane production through: (a) the use of efficient irrigation systems; (b) limiting wasteful evaporation by mulch covers; and (c) accurate scheduling of irrigation.

## **SOIL SALINISATION**

Survey indicated that stakeholders are aware of threat posed to irrigated production by soil sodicity and salinity, although are unconvinced of the need to implement preventative measures. Effective knowledge exchange and technology diffusion tactics required to encourage adoption of such measures.

## **YIELD MAPPING**

Methodologies developed for quantification of intra-field yield variability to assist stakeholders with aspects of precision agriculture.

## **CROP FORECASTING**

Combination of satellite-based remote sensing and crop modelling holds promise for increasing accuracy of sugarcane crop monitoring and yield forecasting.

## **GROUND APPLICATION OF RIPENERS**

The volumes of water required to apply chemical ripeners with irrigation systems is much higher than prescribed on the product label. Irrigation systems are therefore not suitable options for the application of ripeners.

## ESSENTIAL OUTCOMES FROM COMPLETED RESEARCH

## **PRODUCTION SUSTAINABILITY**

Modelling of infield traffic during sugarcane harvesting, loading and haulage operations

- A primary outcome of this research was confirmation that infield traffic should be restricted to the inter-rows to minimise the potential loss of yield.
- It was noted that row traffic on a perennial sugarcane crop would likely result in a compounding loss of yield of up to 4.5 times that of the yield loss estimate (assuming a 10 % replant programme) when projected through to subsequent ratoons. These results strongly support the recommendation of control traffic practices.
- The general yield loss estimates on a field basis under moist field conditions ranged from 1.0% 3.3% for the low impact self-loading systems and smaller slew (< 6 tons mass) loading system to 4.7% 9.2% for the larger slew loading systems (typically > 6 tons mass), non-slew loader operations and chopper harvester operation.
- When taking the compounding effect into consideration, the average yield loss estimate on a field basis under moist field conditions across the cropping cycles (embedded by being locked in the particular system) increase to: 4.4% 13.6% for the low impact self-loading systems and smaller slew (< 6 tons mass) loading system; to 18.7% 32.7% for the larger slew loading systems (typically > 6 tons mass), non-slew loader operations and chopper harvester operation. These yield losses are compared against a hypothetical system where no traffic induced losses occurred.
- Traffic induced yield loss due to stool damage under drier conditions is far less severe than under moist or wet soil conditions.
- The highest yield losses are attributed to systems containing the largest amount of uncontrolled traffic (Note: it is not possible for the non-slew loader to adhere to controlled traffic principles).
- The risks of higher yield losses appear greater as the capacity and gross mass of the equipment increases.
- Mechanical harvesters have a severe impact on crop ratoonability, fostering poor economic returns despite practicing controlled traffic principles. Any poor traffic management or poor matching of wheel tracks to inter-rows would be expected to cause significant additional yield losses. Yield losses would be likely to exceed any of the other high impact systems that are already subject to uncontrolled traffic practices.

- Mechanical harvesters have a severe impact on crop rationability fostering poor economic returns despite practicing controlled traffic principles.
- Dedicated extraction paths (controlled traffic routes) are recommended particularly for high clay soils trafficked frequently under moist soil conditions. Lower clay soils appear to be susceptible to both soil compaction and stool damage under a wide range of soil moisture conditions and thus infield traffic should be reserved for the driest times where possible.
- The construction of slightly raised crop production areas or cropping beds and alternative widened inter-row traffic lanes aligned to equipment wheel tracks can be used to assist drivers to keep wheel traffic away from the crop rows where GNSS systems are not used.
- The yield loss models consist of a detailed yield estimation calculator that considers case specific inputs pertaining to vehicle parameters, soil type, number of passes and soil moisture status and a generalised model developed for higher level analyses and system comparisons that takes vehicle impact ratings and generalised yield responses into account.

## **PROGRESS IN ONGOING RESEARCH**

## WATER MANAGEMENT

## Reducing salinisation of irrigated land under sugarcane<sup>1</sup>

- A method is under evaluation whereby the lateral and depth distribution of salts in soils are mapped using data obtained via electromagnetic induction (EMI).
- Backed-up with a small number of soil samples, EMI data are converted to a number of salinity parameters (i.e. exchangeable sodium percentage, pH and total cations).

## Water footprint of irrigated sugarcane in South Africa<sup>2</sup>

- During 2017/2018, a study undertaken with the SASRI MyCanesim® system and weather data for the period 1970 to 1999 revealed significant scope for improving water use efficiency of irrigated sugarcane production through: (a) the use of efficient irrigation systems; (b) limiting wasteful evaporation by mulch covers; and (c) accurate scheduling of irrigation.
  - <sup>1</sup> Water Research Commission funded project led by the University of the Free State (Professor Leon van Rensburg) in which SASRI participates.
  - <sup>2</sup> Water Research Commission funded project led by the University of the Free State (Dr Henry Jordaan) in which SASRI participates.

## **PRODUCTION SUSTAINABILITY**

## Improving operational crop forecasting by incorporating remote sensing data

- Good progress was made in 2017/2018 to resolve the technical requirements for the incorporation of satellite-derived data into the industry's Canesim® Crop Forecasting System, including:

   (a) development and evaluation of data processing procedures and requirements; and
   (b) simulation of crops at a higher resolution than homogenous climate zone level.
- Refinement of the industry's Canesim<sup>®</sup> Crop Forecasting System through inclusion of remote sensing-derived data relies on the availability of comprehensive field records and GIS data for the two mill areas currently under investigation, namely Pongola and Sezela.
- During the reporting period, good progress has been made in refining these data for the Sezela mill area.

## Updating design norms for soil and water conservation structures<sup>3</sup>

- The Modified Universal Soil Loss Equation (MUSLE) has been selected for the updating process as it most appropriately simulates erosion events.
- Calibration and verification of the ACRU<sup>4</sup> and MUSLE models are in progress.
- Shape files containing slopes and soil forms in the sugarcane growing areas have been located and will guide regionalisation of the design norms.
- <sup>3</sup> Research contracted by the industry to the University of KwaZulu-Natal (UKZN) (Professor Jeff Smithers).
- <sup>4</sup> The agro-hydrological model developed by the Agricultural Catchments Research Unit (ACRU) at UKZN.

## Updating design norms for soil and water conservation structures

- The Modified Universal Soil Loss Equation (MUSLE) has been selected for the updating process as it most appropriately simulates erosion events.
- Calibration and verification of the ACRU and MUSLE models are in progress.
- Shape files containing slopes and soil forms in the sugarcane growing areas have been located and will guide regionalisation of the design norms.

## Yield mapping

- Investigations undertaken during 2017/2018 revealed that readily available sub 5 m accuracy Global Navigation Satellite Systems equipment may assist growers in the derivation of the yield maps necessary for the implementation of precision agriculture techniques that rely on variable rate control technology.
- The research further indicated that the developed methodology is suitable for the quantification of intra-field yield variability.
- Availability of spatially-explicit maps depicting such variability would greatly assist in the design and implementation of tactics based on the general principles of precision agriculture.



#### **Ratoon longevity**

- Preliminary analyses of experimental and commercial yield data were conducted during 2017/2018 to determine rates of ratoon decline on the north coast and in the midlands.
- Initial trends observed suggest that: (a) a decline in ration performance occurs over the first two crops but subsequently eases after the third or fourth crops; and (b) negligible differences in ration decline occur amongst the varieties tested.

## **TECHNOLOGY DEVELOPMENT**

## **Revamping MyCanesim®**

- A major upgrade of the Canesim® crop simulation model was completed and verified in 2017/2018.
- The scientific documentation of the model has been completed and is available online.

## **Technology context**

- MyCanesim<sup>®</sup> is a web-based sugarcane crop simulation system created by SASRI to assist growers, miller-cum-planters, scientists and extension specialists with yield benchmarking and irrigation scheduling activities.
- To ensure the model remains functional and relevant to end-user needs, updates are required at regular intervals.
- This project was initiated to undertake significant revisions to the model that have accumulated since the last major update.
- The purpose of the research conducted was to: (a) add new functionality and improve the crop model and user-interface;
  (b) update system documentation; (c) evaluate the updates to ensure they deliver the required improvements to estimates of crop growth, water-use and yield, as well as better quality irrigation scheduling advice; and (d) market the new system to potential users.

## Progress

- The upgrade and testing of the model was completed in 2017/2018.
- The scientific concepts of the model and their mathematical representation have been documented in a SASRI publication, which will serve as a reference work for scientists, advisors and students involved in research, technology development and training. Comprehensive documentation of the technical specifications is also essential for effective future model development and maintenance.
- The publication: (a) describes how the various crop and soil processes are simulated, including canopy development, crop water use, the soil water balance, and biomass accumulation and its partitioning to roots, leaf and stalk material; and (b) reports on the accuracy of simulations and provides examples of different types of model applications.
- The reference for the publication is: Singels A and Paraskevopoulos AL (2017). The Canesim® sugarcane model: Scientific documentation. Published by the South African Sugarcane Research Institute, Mount Edgecombe. ISBN 978-0-6399083-0-4.

## **RESEARCH CONTRACTS**

On behalf of the industry, SASRI enters into contracts with external research service providers in areas of strategic importance to industry and for which the institute does not have the necessary expertise or resources.

## UNIVERSITY OF KWAZULU-NATAL SCHOOL OF ENGINEERING

## Water and soil conservation structures

Development of updated design norms for soil and water conservation structures in the sugar industry

## START DATE: 2016/04/01 END DATE: 2019/03/31

A contract was signed in 2016/2017 with the University of KwaZulu-Natal for the project "Development of updated design norms for soil and water conservation structures in the sugar industry" under the leadership of Professor Jeff Smithers of the School of Engineering. The goal of the research is to bring industry standards with regard to the design of soil and water conservation structures in line with: (a) International Standards through incorporation of a Soil Loss Equation; and (b) the Land Use Plan requirements as espoused by SUSFARMS®. The three-year project will run until 31 December 2019 and will form the basis of the research of a PhD student.



# NORTH-WEST UNIVERSITY SCHOOL OF BIOLOGICAL SCIENCES [BOTANY DIVISION]

## Effect of elevated $CO_2$ on sugarcane

Effects of elevated CO<sub>2</sub> concentration on local sugarcane varieties

## START DATE: 01/04/2014 END DATE: 31/03/2018

To increase preparedness for the potential impacts on sugarcane cultivation, the industry has mandated SASRI to conduct climate change research, specifically on potential crop production adaptation strategies that might ameliorate predicted change scenarios. To provide data necessary for effective modelling, information on how elevated CO<sub>2</sub> concentrations affect sugarcane physiology and growth is essential. To this end, a research contract was entered into with Dr Jacques Berner at North West University for a project entitled "Effects of elevated CO<sub>2</sub> concentration on local sugarcane varieties". North West University was selected as research partner due to the availability of open-top CO<sub>2</sub> chambers on the Potchefstroom campus.



## Interactive effects of elevated $\mbox{CO}_2$ and water deficit on sugarcane nutrition, water use and yield

## START DATE: 01/04/2017 END DATE: 31/03/2021

In 2014, research was contracted to North-West University to examine sugarcane responses to elevated CO<sub>2</sub> concentration under irrigated conditions. The outcomes of that research indicated that further investigation of the interactive effects of elevated CO<sub>2</sub> and water deficit was required, as such effects have not yet been investigated in South African sugarcane varieties. This contracted-out research, which commenced on 1 April 2017, will address these and other knowledge gaps. The objectives of the research are to: a) determine the indirect benefits of elevated CO<sub>2</sub> on the nutrition, water use and yield of a drought sensitive sugarcane variety during water deficit; and (b) test and refine crop models to enhance simulation capability of these effects.



## STELLENBOSCH UNIVERSITY INSTITUTE OF PLANT BIOTECHNOLOGY

## Sugarcane sucrose enhancement by genetic modification

## START DATE: 2014/10/01 END DATE: 2017/09/30

The initial three-year, renewable contract with the Institute of Plant Biotechnology (IPB) at Stellenbosch University to enhance the sucrose content of sugarcane through the genetic engineering of primary carbon metabolism was signed in 1998. Since 2005, Professor Jens Kossmann directed the research at the IPB. Outcomes of the research have included a sugarcane sucrose enhancement technology that formed the basis of a licensing agreement amongst the SA sugar industry, Stellenbosch University and a prominent multinational agri-biotechnology company. The current contract entitled "Genetic engineering of sugarcane to enhance sucrose accumulation and to improve the fermentability of remaining biomass" will run until August 2017. A follow-on contract for research entitled "Sugarcane sucrose enhancement by genetic modification" was signed in September 2017 for a further three-year period until August 2020, which represents the final phase of industry investment in the research.

#### Biotechnological investigations to improve sugarcane drought stress tolerance

## START DATE: 2015/04/01 END DATE: 2018/03/31

The availability of sugarcane varieties that show resilience to the effects of water-deficit stress is viewed as being of strategic importance to the industry, particularly in the face of a changing climate. Consequently, the industry entered into a contract with the Institute of Plant Biotechnology at Stellenbosch University to conduct research into improving the tolerance of sugarcane to drought through the application of genetic engineering and mutagenic breeding technologies. The initial contract was for the period 1 April 2015 to 31 March 2018 and a follow-up contract for the period 1 April 2018 to 31 March 2021 was signed in March 2018.

## **RESEARCH COLLABORATIONS AND PARTNERSHIPS**

To promote and support innovation, both SASRI as an institution and individual researchers cultivated formal and informal research relationships in 2017/2018 with international and national agencies, consortia, institutions and organisations.



## **RESEARCH GRANTS**

In 2017/2018, SASRI researchers were awarded several grants for bursaries, fellowships, research costs and international conference participation. The funding received from the following agencies is gratefully acknowledged: National Research Foundation (NRF); Technology Innovation Agency (TIA) through Biosafety South Africa; Department of Agriculture, Forestry and Fisheries (DAFF); International Atomic Energy Agency (IAEA); and Water Research Commission (WRC).

	FUNDING AGENCY	<b>GRANT TYPE / PROJECT SUPPORTED</b>
<b>WRF</b>	NATIONAL RESEARCH FOUNDATION	<ul> <li>NRF Professional Development Programme: One post-doctoral and two PhD placements</li> <li>NRF Incentive Funding for Rated Researchers: Discretionary incentive funding awarded to NRF Rated Scientists</li> </ul>
	BIOSAFETY South Africa	Project: Bt GM pre-commercialisation research
	DEPARTMENT OF AGRICULTURE, FORESTRY AND FISHERIES	Project: Sterile Insect Technique logistics research and eldana trap development
	INTERNATIONAL ATOMIC ENERGY AGENCY	Project: Eldana Sterile Insect Technique field release logisctics
Ĩ	WATER Research Commission	Project: Irrigation soil salinisation risk (in collaboration with the University of the Free State) Project: Water footprint of fuel and fibre crops (in collaboration with the University of the Free State)

## **MATTHEW JONES**

DSSAT Development Spirit Gainesville, USA 8-12 January 2018 Participation partially funded by: DSSAT Foundation



## DR SANDY SNYMAN

International Symposium on the Biosafety of Genetically modified Organisims. Guadalajara, Mexico 4-8 June 2017 Participation funded by: NRF Incentive Fund for Rated Researchers and TIA-Biosafety South Africa











## **DR STUART RUTHERFORD**

## DR DES CONLONG

FAO/IAEA International Conference on Area-wide Management of Insect Pests Vienna, Austria 22-26 May 2017 Participation funded by: NRF Incentive Funding for Rated Researchers and IAEA

## **NONGCEBO MEMELA**

International Symposium on Microbe-assisted Crop Production Vienna, Austria 4-7 December 2017 Participation funded by the NRF

## **DR SANDY SNYMAN**

Working visit to Germplasm **Conservation Laboratories** Gatersleben, Germany Leuven, Belgium 23-27 October 2017 Participation funded by: NRF Incentive Fund for Rated Researchers



## **MATTHEW JONES**

WATTHEW JONES Crop Modelling Workshop Montpellier, France 29 May - 2 June 2017 Participation funded by: CIRAD and the international Consortium for Sugarcane Modelling

## DR MARVELLOUS ZHOU

21st EUCARPIA (European Association for research on Plant Breeding) Congress Montpellier, France 8-11 May 2017 Participation funded by: NRF Knowledge Interchange and **Collaboration Programme** 

## **ACHIEVEMENTS AND AWARDS**

*"Without continual growth and progress, such words as improvement, achievement, and success have no meaning." Benjamin Franklin* 



## SANESH RAMBURAN was awarded

"Best Paper at Conference by a member of the Southern African Society for Crop Production" for his paper "From laboratory to field: Assessing the impacts of tissue culture propagation on the agronomic performance of sugarcane" at the 2018 Combined Congress.



## WILLIAM GILLESPIE'S paper, which he co-authored with Ms F Mitchell of the KZN DARD, received the award "Best Oral Presentation: African Crop Science Society" at the 2018 Combined Congress. The paper was titled "Translating soil type into millions: a sweet success story in a rural sugarcane community in South Africa".



**DIMPHO ELEPHANT** was awarded "best paper at Conference by a member (older than 30 years) of the Soil Science Society of Southern Africa" for his paper "The estimation of reserve-K and K immobilization using mid-infrared spectroscopy and multiple linear regressions" at the 2018 Combined Congress.

**DIMPHO ELEPHANT** was also awarded the highly commended Kynoch prize. This award is given to the runner up for the best paper in the agricultural section of the SASTA conference. He co-authored this paper with Dr N Miles and Dr SS Mthimkhulu.



**NONGCEBO MEMELA** received the best poster award at the miCROPe 2017 congress in Vienna hosted by the Federation of European Microbiological Societies.



## DYFED EVANS AND SHAILESH JOSHI were

awarded the 2016 Taylor & Francis prize for their research "Complete chloroplast genomes of *Saccharum spontaneum, Saccharum officinarum* and *Miscanthus floridulus* (Panicoideae: Andropogoneae) reveal the plastid view on sugarcane origins".



**ABRAHAM SINGELS** was awarded a B-rating by the NRF. This rating is given to researchers with considerable international recognition from their peers for the high quality and impact of their recent research outputs.





**RIAN VAN ANTWERPEN** was awarded a C-rating by the NRF. This rating is given to established researchers with a sustained recent record of productivity in the field who are recognised by their peers as having:

- Produced a body of quality work, the core of which has coherence and attests to ongoing engagement with the field.
- Demonstrated the ability to conceptualise problems and apply research methods to investigating them.



## **ASHIEL JUMMAN AND PETER TWEDDLE**

received silver medals from the South African Institute of Agricultural Engineering (SAIAE) for attaining their Doctorate degrees. The medal is generally awarded to SAIAE members who have MSc degrees in Agricultural Engineering awarded with honours, a member with a Doctorate degree or for the best publication of the year.



**NTOMBI MBUMA** won the SASTA Student award for her paper "Identifying elite families for the midlands sugarcane breeding programmes in South Africa". Her co-authors were Prof MM Zhou and Dr R van der Merwe. This prize is for the student who delivered the best paper in the Agriculture section of Congress.

**NTOMBI MBUMA** was also awarded an Excellent Academic achievement prize by the University of the Free State (June 2017). This award is given to the Best MSc Agricultural Plant Breeding student.



**ALANA PATTON** won the SASTA Best Agriculture Poster prize for her poster "Nitrogen use efficiency of South African sugarcane varieties". Her co-authors were Mr ITR Makhubedu and Dr A Weigel.







**NEIL MILES** was awarded the prestigious Kynoch prize for his paper "Predictions of soil nitrogen mineralization to crop fertiliser nitrogen requirements". He co-authored this paper with Mrs R Rhodes and Dr A Weigel. This is a highly respected award in the agricultural section of the SASTA conference and is awarded to the best paper.





## **EXTENSION** ROWAN STRANACK, EXTENSION AND BIOSECURITY MANAGER

## **EXTENSION IS CURRENTLY DELIVERED TO GROWERS UNDER THREE MODELS:**

- 1. Regionally based, levy funded
- 2. Private extension services

## 3. Joint venture to small scale growers

SASRI delivers a regionally-based and levy-funded Extension service to large–scale growers in 12 of the 14 mill areas in the industry. This service is administered and managed centrally at SASRI. In addition to their normal Extension duties, these Extension Specialists also fulfil the statutory function of Pest and Disease Officers. This is required in terms of the Sugar Industry Agreement, 2000. In doing so, they provide strategic oversight to the biosecurity function across the industry.

SASRI regional Extension offers a service that is individualised through on-farm visits providing advice on specific aspects of sugarcane agronomy relevant to the grower's needs. However, Extension also facilitates group learning activities in the form of grower days and study groups. These events create a platform for SASRI Specialists to present the results of their latest research enabling growers to better understand and implement these technologies. Growers also receive regular newsletters and updates electronically. Valuable technical support is given to the many local grower structures operating in the industry, e.g. Local Pest Disease and Variety Control Committees, Environment Committees, local farmer associations and mill group boards. Local milling companies in the UCL and Malelane cane supply areas, deliver a private Extension service.

A third Extension model is one whereby Extension is delivered to small-scale growers through a joint venture with the KZN Department of Agriculture and Rural Development (DARD). Under this Extension Venture Agreement (EVA), six SASRI Extension Specialists provide a support service to DARD Extension Officers working in the field, ensuring they are adequately trained and equipped, and are exposed to all new research outcomes generated at SASRI. In the event of specialist advice being required by small-scale growers, SASRI Extension Specialists ensure that the problem is addressed either by themselves or with SASRI research specialists. A joint Monitoring Committee comprising DARD and SASRI oversees the work programme of EVA through quarterly meetings. In addition, DARD local managers are regularly engaged with to ensure operational issues are addressed.

## RESEARCH DEVELOPMENT AND EXTENSION COMMITTEES (RD&E)

One of the key functions of Extension Specialists is to identify and gather specific research needs in their respective areas. This is enabled through locally elected RD&E Committees in each

Extension area and comprised of local growers and other role players. This link with the SASRI research programme provides an effective means by which growers can have specific research issues addressed. In many instances, growers also assist in this process by providing land on which to conduct trials. Growers also provide important local context to the research as well as advice on the practical implementation thereof. SASRI Extension Specialists are also members of the project teams conducting research in their Extension areas, offering guidance in making these trials as relevant as possible. Once new research outcomes are generated, RD&E Committees facilitate the transfer of these technologies to their growers, thereby completing the exchange of technology between grower and research.

RD&E Committees, in addition to local meetings, gather annually to review research needs from the wider industry. These needs are prioritised and provide the foundation of the SASRI research programme of work for the coming year. These central workshops alternate between the irrigated and rainfed regions.

In March 2018, the irrigated regions held their RD&E workshop. To maximise the impact of this event, the RDE Workshop was held together with a grower day at which subjects relevant to the region, such as irrigation, mechanisation, disease control, crop nutrition and varieties were addressed. Since the day was held on the SASRI Komatipoort Research Station, growers had the opportunity to visit the farm and view some of the trials being conducted there. These two events were very successful and issues raised by growers and millers at the RD&E workshop were carried forward for consideration in the 2019/2020 SASRI Programme of Work.

## **RECOVERY FROM DROUGHT**

The prolonged severe drought of 2014 and 2015 with associated shortages of water for irrigation left a lasting impression on the state of the crop across the industry. High levels of eldana in older cane at the beginning of the season affected cane quality and yields and the pest continued its spread into parts of the KZN Midlands. On the positive side, well-managed and effective spray programmes enabled growers to age their crops, leading to higher yields and better quality than previous many years.

Autumn of 2017 was relatively dry across the industry but once again, like the last three years, unseasonal and heavy rains in May saved the crop from further damage due to water stress. Frost was not a significant factor in the KZN Midlands in 2017.

Conditions became dry once again in the spring 2017, resulting in an improvement in cane quality due to natural ripening. In irrigated areas, as in previous seasons, water-saving was prioritised and often other crops were favoured over sugarcane. Across the industry, there was a general shortage of seedcane necessitating the use of emergency planting material where this could be found.

In October 2017, rainfall returned to normal and continued into 2018 when unfortunately the peak growing months of January and February were relatively dry. The erratic and unseasonal rainfall made ripening decisions difficult, particularly under rainfed conditions. However, the use of the PurEst® app assisted many growers and Extension Specialists with the decision whether to apply ripener or not. This was the second season where there was widespread use of this decision support tool and it is now in regular use on many farms.

## VARIETIES AND SEEDCANE

The promotion of new SASRI varieties remained a high priority with Extension. One of the most common questions from growers is that of variety choice. This management decision is becoming increasingly complex with a wider range of varieties available. During 2017, varieties N63, N64 and N65 went into bulking for release in 2018. There was widespread interest and appreciation for the number and quality of recent variety releases. Of particular note was the general good performance of N51, N52, N54 and N57; this last variety growing exponentially in area in the irrigated North. Of the recent releases, N61 performed well both in variety trials and where it was being bulked up commercially on farms.

To give the best advice to growers, Extension draws heavily on experience and knowledge of the area combined with production and pest and disease data. A very useful tool for Extension are SASRI farm variety trials. These are established in most sugarcane-growing areas and allows Extension to gauge the relative performance of a wide range of varieties grown under the same conditions and on the same harvest cycle. Established and overseen by a SASRI Variety Specialist, the results are publicised widely at a local level and grower days are frequently held at these trials.

Ensuring adequate seedcane supplies remained a major challenge to Extension and Biosecurity staff this year. Where seedcane schemes have been in place for some time, these have proved invaluable in ensuring adequate supplies even in times of drought (especially in recent seasons). Focus in many regions was on the 2023 deadline. By 2023, all regions must ensure that all commercial plantings are to be using either Certified or Approved Seedcane only. This has initiated efforts to start more seedcane schemes, such as in the Lowveld. A further consideration in these efforts will be ensuring that seedcane is available to all growers irrespective of size.

## EDUCATION

SASRI Extension Specialists deliver modules on the SASRI Senior and Junior Certificate Courses. These learning platforms provide Extension with valuable grower interaction and an opportunity to keep up to date with the latest technology. Extension deliver lectures and practical instruction on irrigation, land use planning, weed control and management. A modularised Senior Course continued to be delivered to growers on the North Coast and Midlands. The success of this course held on one day per month over 10 months is proving a highly effective model for instances where growers cannot leave their farms for extended periods of time and further courses are in planning for other parts of the industry. Support was also provided to education initiatives in sugarcane production arranged by the University of Mpumalanga.

## SUSFARMS<sup>®</sup> AND SOIL CONSERVATION

Growers in the Noodsberg, UCL and Eston mill supply areas continued their participation in the SUSFARMS® 2018 Collaboration. Extension has provided extensive support to the development and implementation of SUSFARMS® and the associated Progress Tracker as an environmental sustainability management tool. A process of verifying Progress Tracker reports was initiated to validate responses recorded on the Tracker with what had been implemented on the ground.

There has been a steady demand from growers throughout the industry for Land Use Plans over the past few years. With limited resources available to complete these plans, there has been consideration recently of the possibility of re-introducing a centralised farm planning service, based at SASRI. Currently SASRI provides a limited service of this nature through interns, supplementing the full-time planning technician attached to the Midlands Collaboration.

## SOIL HEALTH AND CROP NUTRITION

Soil acidity problems are being more effectively addressed through the introduction of soil profile sampling and the use of a combination of lime and gypsum in the amelioration of acidity. Many growers report good yield responses to liming and the practice is now generally widely adopted. One of the primary aims of Extension is to promote the use of the Fertiliser Advisory Service (FAS). To this end, two Extension Specialists serve on the FAS steering committee to contribute their expertise and to represent the interests of their growers in the delivery of the service. There have been continued efforts to encourage growers to send soil and leaf samples from other crops and with increased diversification on farms, this could be a lucrative and highly beneficial service in future. Significant progress was made towards this goal and decision support tools were developed to support advice to other crops.

## PEST AND DISEASE CONTROL

In their support to LPD&VCCs, Extension Specialists help in guiding general pest and disease strategies in their areas. SASRI Extension Specialists also carry out certain line management responsibilities in the management of Biosecurity staff.

The largest proportion of time was, as in most years, spent on the management of eldana. Even in areas such as Pongola and the Mpumalanga Lowveld where eldana problems are largely unknown, this pest is now considered a management factor, particularly in instances where carryover cane was necessitated. The areas most under threat during the year were the Midlands regions. Despite considerable successes in control in parts of the southern Midlands and South Coast, in the Midlands North area the pest continued to spread. SASRI Extension was closely involved with monitoring and in strategic decision-making regarding the control of the pest in the region.

A major focus for Extension during the year was the longhorn beetle incursion. Extension Specialists and Biosecurity staff from across the industry visited the infested farms to familiarise themselves with the pest. Efforts to create a wider awareness of the pest could contribute to its early detection in other parts of the industry should this occur. SASRI Extension was closely involved in monitoring the massive operation to harvest and eradicate close to 1 000 hectares of cane in the Entumeni area and to ensure suitable cover crops were planted. Extension and Biosecurity also continued monitoring of damage and adult beetle flights as and when these were identified.

SASRI Extension was also involved in efforts to minimise damage caused by yellow sugarcane aphid in certain parts of the industry and to bring to the attention of research the seriousness of this issue. This pest has resulted in localised severe yield losses and the need for premature crop re-establishment. Chemical control of this pest has proved challenging and wider integrated pest management strategies are the only possible long-term solution to the problem.

## THE EXTENSION VENTURE AGREEMENT

SASRI and the Department of Agriculture and Rural Development have an Extension Venture Agreement (EVA) that has been in place since 1996. Over the years, this agreement has proved an excellent example of a private-public sector partnership, delivering added value to both partners. The EVA model is widely held, both nationally and internationally, as a practical and workable framework for delivering Extension to a large number of recipient farmers. Currently there are approximately 22 000 small-scale growers in the South African sugar industry making the delivery of individual Extension impractical. However, through group interactions, and with additional Extension staff accessed through the DARD, an effective Extension service is provided.

Under EVA, SASRI employs five sugarcane Extension Specialists, jointly funded by SASRI and DARD. These specialists support the DARD Extension staff working with small-scale and land reform sugarcane growers farming in KwaZulu-Natal. This support assists in the planning of work programmes for sugarcane related Extension, regular updates on new technology and better management practices for sugarcane. Specialist advice is also given to DARD Extension staff and where necessary, SASRI subject specialists are engaged to help diagnose and remedy farm or area specific problems.

EVA is overseen by a joint monitoring committee comprising DARD and SASRI senior management. Meeting quarterly, this committee receives updates on the programme of work as well as the performance of the small-scale and land reform sectors of the industry. This forum also provides a strategic platform at which to discuss and launch joint efforts to improve the sustainability of growers.

Increasingly, the EVA has become involved in delivering Extension to land reform grower beneficiaries. In this, regional levy-paid Extension also provides support and, under the broader SASRI umbrella, Extension is managed and deployed regionally as a unified team. In so doing, EVA has access to an even wider range of advice and support. An excellent example in 2017 were the very successful government-funded cane rehabilitation and ratoon maintenance projects on the South Coast, where EVA and SASRI regional Extension provided invaluable technical support.

To deliver an effective and relevant Extension service the EVA team relies heavily on the farming calendar to guide the timing of field events. Learning events with growers are timed strategically to coincide with activities currently underway in the cropping cycle, for example, crop estimating is conducted at the beginning of the season while planting and weed control in springtime. With the establishment of demonstration plots in the various regions, a living field school that provides instruction and learning on the various farming operations is offered. In some instances, these plots are also sources of good quality seedcane for growers in the immediate area. This is a huge benefit to future planting practises of these growers. Access to good quality seedcane and the transport thereof is a major challenge for small-scale growers and an issue that has enjoyed close attention in recent years. Demonstration plots have proved to be the catalyst for development and independence amongst the grower communities, reducing reliance on outside funding and support and thereby enabling growers to farm independently. Some 80 demonstration plots were planted across KZN during 2017 and 2018.

## SUSFARMS<sup>®</sup> was promoted amongst small-scale growers during the year. There has been some work to adapt SUSFARMS<sup>®</sup> to the small-scale farming environment, due to its use as a guide to better management practices (BMPs) as well as a monitoring tool.

In 2018, the area under cane for small-scale growers was estimated to be 38 656 hectares. This was an encouraging recovery of about 2 200 hectares more than the previous year. Up until then there had been a long-term trend of land going out of cane production in the small-scale grower sector. The sustainability of small-scale growers is an on-going priority for Extension and key areas where growers needed assistance to remain viable were thus identified. Extension activities were then tailored to address these. Seedcane, planting, varieties, crop nutrition, weed control and cane quality were common subjects during grower days, modular courses and individual farm visits.

Where small-scale grower development projects were undertaken, EVA staff were able to contribute significantly to the technical input required. Attendance at local grower structures and co-operative meetings also formed an important part of the EVA programme of work. Because of these structures, effective channels of communication have been created between growers, DARD and SASRI.

A key role of the SASRI-EVA sugarcane Extension Specialists is to equip and train DARD Extension staff to deliver advice to growers in their areas. Regular refresher courses focused on the farming calendar are held to facilitate this learning. Local DARD Extension Officers have then been able to present courses themselves to their growers, and this is in keeping with one of the primary goals of the EVA programme. Overall, the close co-operation and effective communication between EVA partners has resulted in maintaining a highly effective service to small-scale growers.



## TECHNOLOGY DEVELOPMENT AND KNOWLEDGE EXCHANGE

MICHELLE BINEDELL, KNOWLEDGE MANAGER

Technology development and knowledge exchange aims to move innovative research results into the marketplace so that adoption of technologies and best practice can lead to increased productivity, profitability and ultimately sustainability. Within the sugar industry context, various mechanisms are used by SASRI to communicate research outcomes, highlight the value of best practice and facilitate knowledge sharing.

## **POPULAR PUBLICATIONS**

Once again, *The Link* and *Ingede* magazines (aimed at our English/ Afrikaans and isiZulu speaking growers) served as the stalwarts for information dissemination to the industry. The three editions of each focused on many of the issues that were raised by the industry during our annual Research, Development and Extension workshop, along with issues that were pertinent to specific regions.

# "Words, once they are printed, have a life of their own!" Carol Burnett

## THE LINK

The value of on-farm trials was highlighted in one of two articles focused on individual growers. The May 2017 edition showed how Brad Thompson from Eston has partnered with SASRI to conduct nematode and variety trials on his farm. The January 2018 edition highlighted the valuable efforts of a South Coast grower, Richard Cole, in reducing soil acidity, implementing a 12 month fallow with cover crops and returning to green cane harvesting. Throughout The Link, a special focus was made on the control of insect pests. This included an update on the Longhorn Beetle issue to communicate the various remedial measures gazetted to ensure the containment and control of the pest.

Other editions of the Link focused on the threat of the Fall armyworm and Yellow Sugarcane Aphid. Thrips and nematode management also continued to get attention.

In terms of soil sustainability, articles covered the role of sulphur in optimising yields, and the role of zinc deficiencies in reducing crop growth and yields. Tips for growing lucerne were also provided for growers wanting to produce fodder and make use of it as a green manure.

In 2018, three new varieties N63, N64 and N65 were released. These hold much promise for the industry.

Readers were also alerted to the risks associated with mixing ripeners and pesticides – a practice that is neither legal nor advisable given the risk associated with ripening eldana-infested fields. On the disease front, an update on Tawny Rust was provided with details on the latest rust ratings that were established for commonly-grown released varieties.

In a series of weed control articles, management and control measures for *Cyperus rotundus* (rooi uintjies) and *Parthenium hysterophorus* (Parthenium) were given along with a warning of the effect of herbicide residues on cover crops.



For the irrigated region, articles covered chemical ripener recommendations for irrigated varieties N49, N53 and N57 and two articles covered the keys to irrigation system performance through skilled operation and effective management. In another useful article, our Irrigation Specialist explained the benefits of investing in high capital systems that have lower operating costs over the life cycle of the system.

On the technology front, SASRI launched two additional smartphone apps, FertiCalc and RustCalc along with a web-based application named StalkGro. The articles provided explanations on the use of the applications as well as their value in decision making. The smartphone apps are freely available on the Google Playstore and Apple iStore.

Following a Land Use Planning training session in the Felixton area, readers were reminded of the importance of waterways and the correct specifications associated with their construction.

Finally, with an interest in keeping abreast of what's in store for the industry in a changing climate, SASRI modellers indicated the expected changes in sugarcane yields for each region as well as new areas that may become suitable for rainfed production.

## THE INGEDE

The *Ingede* focused on important aspects of sugarcane agriculture for the small-scale grower. Topical tips (a regular feature of each Ingede) are appropriate for each month in the farming calendar and provided clear guidance on management interventions and necessary activities to ensure a good crop. Much attention was given to two new pests of the industry, namely the Longhorn Beetle and Fall armyworm. Whilst the Fall armyworm has not yet spread in sugarcane, it still represents a potential threat to the industry. Readers were also updated on the ongoing efforts to attempt to contain and manage the outbreak of Longhorn Beetle in Entumeni.

Just prior to the time of harvest, Ingede readers were provided with advice on how to prepare for the harvesting season along with advice on the best practices associated with planting, correct fertiliser application and the choice of the most appropriate varieties.

The Effects of Climate Change on farming were highlighted as well as an interesting article on careers associated with agriculture, science and engineering.

The success of modular courses was also explained and an article on biological control provided an illustrated guide on biocontrol agents suitable and available for growers to use against land and water weeds.

In an effort to improve production management, two articles focused on how to arrange a contractor and harvesting order as well as best practice for irrigation scheduling.



## **OTHER NEWSLETTERS AND ARTICLES**

Direct communication to growers in the numerous regions took place through the development of ten *Extension newsletters*. These communicated upcoming events, alerts and latest trial results.

Nine articles to Coastal News, once again show-casing SASRI's achievements and promoting best practice, were produced along with two articles to Shukela SA, one article in Farmers Weekly and six articles in the South African Sugar Journal.

The electronic newsletter for the Fertiliser Advisory Service, which was launched in 2016/17, continued to deliver information on the latest FAS services available to growers through a series of articles.

## **BOOKLETS AND GUIDES**





```
Two posters were created to alert the industry of the
Longhorn Beetle. These provided illustrations on how to
identify damage symptoms and life cycle stages of the pest.
```

- A booklet on Integrated Weed Management of Creeping Grasses was created to provide a series of tactics that could be used to manage the weed.
- Finally, three new variety booklets were produced for the coastal, midlands and irrigated regions. These booklets summarised the most-commonly grown varieties in each region and serves as a useful pocket guide to assist variety choice.

## **INFORMATION SHEETS**

Information Sheets provide a platform for the communication of research outcomes as well as guidelines and advice on the management of the sugarcane crop. A total of five information sheets were published containing new and updated information on varieties, pests, diseases and good production practices.

#### RADIO

During 2017/18, over 80 radio programmes were broadcast at 10 radio stations within KwaZulu-Natal. Since many of the rural population in South Africa have access to radio, this medium is being used very successfully to broadcast agronomic advice to isiZulu speaking growers.

Radio broadcasts on topical issues have reached many small-scale growers who may otherwise never get to hear these messages, thereby supporting technology exchange!



## **GROWER INTERACTION**

Significant face-to-face interaction with industry stakeholders in 2017/18 served to effectively transfer best practice, research outcomes and technical know-how, thereby informing the industry of new advancements. Extension Specialists and researchers conducted over 1 770 visits to growers, hosted 129 grower days and exhibitions and were involved in 346 conferences, workshops, refresher courses, seminars and demonstrations. SASRI also hosted 1 102 visitors.

## **CERTIFICATE COURSES**

## Certificate Courses served to build the competence and capacity of the industry, equipping new emerging farmers and new generation farmers with the knowledge to farm more effectively and sustainably!

The demand for skills development and training in sugarcane agriculture has continued to increase into 2017/18. SASRI responded to this demand again by delivering two three-week Junior Certificate Courses in Sugarcane Agriculture in April and October 2017. A total of 107 students attended the Junior Courses, 74% from South Africa and the balance from Zambia, Malawi, Swaziland, Tanzania and Mozambique.

Two Senior Certificate Courses, aimed at tertiary-level students, were held in June 2017 and February 2018 with 115 students attending. Over 61% of students were South African applicants, while the balance of students were from Malawi, Swaziland, Zambia, Mozambique and Tanzania.

## 2018 INFOPACK DVD

One of the most valuable resources produced by SASRI is the InfoPack DVD which contains a historical collection of nearly all SASRI publication resources. This resource can be used to rapidly locate previously published articles, information sheets, books, manuals or posters.

The 2018 version of the InfoPack had a number of new additions. These included:

- The manual, Integrated weed management of creeping grasses in sugarcane.
- A booklet, Feedback to RD&E Committees: 2017 Stakeholder Issues. This contained SASRI's response to industry issues raised at the RD&E AGM of 2017.
- All new and updated *Information* Sheets published over the past year.
- Three new variety booklets.

## **SASRI WEBSITE**

At the end of the 2017/18 financial year, a new website was released for SASRI. The site is now much more user friendly and contains all Information Sheets available to growers. The site now has more extensive information on the Fertiliser Advisory Service and how to sample for other crops. The decision-support-tool section provides access to a number of web-based applications that can assist in yield determinations and summarises the smartphone apps that can be downloaded from the app stores.

## **BIOSECURITY** ROWAN STRANACK, EXTENSION AND BIOSECURITY MANAGER

The SASRI Biosecurity inspectorate comprises of 24 field inspection teams with attendant officers and technicians. The inspectorate operates in all regions of the industry and is managed centrally together with Extension, who also provide management and technical support. Twelve Local Pest Disease and Variety Control Committees (LPD&VCCs) drive the industry biosecurity function. These committees are situated across the industry and have representation from both the milling and growing sectors, with SASRI staff providing the technical and administrative support.

Regular LPD&VCC meetings enable growers to remain abreast of new outbreaks and to make appropriate decisions to effect control of these threats. These decisions are based on data and technical support provided by the SASRI Biosecurity inspectorate. Committee members, in leading by example, exercise peer pressure on their neighbours to carry out control measures. Every year brings with it new challenges and this year was no exception.

The year 2017 will long be remembered as the year in which probably the largest ever biosecurity containment exercise in the history of the South African sugar industry was undertaken. This was aimed at the containment of the longhorn beetle *(Cacosceles newmannii)* and resulted in the removal of 914 hectares of sugarcane in the Entumeni area and the replacement of cane with pasture by the end of 2017.

The co-ordinated approach to this containment effort could only have been possible under a centralised LPD&VCC operation. To effectively organise all of the legislative, financial, scientific and operational requirements necessary to undertake an operation of this scale, it was essential to have a central co-ordinating body. However, this effort would not have been possible without the full co-operation and commitment of the affected growers.

A further success story was effective suppression of eldana populations in certain LPD&VCC control areas. LPD&VCCs, growers and their associations supported by SASRI Extension, SASRI Biosecurity and the agrochemical trade, achieved this once again, through a co-ordinated and committed approach. In particular, the Zululand, North Coast and Lower South Coast regions had steady and significant reductions in eldana numbers. In the Midlands regions, the recent droughts resulted in an upsurge and spread of eldana, but these too appear to have been arrested through extensive monitoring and scouting and the implementation of remedial spraying where required. All LPD&VCCs have been challenged in terms of the requirements of the industry LPD&VCC Rules, to have in place adequate supplies of Certified and Approved Seedcane within the next eight years. LPD&VCCs are now actively investigating the establishment of seedcane schemes to benefit all growers. Whilst in some areas this objective has already been achieved, there are a number of other regions where only embryonic seedcane schemes are in operation. The provision of sufficient good-quality seedcane therefore remains a major challenge in the future.

## LONGHORN BEETLE (CACOSCELES NEWMANNII)

The threat posed by this pest is arguably one of the most serious to face the industry in a long while. First recorded late in 2015 on three farms in the Entumeni area of Zululand, the pest was identified on a further two farms over the next two years. By the beginning of the 2017/18 season, more than 500 hectares of sugarcane was infested with the pest.

Following a widespread flight of adult longhorn beetles that emerged from January to March 2017, it could finally be confirmed that the particular species was *Cacosceles newmannii*, an indigenous species of longhorn beetle of which there were only a limited number of prior records.

The serious nature of this pest necessitated an amendment be made to the Notice in the Government Gazette to declare the longhorn beetle a hazardous pest and proclaim certain control measures such as the eradication of infested fields. These amendments were published in January 2017. In addition, it was necessary to place the affected farms under quarantine requiring, amongst other things, that commercial cane from these farms be transported only to the Amatikulu mill and only in specially constructed enclosed trailers. All seedcane movement from affected farms was stopped. Despite the affected growers eradicating heavily infested fields, the pest continued to spread locally. It was agreed that eradication orders needed to be issued on all infested fields as well as other fields deemed to be high-risk in an attempt to arrest the spread of the pest. The total removal of affected and adjacent fields of sugarcane together with an extended fallow period with a cover crop was considered the only practical and effective approach to controlling the pest.

Recognising the magnitude of the threat to the industry and following considerable deliberations, in June 2017 SASA Council approved a fund to enable efforts to contain and suppress populations of the pest. Funds were made available to cover the financial implications of premature harvest, early eradication of cane roots, an extended fallow rental as well as covering the cost of cane eradication and the planting of suitable cover crops.

A long-term research programme was approved and implemented during 2017. this included a dedicated SASRI Entomologist assigned to the containment project and associated research. Dr Marion Laval, a post-doctorate researcher from France, will work full-time on research into the longhorn beetle. Based at Stellenbosch University, Dr Laval will be supported by a team from the University of Pretora who will undertake research into pheromones, an essential component of future control strategies.

A special task team comprising a number of SASRI specialists and management directly involved in the containment and research projects was formed. This group met weekly to provide oversight and input to the eradication process. Regular meetings were also held with the affected growers.



By the end of 2017 the area requiring harvesting and eradication had risen to 1 099 hectares. With considerable effort and commitment all of the infested sugarcane on the affected farms was harvested and delivered to the mill. In addition, approximately 630 hectares of this area was eradicated and planted to cover crops before the end of the year. The two growers most affected by the longhorn beetle outbreak undertook the monumental task of eradication on their farms and are owed a debt of gratitude by the industry for their commitment. In a sense, there was reward for them in that the 2018 adult beetle flight was significantly less extensive than the previous year, raising some hope that a measure of containment had been achieved.

## ELDANA

Across the industry, there was once again great emphasis on eldana surveys during 2017. As in the previous year, all committees exceeded their minimum requirement for eldana surveys and some regions surveyed almost double the required norm. Approximately 86 000 hectares was surveyed for eldana, which is estimated at 24% of the area under cane in the industry. These surveys were put to good effect in that overall, across the industry only 4% of fields were above local hazard levels requiring action, either in the form of spraying or premature harvest. This was an improvement from the previous season were 7% of fields surveyed required remedial action. This is confirmation that growers are managing the pest effectively.

The Midlands South, Midlands North and Umzimkulu were granted a further extension to their temporary eldana spraying rules following successes with the implementation of these rules two seasons prior. Whilst there had been further spread of eldana in the Midlands North, overall the levels remained low, with growers responding rapidly and decisively to any occurrence with either spraying or harvest. The eldana threat became somewhat more evident in the irrigated Northern areas of the industry where drought and water restrictions had placed the crop under stress, leading to a significant increase in eldana numbers. This culminated in the off-season of 2018 when carryover cane, particularly in the Pongola area, was found to be severely damaged requiring urgent harvest at the start of the season. Similar isolated problems occurred in the Lowveld.

Integrated Pest Management (IPM) for eldana control was widely promoted in areas under threat. Careful management of varieties and specifically the introduction of eldana resistant varieties remains a cornerstone of this approach. To this end, the new varieties N54, N55, N56, N58, N59, N61 and N62 have all proved their worth as promising replacements for older, more susceptible varieties. A further active ingredient, emamectin, was registered for eldana control in cane stubble. This could prove useful in certain instances where high levels of eldana in the preceding crop carry over to start new populations in the same field.

## **SMUT AND MOSAIC**

These diseases remained at low levels across the industry. As in previous seasons, surveys in commercial fields were below requirement due to the pressure to carry out more eldana surveys. Approximately 29 000 hectares was surveyed, of which 718 hectares was above the local hazard level. The majority of these hazard fields were due to high smut levels requiring remedial action; either roguing or plough out in isolated cases. The majority of the smut fields were in the irrigated Northern regions with only isolated fields with high smut recorded south of these regions.

## RSD

Of the 8 087 RSD samples taken from commercial cane, 2% were found to be infected. This was lower than the average infection found in previous seasons, which has gone as high as 10% in the past. The disease is more prevalent in the northern regions with the Lowveld and Umfolozi recording the highest level of infection in commercial fields. Of the 1 212 RSD samples taken in seedcane, only eight of these were found to be positive. Compulsory testing of all seedcane fields has largely prevented planting of any infected seedcane. This requirement should contribute to an overall reduction in RSD as seedcane sources improve over time.

## SEEDCANE

Seedcane was once again one of the key focus areas during the annual LPD&VCCs Chairman's meeting. Committees reported regional progress toward compliance with the 2023 deadline whereby all commercial fields are to use either LPD&VCC Certified or Approved Seedcane for planting. Areas such as the irrigated Northern regions are making strong efforts to establish seedcane schemes while other schemes already in operation are being strengthened and refined to meet the requirement. In addition, small-scale growers will also be able to access regional schemes in the absence of establishing their own on-farm nurseries. In this regard, the Felixton Outreach Committee has established an ideal model to ensure Certified Seedcane reaches small-scale growers. As a measure of progress towards the 2023 deadline, approximately 5 500 hectares of Approved Seedcane would be required to meet the industry's needs at planting. During the 2017/18 planting season, a total of 2 400 hectares of Approved Seedcane Nurseries were approved for use, meaning that the area under Approved Seedcane needs to double over the next four years.

#### **OTHER PESTS AND DISEASES**

An incursion of fall armyworm *(Spodoptera frugiperda)* hit southern Africa during the report period. This pest was particularly devastating on maize, as well as other crops and vegetables. The pest was positively identified on sugarcane in Malawi and an isolated outbreak occurred in the Mpumalanga Lowveld. Fortunately damage was not widespread or severe.

Yellow sugarcane aphid *(Sipha flava)* persisted in some areas. The North and South Coast regions were particularly hard hit. Despite growers spraying these infestations with registered insecticides, the pest still proved difficult to control and caused serious yield losses in some instances. As a result of difficulties experienced in researching this pest, the decision was made to partner with Nakambala Estate in Zambia where the pest is also extremely damaging and widespread. Fortunately, this pest is predictable in its occurrence thus enabling more research that is effective. A student based in Zambia carried out research under the supervision of a senior entomologist at SASRI.

## **REGIONAL BIOSECURITY**

Monitoring for the possible incursion of *Chilo sacchariphagus* continued along the borders of South Africa and Mozambique using a grid of pheromone traps. Workshops and training involving SADC sugarcane estates threatened by Chilo were held in 2017 and 2018. This cross-border contact is also useful to track other regional threats such as yellow sugarcane aphid, which is now present across the entire SADC sugarcane-producing region.



## **ADVISORY AND SUPPORT SERVICES** KERRY REDSHAW, OPERATIONS MANAGER

## **SPECIALIST ADVISORY SERVICES**

SASRI researchers and specialists provide essential sugarcane agriculture services and support to the local sugarcane industry as well as to a number of external customers (local and international). These expertise and experiences are offered as specialist advisory services to external clients for a consultancy fee.

The income generated from the delivery of these services is used to offset operational expenses. These requests include specialist advice, technical support and training to SADC partners, SA agrochemical companies and other external clients. Specialist advice includes, but is not limited to, variety choice and evaluation, crop nutrition, irrigation advice, pest and disease identification, control and management, nematode analyses, crop forecasting, ripener advice and decision-making, soils management and crop performance and management.

SASRI received 50 Specialist Advisory Requests (SARs) during 2017/2018. After evaluating capacity and relevance to SASRI, 43 of these requests were addressed by the end of March 2018.

## **EXTENSION REQUESTS FOR ADVICE**

SASRI received a number of requests for advice from Extension Specialists. These services were provided to growers as part of the ongoing service provision to the SA sugar industry.

SASRI received 25 Extension Requests for Advice (ERA) during 2017/2018. Of these, 23 ERAs were for Land Use Plans (LUPs) and farm maps. Due to limited staff capacity in GIS, SASRI have had a backlog of LUP requests from previous years. These requests are completed as and when staff capacity permits. With the increasing level of adoption of SUSFARMS® in the industry, growers are realising the importance of having a LUP for effective management of their farms. Spatial management planning services have resulted in better management of grower fields and consequently higher yields through better spatial planning and mapping of fields.

## FERTILISER ADVISORY SERVICE

The Fertiliser Advisory Service (FAS) is a user-pays entity that uses state-of-the-art laboratory instrumentation and methods to provide growers with unbiased, customised advice based on management practices and attainable yields. The FAS is SABS ISO 9001 certified and provides accurate, sugarcane-specific fertiliser advice to ensure growers achieve sustainable and cost-effective returns from their input costs. FAS uses a Laboratory Information Management System to improve efficiencies in the delivery of accurate and reliable results and recommendations to customers.

While soil and water sample submission numbers during 2017/2018 were higher than 2016/2017, fertiliser and leaf sample numbers decreased relative to the previous season. A breakdown in sample numbers for 2017/2018 are in the table below:

## NUMBER OF SOIL, LEAF, FERTILISER AND WATER SAMPLES ANALYSED BY FAS:

	2017/2010 2010/2017				
	SA GROWERS	SASRI RESEARCH	OUTSIDE SA	TOTAL	TOTAL
SOIL	23 987	2 004	4 449	30 440	24 739
LEAF	1 248	676	2 991	4 915	7 675
FERTILISER	3 513	13	118	3 644	4 099
WATER	94	15	111	220	152

## **DISEASE DIAGNOSTICS**

SASRI provides a disease diagnostics service for local and SADC growers to assist in mitigating risk and preventing yield loss associated with a range of diseases. Although not limited to the following, two of the main focus areas of the disease diagnostic services are Ratoon Stunt Disease (RSD) and Yellow Leaf Virus (YLS). During 2017/2018, a total of 12 009 RSD samples were analysed with 8 617 of these samples coming from SA growers and 3 196 from other countries. The remaining number of samples (196) were from SASRI research trials. The number of RSD samples analysed for SA growers decreased by 961 samples in the 2017/2018 season. SASRI also conducted training on a user pays basis, in Malawi and Tanzania on RSD disease surveys, sample collection and diagnostic techniques.

## QUARANTINE

SASRI has a government-approved, world-class quarantine facility located at Mount Edgecombe for all sugarcane varieties imported into and exported from South Africa. Sugarcane varieties from foreign countries are imported into South Africa to broaden the genetic base of the parental breeding material. Imported varieties are also evaluated as potential commercial varieties. Through Variety Evaluation and Licence Agreements, SASRI controls the distribution of South African varieties into Africa to protect SASRI's Plant Breeders' Rights. SASRI is responsible for obtaining phytosanitary certificates from the division of Plant Health at the Department of Agriculture, Forestry and Fisheries for the export of any sugarcane from South Africa.

During 2017/2018, a number of different disease-free varieties were exported to DRC, Mozambique, Nigeria, Reunion, Zambia and Zimbabwe. Du Roi Laboratory supply SA varieties to countries where there are Variety Licence Agreements in place. Sugarcane fuzz was exported to Zimbabwe, Mauritius and Iran.

#### WEED BIOCONTROL

SASRI entered into a Memorandum of Agreement (1 November 2014 to 31 March 2018) with the Department of Environmental Affairs to mass rear, supply and deliver specified biological control agents for a range of invasive alien plant species for the Natural Resource Management Programmes.



SASRI has also tendered for a new three year contract (1 April 2018 to 31 March 2021) with the DEA and received confirmation that this application was successful.

During 2017/2018, SASRI mass reared and distributed 217 492 biological agents. The agents are effective for the control of *Pereskia aculeate* (Barbados Gooseberry), Parthenium hysterophorus, Salvinia molesta (Kariba Weed), Eichornia crassipes (Water hyacinth), Pistia stratiodes (Water lettuce) and Chromolaena odorata (Triffid weed).

## **GENETIC ANALYSIS**

SASRI provides a genetic analysis service to SASRI researchers for research projects, Quarantine, Biosecurity and to external clients as specialist advisory requests (SAR). This genetic analysis service includes DNA sequencing and DNA fragment analysis. During 2017/2018, 860 DNA sequences and 2 932 DNA fragment analyses were conducted. All South African commercial varieties have been fingerprinted and it is standard procedure for all pre-release varieties considered for bulking to undergo this analysis. In addition, researchers, Quarantine and Biosecurity regularly use this service for the accurate identification of varieties, pests and diseases.

## MECHANISATION AND ADVISORY SERVICE AND MACHINERY DEVELOPMENT

SASRI provides advice and recommendations on mechanisation alternatives on a request basis as well as costings and system optimisation. Annually, SASRI prepares two Mechanisation cost reports for the industry. The first report provides the costing of different equipment and machinery systems and the second report provides the costings of a range of system scenarios including land preparation, planting and ratoon management. These reports are available on the SASRI website. When necessary, SASRI investigates the need for machinery development and, where appropriate, initiates and collaborates in the development of new machinery.

Many stakeholders make use of these mechanisation reports. Growers use them for annual budget preparation while SA Canegrowers economists use the reports for updating the industry cane salvage rates and industry budgets. SASRI specialists use these reports for the sugarcane certificate courses and for updating various Decision Support Tools.

## POLICY DEVELOPMENT AND IMPLEMENTATION

SASRI offers specialist advice on policy development and implementation. In addition to this, SASRI provides specialist technical advice on specific requests pertaining to irrigation, transport, mechanisation and energy related issues and industry initiatives.

Examples include:

- monitoring and providing comment on the development and implementation of the national government's water policy on behalf of the sugar industry;
- monitoring and providing comment on the development, amendment and implementation of transport related legislation such as: Haulage tractor; Consignee/consignor etc;
- transport related sugar industry RTMS and Smart Trucks (PBS) meetings; and
- energy tariff changes and impacts thereof.

## WEATHER INFORMATION

SASRI collects, collates and processes meteorological data continuously from a grid of automatic and manual weather stations distributed across the industry. This also involves the maintenance and calibration of the automatic weather station network and data processing system and the provision of summaries of meteorological data for comparative purposes. These data and related weather applications are available on SASRI's WeatherWeb (www. sasri.org.za). It is possible to view and download all information in the form of maps, graphs or reports.

Users can view current weather information on the WeatherWeb from a range of weather stations. Rainfall and temperature figures are updated every five minutes, and the site also provides evapotranspiration values and a fire danger index. Real-time weather information is useful for decision-making regarding irrigation, chemical application and harvesting operations.

SASRI offers an Automatic Weather Station (AWS) installation and maintenance service both within and outside the borders of South Africa. SASRI provides support to Mondi for the installation and maintenance of 29 AWS weather stations. This AWS service is also provided to customers in Mozambique, Swaziland and Zambia. All installations are conducted according to established standards and include programming of data loggers to suit user needs and setting up automated data collection. All data from the AWS is processed to ensure integrity. Maintenance routines include regular on-site calibration of sensors and equipment, repairs or replacements and general site maintenance. Calibration reports and certificates of compliance are issued with each visit.

## **CROP FORECASTING**

SASRI provides the industry with operational forecasts of the sugarcane crop, monthly from October of the preceding year to August of the current year, on a mill and industry level. Specialists make use of weather and irrigation water supply data, climate forecasts and the Canesim® crop model for these forecasts. Detailed cane yield forecast information are available to registered users, while industry estimates of cane production are shared widely within the industry.

Information from Canesim<sup>®</sup> crop forecasts are also used by the SASA RV Forecast Committee to provide monthly forecasts (from April onwards) of seasonal average RV content of cane. These estimates are recorded for each mill area to guide Mill Group Boards and to calculate growers' remuneration for cane deliveries.

## **PUBLICATIONS AND PRESENTATIONS**

(1 APRIL 2017 - 31 MARCH 2018)

## **CONFERENCE PROCEEDINGS**

Adetoso AA, Singels A, Paraskevopoulos AL and Jordaan H. Management practices and the water footprint of irrigated sugarcane production in South Africa. *23rd International Congress on Irrigation and Drainage*, Mexico. 8-14 October 2017

Behary-Paray, N, Woods, M, Pieterse E and Conlong D. Rearing of the sugar cane spotted borer *Chilo sacchariphagus* (Lepidoptera: Crambidae) for quality SIT in Mauritius. *2nd IAEA Research Coordination Meeting on CRP Moth SIT*, New Zealand. 12-17 March 2018.

Campbell PL, Rutherford RS and Govender P. (2018). Encouraging integrated weed management in the sugarcane industry. *Proceedings of the African Combined Congress, Cape Town.* 14 - 18 January 2018

Conlong DE and Rutherford RS. The Potential Addition of SIR and Bt-sugarcane to the Toolbox of an AW-IPM Programme against *Eldana saccharina* in South African Sugarcane. *3rd FAO/IAEA International Conference on Area-Wide Management of Insect Pests*, Austria. 22 – 26 May 2017.

Conlong DE, Boersma N, Mouton C, Duba O, Gillespie DY, Ngomane NC, Woods M and Pieterse E. Developments in the SIT programme against *Eldana saccharina* Walker (Lepidoptera: Pyralidae), a major pest of South African sugarcane. *Second IAEA Research Coordination Meeting on CRP Moth SIT*, New Zealand. 12-17 March 2018.

Elephant D, Miles N and Muchaonyerwa P. The estimation of reserve-K and K immobilization using mid-infrared spectroscopy and multiple linear regressions. *Proceedings of the African Combined Congress,* Cape Town. 14-18 January 2018.

Gillespie WA, Mkhabela N, Masondo R and Hlela S. *SASAE Extension and Advisory Conference Extension and Research professionals,* Durban. 14 - 15 March.

Jacob RM and Lloyd Evans D. An Integrative Approach to Generating a Reference Transcriptome for Sugarcane. *CHPC National Conference 2017*, Pretoria. 3 – 7. December 2017.

Malan C, Baartman J, Berner JM, Patton A, Hoffman N, Singels A and van Heerden PDR. Effects of elevated CO<sub>2</sub> on stomatal conductance, biomass partitioning and yield of sugarcane grown in absence of soil water deficit. *2nd International Agriculture and Climate Change Congress*, Spain. 26 - 28 March 2017.

Memela N, McFarlane SA, Conlong DE, Rutherford RS and Schmidt S. For and Against: Towards the use of endophytes for the control of Eldana saccharina. *Combined Congress of the Entomological and Zoological Societies of Southern Africa*, Pretoria. 3-7 July 2017.

Moeng E, Mutamiswa R, Conlong DE, Assefa YA, Nyamukondiwa C and Le Ru BP. Species diversity of lepidopteran stem borers in Botswana. *Proceedings of the Combined Congress of the Entomological Society of Southern Africa and the Zoological Society of Southern Africa*, Pretoria. 3-7 July 2017.

Mutamiswa R, Moeng E, Le Ru Bp, Conlong De, Assefa Ya and Nyamukondiwa. Species diversity and abundance of lepidopteran stem borer natural enemies in Botswana. *Proceedings of the Combined Congress of the Entomological Society of Southern Africa and the Zoological Society of Southern Africa*, Pretoria. 3-7 July 2017.

Ramburan S, Snyman SJ and Shezi SN. From laboratory to field: Assessing the impacts of tissue culture propagation on the agronomic performance of sugarcane. *Proceedings of the African Combined Congress,* Cape Town. 14-18 January 2018.

Ramouthar PV and Pillay U. Towards improving sugarcane variety tolerance testing. *Symposium of the Nematological Society of Southern Africa*, Fairmont Zimbali Hotel and Conference Centre. 7-11 May 2017.

Pillay U, Ramouthar PV and Rutherford RS (2017). "Can fungicides help in the battle against Meloidogyne? Preliminary in vitro assessments". *Symposium of the Nematological Society of Southern Africa,* Fairmont Zimbali Hotel and Conference Centre. 7-11 May 2017.

Singels A, Paraskevopoulos AL and Mashabela LM (2017). Optimizing the use of limited irrigation water during drought: Impact of irrigation strategies on farm profitability. *Netafim's 2nd Irrigated Sugarcane Conference*, Durban. 4 - 8 November 2017.

Rutherford RS and Conlong DE. F1: Fast-Tracking *Eldana saccharina* Moths for Sterile Insect Release. (Poster Presentation). *Third FAO/IAEA International Conference on Area-Wide Management of Insect Pests: Integrating the Sterile Insect and Other Techniques*, Austria. 22 – 26 May 2017.

Snyman SJ, Gouse M, van den Berg J, Siebert S and Potgieter L. Biosafety aspects in the pre-commercialisation phase of developing GM sugarcane in South Africa. *Congress of the International Society for Biosafety Research of Genetically Modified Organisms (ISBGMO),* Mexico. 4-8 June 2017. Van Antwerpen R, Barnard JH and van Rensburg LD. Electromagnetic induction: can it be used to identify the depth of abrupt change in clay content? Proceedings of combined congress, Cape Town, 14-18 January 2018.

Van Antwerpen R and Jumman A. Estimating soil water holding capacity for irrigation design in the SA sugarcane industry. *SABI Congress 2017.* Cape Town .

Van Heerden PDR. PurEst™ demonstration. *Third AFAAS Africa-Wide Agricultural Extension Week combined with the 51st Annual Conference of the South African Society for Agricultural Extension: Delegates' Tour*, Durban. 1 November 2017.

Way MJ, Conlong DE, Rutherford RS, Sweby DL, Gillespie D, Stranack RA and Grobbelaar B. New record of a Cerambycid in the South African Sugarcane Industry. *Combined Congress of the Entomological and Zoological Societies of Southern Africa*, Pretoria. 3-7 July 2017.

Zhou MM, Joshi SV and Lichakane ML. Sugarcane germplasm characterisation and implications for breeding cultivars for diverse agro-ecological regions of South Africa. *EUCARPIA Genetic Resources Conference*, France. 8-11 May 2017.

## **TECHNICAL REPORTS**

Singels A and Paraskevopoulos AL (2017). The Canesim® sugarcane model: Scientific documentation. Published by the South African Sugarcane Research Institute, Mount Edgecombe. ISBN 978-0-6399083-0-4.

## **SCIENTIFIC JOURNAL PUBLICATONS**

Banasiak M and Snyman SJ (2017). Exporing in vitro germplasm conservation options for sugarcane *(Saccharum spp. hybrids)* in South Africa. *In Vitro Cellular and Developmental Biology – Plant 53:* 402.

Botha P and Stranack RA (2017). Integrated pest management strategies adopted by sugarcane growers in the midlands of Kwazulu-Natal to counter an incursion of African Sugarcane Borer. *Rural Extension and Innovation Systems Journal* 13, 2: 127-130.

Bonte J, Van De Walle A, Conlong DE and Declercq P (2017). Eggs of *Ephestia kuehniella* and *Ceratitis capitata*, and motile stages of the astigmatid mites *Tyrophagus putrescentiae and Carpoglyphus lactis* as factitious foods for *Orius spp. Insect Science* 24:613-622.

Cilliers M, van Wyk SG, van Heerden PDR, Kunert KJ and Voster BJ (2017). Identification and changes of the drought-induced cysteine protease transcriptome in soybean (Glycine max) root nodules. *Environmental and Experimental Botany* 148: 59-69. Goodall JM, Denny RP and Campbell PL (2017). Observations from seedbank studies on *Solanum mauritianum* Scop. (bugweed) in a pine plantation, *South African Journal of Botany*, 112:11-14.

Jones MR and Singels A (2018). Refining the Canegro model for improved simulation of climate change impacts on sugarcane. *European Journal of Agronomy* 100: 76-86.

Hajari E, Snyman SJ and Watt MP (2017). The effect of form and level of inorganic N on nitrogen use efficiency of sugarcane grown in pots. Journal of *Plant Nutrition* 40(2):248-257.

Kleynhans E, Barton MG, Conlong DE and Terblanche JS (2017). Population dynamics of *Eldana saccharina* Walker (Lepidoptera: Pyralidae): Application of a biophysical model to understand phenological variation in an agricultural pest. *Bulletin of Entomological Research* 108(3): 283-294.

Le Ru BP, Capdevielle-Dulac C, Musyoka BK, Goftishu M, Assefa Y, Ndemah R, Molo R, Chipabika G, Conlong DE, Ong'amo G and Kergoat GJ (2017). Molecular phylogenetics and definition of the *Acrapex minima* Janse group (Lepidoptera, Noctuidae, Apameini, Sesamiina) with the description of four new species from the Afrotropics. *Annales de la Société entomologique de France (N.S.)* 53:4, 219-235.

Keeping MG (2017). Uptake of silicon by sugarcane from applied sources may not reflect plant-available soil silicon and total silicon content of sources. *Frontiers in Plant Science* 8:760.

Lloyd Evans D and Joshi SV (2017). Herbicide targets and detoxification proteins in sugarcane: From gene assembly to structure modelling. *Genome* 60:7, 601-617 Presentations at congresses or symposia.

Martin LA, Lloyd Evans D, Castlebury LA, Sifundza JT, Comstock JC, Rutherford RS and McFarlane SA (2017). *Macruropyxis fulva* sp. nov., a new rust (Pucciniales) infecting sugarcane in southern Africa. *Australasian Plant Pathology* 46 (1): 63-74.

Martin LA, Rutherford RS and McFarlane SA (2017). Touchdown PCR assay for the rapid diagnosis of tawny rust caused by *Macruropyxis fulva* on sugarcane. Australasian Plant Pathology 46: 103-105.

Mbuma N, Zhou MM and Van der Merwe R (2017). Identifying elite families and determining optimum family selection rates in sugarcane breeding. *Crop Science* 57: 1-13.

Mudavanhu P, Addison P and Conlong DE (2017). Effect of mass rearing and gamma irradiation on the mating behaviour of Eldana saccharina. Special Issue-Improving Pest Control: Mass Rearing and Field Performance. *Entomologia Experimentalis et Applicata* 162: 159-167. Mutamiswa R, Moeng E, Le Ru BP, Conlong DE, Assefa YA, Goftishu M and Nyamukondiwa C. (2017). Diversity and abundance of lepidopteran stem borer natural enemies in natural and cultivated habitats in Botswana. *Biological Control* 115: 1-11.

Naidoo N, Ghai M, Moodley K, Mkhize L, Martin L, McFarlane S and Rutherford RS (2017). RS-LAMP assay and use of lateral flow devices (LFDs) for rapid detection of *Leifsonia xyli* subsp. *xyli* (Lxx). *Letters in Applied Microbiology* 65: 496-503.

Nkala J (2017). Review of successful land reform beneficiary projects resulting from co-ordinated service delivery within the South African sugar industry. *Rural Extension and Innovation Systems Journal* 13, 2: 172-175.

Rutherford RS, Maphalala KZ, Koch AC, Snyman SJ and Watt MP (2017). Field and laboratory assessments of sugarcane mutants selected in vitro for resistance to the imidazolinone herbicide imazapyr. *Crop Breeding and Applied Biotechnology* 17: 107-114

Sengwayo S, Zhou MM and Labuschagne M (2017). Location and crop-year effects for yield, quality and agronomic traits among coastal short cycle breeding programmes in *South Africa. South African Journal of Plant and Soil* 35:2, 79-87.

Sengwayo S, Zhou MM and Labuschagne M (2017). Trends in variance components for yield, quality and agronomic traits among coastal short cycle breeding population. *South African Journal of Plant and Soil* 35:2, 89-99

Snyman SJ, Banasiak M, Mhlanga P, Mupanehari E and Watt MP (2018). Strategies for maintaining and increasing throughput of in vitro cultures of sugarcane. *Acta Horticulturae* 1205, 763-768.

Snyman SJ, Shezi SN and Ramburan SA (2018). Field assessment of in vitro micropropagated NovaCane® sugarcane *(Saccharum spp. hybrids). Sugar Tech* 20: 609.

Zhou MM (2017). Simultaneous selection for multiple traits in Sugarcane breeding populations using logistic regression models. *South African Journal of Plant and Soil* 35:3, 165-171.

#### SASTA PUBLICATIONS

Adendorff MW, Jumman A, Paraskevopoulos A, Singels A and FC Olivier (2017). Irrigation scheduling demonstration trials: an effective means to promote adoption. *Proceedings of the South African Sugar Technologists Association* 90: 191-195.

Campbell PL, Rutherford RS and Drew K (2017). The investigation of a suitable summer breakcrop after imazapyr application for integrated management of Cynodon dactylon. *Proceedings of the South African Sugar Technologists' Association* 90: 135. Elephant D, Miles N and Mthimkhulu SS (2017). Effects of surface-applied lime and gypsum on soil properties and yields of sugarcane ratoon crops. Short Communication - *Proceedings of the South African Sugar Technologists Association* 90: 113-117.

Evans DL and Joshi SV (2017). A New Origin of Sugarcane: The Undiscovered Species. *Proceedings of the South African Sugar Technologists Association* 90: 163-166.

Evans DL and Joshi SV (2017) Molecular Phylogeny of Sugarcane: Discovering A New Species. *Proceedings of the South African Sugar Technologists Association* 90: 151.

Gillespie WA, Way MJ, Masondo T, Webster T and FJ Mitchell (2017). The positive influence of Demonstration Plot Extension Methodology in a rural sugarcane community. *Proceedings of the South African Sugar Technologists Association* 90: 196-198.

Hoffman N, Patton A, Malan C, Baartman J, Berner J, Singels A, Paraskevopoulos A and van Heerden PDR (2017). An experimental and crop modelling assessment of elevated atmospheric CO<sub>2</sub> effects on sugarcane productivity. *Proceedings of the South African Sugar Technologists Association* 90: 131-134.

Jones M, Khambule S and Singels A (2017). A web-based decision support tool for analysing monthly sugarcane growth rates in South Africa. *Proceedings of the South African Sugar Technologists Association* 90: 137.

Jumman A (2017). A simple spreadsheet-based irrigation electricity cost calculator. *Proceedings of the South African Sugar Technologists Association* 90: 186-189.

Kadwa M, Ramburan S, Nicholson RJ and Redshaw KA (2017). A financial estimation of the mill-area scale benefits of variety adoption in South Africa: A simplistic approach. *Proceedings of South African Sugarcane Technologists Association* 90:51-61.

Lichakane ML and Zhou MM (2017). Eldana saccharina damage on a coastal long cycle Population and the implications on Sugarcane Breeding. Proceedings of South African Sugarcane Technologists Association 90: 143-146.

Mbuma NW, Zhou MM and Van der Merwe R (2017). Identifying elite families for the Midlands sugarcane breeding programmes in South Africa. *Proceedings of South African Sugarcane Technologists Association* 90: 147-150.

McFarlane K and Walton AD (2017). An investigation into stored seed viability. *Proceedings of the South African Sugar Technologists Association* 90: 162.

## **PUBLICATIONS AND PRESENTATIONS**

Miles N, Rhodes R and Weigel A (2017). Prediction of soil nitrogen mineralization to crop fertiliser nitrogen requirements. *Proceedings of the South African Sugar Technologists Association* 90: 118-121.

Mthimkhulu SS and Miles N (2017). The current fertility status of soils of the South African sugar industry *Proceedings of the South African Sugar Technologists Association* 90: 92-103.

Ngomane NC Gillespie DY and Conlong DE (2017). The effect of an improved artificial diet formulation on *Eldana saccharina* rearing, growth and development. *Proceedings of the South African Sugar Technologists Association* 90: 66-77.

Nicholson RJ, Ducasse G, Rutherford RS and Campbell PL (2017). Investigating the potential cost benefit of a herbicide tolerant and insect resistant genetically modified cane variety at various growing cycle lengths, under coastal conditions. *Proceedings of the South African Sugar Technologists' Association* 90: 236-245.

Nxumalo PD and Zhou MM (2017). The relationship between the self-trashing trait and Eldana saccharina (Lepidoptera Pyralidae) damage in sugarcane and implications for resistance breeding. *Proceedings of South African Sugarcane Technologists Association* 90: 152-155.

Paraskevopoulos A, Mashabela ML and Singels A (2017). MyCanesim® Lite: A simple web-based sugarcane simulation tool. *Proceedings of the South African Sugar Technologists Association* 90: 138.

Patton A, Makhubedu T and Weigel A (2017). Nitrogen use efficiency of selected South African sugarcane varieties. *Proceedings of the South African Sugar Technologists Association* 90:136.

Pillay U and Ramouthar PV (2017). Here, there or everywhere? An investigation into nematode trial sampling. *Proceedings of the South African Sugar Technologists Association* 90: 199.

Poswa LZ and Miles N (2017). Factors controlling the solubility of phosphorus in soils of the South African sugarcane industry. *Proceedings of the South African Sugar Technologists Association* 90: 122-125.

Kadwa M, Ramburan S, Nicholson R, and Redshaw KA (2017). A financial estimation of the mill area-scale benefits of variety adoption in South Africa: A simplistic approach. *Proceedings* of the South African Sugar Technologists Association 90: 51-61. Ramburan S and Tweddle P (2017). An economic conversion tool for sugarcane experimental and commercial production scenarios. *Proceedings of the South African Sugar Technologists Association* 90: 216-224.

Shezi SN, Ramburan S and Modi AT (2017). Agronomic performance of tissue culture (NovaCane®) versus conventional seedcane under rainfed conditions. *Proceedings of the South African Sugar Technologists Association* 90: 161.

Singels A, McFarlane SA, Way MJ, Sithole P and Nicholson RJ (2017). Review of South African sugarcane production in the 2016/2017 season: light at the end of the tunnel? *Proceedings of the South African Sugar Technologists Association* 90: 1-19.

Snyman SJ and Rutherford RS (2017). Timeframe for the development of borer resistant genetically modified sugarcane. *Proceedings of the South African Sugar Technologists Association* 90: 87.

Tweddle PB, Harris A, Makhaye A and Rapson B (2017). Yield variability mapping for a cut and stack system. *Proceedings of the South African Sugar Technologists' Association* 90: 190.

Tweddle P and Lyne P (2017). PBS vehicles in the South African sugar industry: opportunities and limitations. *Proceedings of the South African Sugar Technologists Association* 90: 178-185.

Van Antwerpen R, Miles N and Mthimkhulu SS (2017). Mass and composition of ash remaining in the field following burning of sugarcane at harvest. *Proceedings of the South African Sugar Technologists' Association* 90: 104-112.

Van Heerden PDR and Hoffman N (2017). A new decision-making framework for developing variety-specific chemical ripening recommendations. Proceedings of the South African Sugar Technologists Association 90: 225-235.

Way MJ, Conlong DE, Rutherford RS, Sweby DL, Gillespie DY, Stranack RA, Grobbelaar E and Perissinotto R. (2017). *Cacosceles* (Zelogenes) *newmannii* (Thomson) (Cerambycidae: Prioninae), a new pest in the South African sugarcane industry. *Proceedings of the South African Sugar Technologists' Association* 90: 62-65.

Zhou MM (2017). Performance of imported genotypes and implications for utilization in SASRI breeding programmes. *Proceedings of South African Sugarcane Technologists Association* 90: 156-160.

## **THESES AND DISSERTATIONS**

Caphane J. Rearing and radiation biology studies on *Chilo sacchariphagus* Bojer (Lepidoptera: Crambidae). PhD, University of Mauritius. Supervisor: Dr DE Conlong [SASRI] and Dr S. Facknath [University of Mauritius].

Kheswa N. Development of *Beauveria brongniartii* as a Bio-Insecticide of White Grub (Coleoptera: Scarabaeidae) of Sugarcane in KwaZulu-Natal, South Africa. MSc thesis, University of KwaZulu-Natal, Pietermaritzburg. Supervisors: Dr DE Conlong [SASRI] and Prof M Laing, Dr M Shuttleworth [UKZN].

Mthimkhulu SS (2017). Long-term fertilizer and residue management effects on structural stability of two soil types in South Africa. PhD thesis, University of KwaZulu-Natal. Supervisors: Dr J Hughes [UKZN], Dr L Titshall [SASRI], Prof R van Antwerpen [SASRI] and Dr P Podwojewski [UKZN].

## BOOKS

Van Antwerpen R, van Heerden PDR and Tweddle P, Cheong R Ng and Rivière V (2017), Advances in harvesting and transport of sugarcane (Chapter 10), Achieving sustainable cultivation of sugarcane Volume 1 (Ed. Rott P). *Burleigh Dodds Science Publishing Ltd. Cambridge.* ISBN-13: 9781786761446.

Singels A (2017). Crop modelling to support sustainable sugarcane cultivation. In: Achieving sustainable cultivation of sugarcane. Vol 1: Cultivation techniques, quality and sustainability. (Ed. Rott P) 21-44. *Burleigh Dodds Science Publishing Ltd. Cambridge*. ISBN 978-1-78676-144-6.

Singels A and Paraskevopoulos AL (2017). The Canesim® sugarcane model: Scientific documentation. Published by the South African Sugarcane Research Institute, Mount Edgecombe. ISBN 978-0-6399083-0-4.





## SOUTH AFRICAN SUGARCANE RESEARCH INSTITUTE

170 Flanders Drive, Mount Edgecombe, 4300 Private Bag X02, Mount Edgecombe, 4300 Tel: (031) 508 7400 Fax: (031) 508 7597 ISSN: 978-0-6399083-7-3

www.sasri.org.za