SOUTH AFRICAN SUGARCANE RESEARCH INSTITUTE

2016/17 PROGRESS REPORT

CONTENTS

STATISTICAL SNAPSHOT

RESEARCH PROJECTS AS AT 31 MARCH 2017

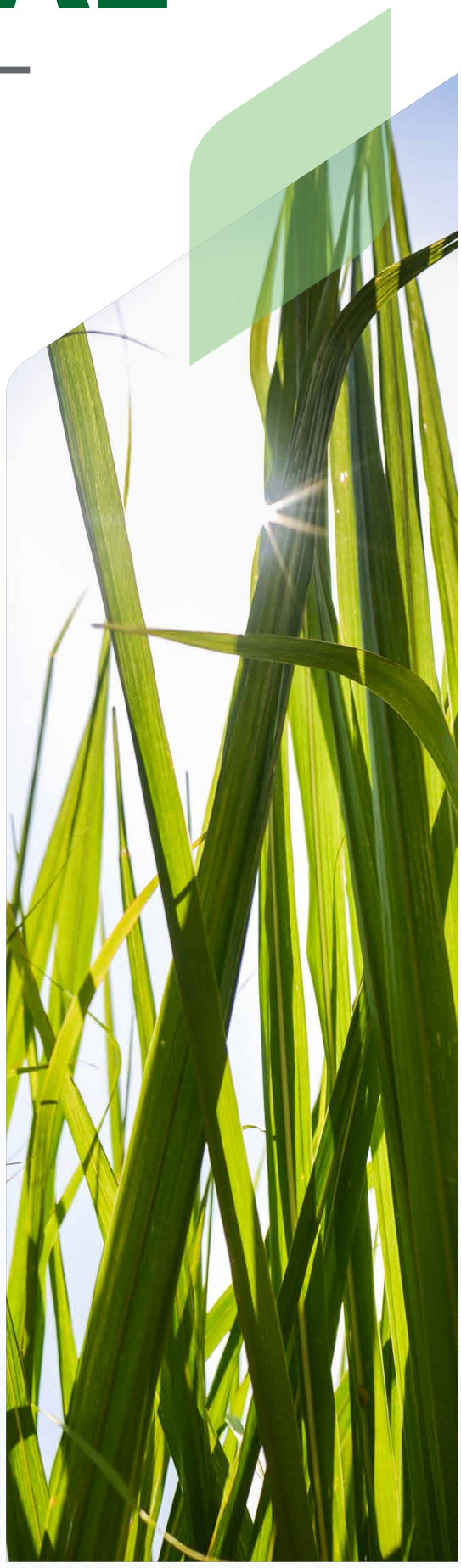
Closed	17
Ongoing	50
New	17

STAFF COMPLEMENT

(EXCLUDING CONTRACT STAFF)

Biosecurity	148
Crop Biology	47
Plant and Environment	19
Breeding and Field	216
Diagnostic and Analytical	35
Extension	27
Knowledge Management	7
Human Resources	4
Administration and Management	7
Management	3
TOTAL	513

Number of Honorary appointments at tertiary institutions	14
Number of NRF rated scientists	8
Number of postgraduate students associated with SASRI	5
Number of postgraduate students based at SASRI	12
Number of research interns	18
Number of SASRI staff registered for post-graduate studies	7



SRASA COMMITTEE (as at 31 March 2017)

Chairman

GD Stainbank

Vice-Chairman

PW Russell

GROWERS Representatives

TB Funke
TJ Murray
AM Russell
S Sharma
R Talmage
GW Taylor
KM Hurly (alternate)
GDP Littley (alternate)
S Mashaba (alternate)
ST Naidoo (alternate)

MILLERS Representatives

EA Brüggemann
J Dewar
N Dlodlo
FM Eggers
AJ Harris
SS Munsamy
RS Ninela
DP Rossler
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 (as at 31 March 2017)

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: **PDR 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**

CHAIRMAN'S REPORT

Graeme Stainbank
(Chairman - SRASA Committee)

Models of funding for research and technology exchange vary from crop to crop and country to country. In many parts of the world, such funding support has traditionally emanated from government through taxpayer contributions. More recently however, and variably across a range of countries, this model of funding is changing.

In the South African sugar industry, sugarcane agricultural research has traditionally been industry-funded. As one of the benefits of a regulated industry, South African taxpayers never had to sponsor our agricultural Research and Extension (R&E). Rather, growers and millers traditionally shared the costs of SASRI, both horizontally and vertically in our value chain. In recent years, however, this model of funding has shifted with growing recognition from government enabling significant support for some of the R&E activities at the institute.

Throughout this time, it is undoubted that constant re-evaluation of our activities has been required to ensure that we remain efficient and sustainable. The ongoing challenge is to balance the limited pool of resources with the ever-growing demand for innovation and new technology. How we do this and what current practices we change, is a constant query from SASRI senior management and the SRASA Committee[1] .

As a result of the drought, and for a number of years now, our researchers have been expected to deliver more with less. This comes at a time when sugarcane industries around the world are facing extreme competition from sugar beet producers that have made significant advances in productivity, despite being subjected to the same cost squeeze. Naturally therefore we ask ourselves the question should we be doing more of what the beet industry is doing?

There are two fundamental differences between the two industries who both extract sucrose from a plant: the first relates to the extent of investment in agricultural research (from both government and the business sector) and the second concerns the nature of the crop. Whether or not pursuit of externally funded and owned research is an appropriate model to follow is intimately linked with key characteristics of the crop in question. Beet is planted annually and is sold as a seed, whilst as we all know, cane is ratooned or cut for seed. The beet seed supplier therefore holds the purse and sells according to his performance and the competition. Further, since cane is a more physiologically complex crop than beet with a much extended life-cycle, development of new and desirable traits takes a lot longer, impacting on the ability to demonstrate short-term yield improvements.

Enhanced collaboration amongst a range of stakeholders represents a valuable avenue for strengthening the impact of sugarcane research involving government, academic institutions, cane industries around the world and service providers to the industry. SASRI management is actively pursuing all these options and has made significant progress in this regard.

The recently approved 5-year strategic plan places considerable emphasis on the importance of enhancing adoption of SASRI technology and recommendations and has highlighted the importance of communicating, more persuasively, the value of SASRI. Recent reporting on the beneficial empirical impact of the cane breeding programme is just one example of this and delivers clear evidence of the financial benefit of the research programme. Alignment of SASRI's research programmes along the length of the value chain, and in close consultation with stakeholder requirements, has yielded more than 90 years of value to the industry. With some fine tuning, I believe SASRI can continue to deliver excellence for the next ninety years.

[1]The SRASA Committee (formerly the SASRI Committee) is a committee of SASA Council tasked with oversight of the activities at the research institute.

DIRECTOR'S REPORT

Dr Carolyn Baker
(Director)

Provision of innovative and useful solutions that contribute to the sustainability of sugarcane agriculture in the South African sugar industry remains our key priority at SASRI. Continuous discussion amongst our specialists culminates in the development and refinement of a portfolio of projects that addresses each of the strategic targets outlined in our industry-approved five-year strategic plan. There has been recent increased emphasis on facilitating implementation of SASRI recommendations to enhance sugarcane productivity. This has resulted in the focus on projects in technology development and also knowledge exchange, which are designed to enable delivery of solutions to growers quickly and more effectively, to be acknowledged.

While the outputs of the research programme are important, it is the impact of the outputs on grower sustainability that drives our activities. As such, the value of SASRI is then measured in respect of the outcomes as a consequence of our research, development and innovation (RDI) initiatives. Being able to measure the value of these outcomes is notoriously difficult, and yet there is widespread recognition that without RDI, agricultural sustainability would be severely compromised. This report reflects that in this past year significant progress has been made at SASRI in a number of areas.

GENETICALLY MODIFIED SUGARCANE

With the approval by SASA Council in December 2016 for commencement of a programme aimed towards the commercial release of a genetically modified (GM) variety, the path was opened for SASRI to join other sugar industries in the world who are already far advanced in this endeavour. Nevertheless SASRI has considerable expertise in this area, having engaged in GM research since the mid-1990s. This has culminated in the demonstration of proof-of-concept of a herbicide-tolerant GM variety in early 2000.

Following consideration of a comprehensive feasibility study, the industry elected to opt for development of an insect resistant variety that would be of benefit to all sectors of the industry, and that would enable improved management and control of the industry's most significant pest, *Eldana saccharina*. Development and release of such a GM variety is a lengthy process, requiring strict adherence to all regulatory requirements, and is likely to take a further 10 to 13 years before its first commercial plantings. Throughout the extensive deliberations leading up to the decision to proceed along the GM route, the industry conscientiously considered all the pros and cons related to GM production. Consequently, they are to be congratulated for their foresight in enabling SASRI to conduct the sort of research since the 1990s that has favourably positioned us to have both the skills, expertise and also the facilities to commence with a GM commercial programme.

STERILE INSECT TECHNIQUE

Considerable attention during the 2016/2017 season was given to exploration and progress associated with investigations into, and planning for, sterile insect technique (SIT) as one of the management components associated with eldana control. The industry decision not to support construction of an irradiation facility at Mount Edgecombe that would house a ɣ-ray irradiation source, led to the development of an alternative strategy for irradiating the male moths to induce sterility, enabling continuation of the proof–of-concept study. This novel approach (F1 sterility) entails producing eldana pupae in our custom-built insect rearing unit (IRU) at Mount Edgecombe, and transporting them to an irradiation facility in the Western Cape (XSIT) that produces sterile moths for False Coddling Moth control. Following moth emergence from the pupae at XSIT, male eldana moths are irradiated, mated with un-irradiated females and the consequent egg batches shipped back to SASRI for rearing and then use in the research project. This alternative approach represents a perfect example of a new and exciting way of conducting research that entails a combination of innovation and collaboration.

PLANT BREEDING

Prompted by a land claim on one of our selection sites, and also the requirement to scrutinise the efficiencies within our plant breeding programme, an investigation into the Plant Breeding and Selection programme was launched in 2015. This entailed careful assessment of the existing variety selection procedures and protocols, and a detailed analysis of the impact of any possible modifications in the programme on the delivery of new varieties for the industry. Although this study is ongoing, preliminary findings reflect that, while there may be opportunities to streamline the programme, any changes to the fundamental number of new clones that are produced annually would have a clear influence on the overall genetic gains that could be attained. It was agreed that external expert review of this aspect of our business would provide assurance for any proposed changes.

Good progress was made in ensuring that sufficient quantities of all new varieties would be available for distribution to the industry at the time of release. The equipment for the new NovaCane® facility was acquired in readiness for development of the first batch of pre-release plants that would enter the final bulking stage in the plant breeding programme. This state-of-the art facility represents a significant investment by the industry and the culmination of many years of research and refinement of protocols that were dedicated towards the delivery of a tissue-culture system that was most suited to sugarcane.

BIOSECURITY

Managing the threats imposed by existing and new pests and diseases remains a priority at SASRI. The registration of several new agrochemicals with differing modes of action and that showed efficacy in combatting eldana, enabled the introduction of an Insecticide Resistance Action Committee (IRAC) compliant spray programme. This enabled growers in the worst-affected eldana areas, especially those along the coast, to age their cane and achieve improved yields. This progress represented a significant improvement in the constant battle with the industry's number one pest.

Of concern was the incursion of a new pest, the longhorn beetle (*Cacosceles (Zelogenes) newmannii*) in the Entumeni area. This cerambycid beetle appears to have made the ecological shift from its natural host (indigenous forests) into the sugarcane, where its larvae create significant damage to sugarcane plants by boring into the stem from the roots. Following an alert to the SRASA Committee in October 2016, the industry responded swiftly to enable implementation of a containment programme, aimed at curtailing the spread of the pest and reducing its population size. Remedial measures gazetted in March 2017 served to underpin the containment programme. Although the containment programme is in progress, the constant risk of adult beetle dispersal remains severe, and the biosecurity inspectorate remains on high alert.

COLLABORATION AND SUPPORT

In 2016/2017, our programme of work reflected an enhanced portfolio of collaborative projects and also a significant improvement in the financial support from external sources. The effort and hard work dedicated towards achieving these goals is significant, and was made possible through the steadfast commitment of the highly talented staff at SASRI. I thank each and every one of them for their perseverance and ability to continue delivering innovative solutions and outcomes for all of our growers in what was a very difficult season in our industry. Finally, the continued support, investment and strategic direction from the industry is fully acknowledged.

OVERVIEW OF SASRI RESEARCH

Dr Derek Watt
(Research Manager)

KEY RESEARCH ISSUES IN 2016 - 2017

RESEARCH FOCUS: Enhancing crop production resilience under unfavourable conditions.

Delivery of outcomes that enhance the resilience of sugarcane production under sub-optimal climatic conditions remained a focus of the research programme during 2016/2017. For the third consecutive season, the industry experienced below average rainfall, with an industry average of 20% below the long-term mean across the southern rain-fed and northern irrigated regions. In the northern regions, the persistently low rainfall in the catchments of dams supplying irrigation water led to an intensification of water restrictions in 2016/2017, resulting in allocations as low as 10% of normal. Under these unfavourable conditions, 15.07 million tons of cane were produced, yielding 1.55 million tons of sugar; production figures slightly higher than those of the 2015/2016 season but below the five-year season mean[1]. Given the ongoing challenges to industry sustainability, the research programme continued focused efforts to deliver technologies to improve crop resilience to stress and to more effectively manage the primary industry pest, eldana.

[1]Weather and production data source: Singels *et al*. (2017). Review of South African sugarcane production in the 2016/2017 season: Light at the end of the tunnel? *Proc. S. Afr. Sug. Technol. Ass*. 90: 1-19.

CROP STRESS RESILIENCE

The 2016/2017 SASRI research portfolio consisted of several projects specifically aimed at increasing stress resilience through breeding and associated technologies, as well as delivering technologies to enable effective and sustainable use of limited water resources.

Contained within the portfolio were projects conducted either in-house or externally through research collaborations [**Figure 1**]. In some instances, external funding was sourced, including from the Water Research Commission for broad-interest projects investigating crop water footprints and options to minimise and manage soil salinisation under irrigation.

Figure 1. *Research to Enhance Crop Stress Resilience*

ELDANA MANAGEMENT

The significant crop production constraints associated with the sub-optimal rainfall of the 2016/2017 season were, once again, exacerbated by the increased vulnerability of the drought-stressed crop to eldana infestations. However, the eldana data for 2016/2017 were encouraging despite the difficult conditions; the industry average eldana infestation levels did not reach those recorded during previous drought seasons. In particular, eldana survey data from the north coast, an area with historically high infestations levels, were heartening and generally ascribed [2] to the effectiveness of the pesticide control programme developed and implemented in partnership with growers, miller-*cum*-planters and other industry stakeholders. Of concern, however, was the increasing incidence of the pest in the midlands region during 2016, although the numbers remained low compared with other regions.

Eldana Integrated Pest Management

SASRI is committed to the development of an IPM programme for the sustainable long-term management of eldana.

While the short-term benefits of IRAC[3] compliant eldana pesticide spray programmes were clearly evident under the difficult production conditions of 2016/2017, the research programme remained committed to the development of an integrated pest management (IPM) programme that will ultimately enable sustainable long-term management of eldana within the industry [**Figure 2**]. At the foundation of eldana IPM are cultural practices, soil health, optimal crop nutrition and effective water management strategies that will minimise crop stress and consequent vulnerability to eldana infestation during drought.

Building on a foundation of best practice for sugarcane production, the research programme in 2016/2017 continued investigations into the development of technologies for eldana IPM. Research in this area aimed to improved intrinsic, extrinsic and induced resistance to eldana, together with technologies associated with habitat management and biological control **[Figure 3].**

Notable Eldana IPM Milestones

Two notable milestones were achieved during 2016/2017 towards the development of the eldana IPM toolkit.

Milestone 1: The industry leadership approved a SASRI recommendation to pursue research that will ultimately result in the release of a variety that has been genetically-modified for eldana resistance.

Milestone 2: In 2016/2017, the industry leadership supported research into an innovative F1 sterility approach for application to the sterile insect technique (SIT) for eldana management.

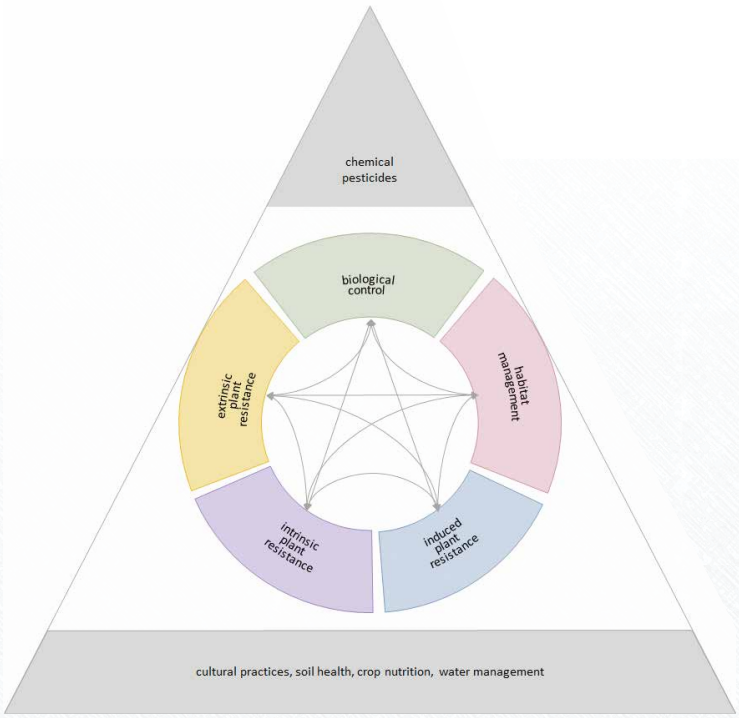


Figure 2. *Eldana IPM Research Pyramid Depicting the Most Important Management Elements (adapted from Stenberg [2017]. Trends in Plant Science 22: 759)*

[2] From data provided by Adrean Naudè (SASRI Extension Specialist: North Coast), cited in Singels *et al*. (2017). Review of South African sugarcane production in the 2016/2017 season: Light at the end of the tunnel? *Proc. S. Afr. Sug. Technol. Ass*. 90: 1-19.
[3] Insecticide Resistance Action Committee (IRAC)

Intrinsic Plant Resistance	Harnessing genetic sources of eldana resistance inherent in sugarcane through conventional breeding
Extrinsic Plant Resistance	Accessing novel genetic sources of eldana resistance through introgression breeding, mutation breeding and genetic engineering
Induced Plant Resistance	Inducing direct and indirect crop defences to eldana through the application of novel priming compounds
Habitat Management	Promoting botanical diversity to break sugarcane cropping monocultures to enhance association resistance to eldana
Biological Control	Using living organisms to reduce eldana population densities

Figure 3. *Essential Management Elements for the Eldana IPM Toolkit under ongoing development in the Research Programme*

Bt Sugarcane Variety

In 2016/2017, the SA sugar industry made the bold decision to move towards the commercialisation of a Bt GM sugarcane variety by 2032.

Almost two decades ago, proof-of-concept was demonstrated by SASRI that the expression in South African sugarcane varieties of an insecticidal protein gene from the bacterium *Bacillus thuringiensis* (Bt) is effective in markedly increasing resistance to eldana. However, at the time and for several years after, a clear path to commercialisation of a Bt sugarcane variety was shrouded with a complex interplay of issues relating to intellectual property ownership, technology access partnerships, consumer perceptions of genetic modification (GM) technology biosafety and questions regarding the potential marketability of sugar derived from a GM crop.

During the course of the second decade of the twenty-first century, several shifts in the Bt and general GM technology landscapes occurred that brought the prospect of an eldana-resistant GM sugarcane variety for the South African sugar industry into closer focus.

- The complex intellectual property landscape surrounding the Bt GM technology became more clearly and readily resolvable.
- Perceived softening of attitudes of South African consumers to agricultural products derived from GM crops, as a result of ongoing safe consumption of GM maize and soya products, eased concerns regarding consumer resistance.
- Progress towards commercialisation of GM sugarcane and sugar beet varieties by other industries eased concerns regarding potential future negative international market sentiments to sugar derived from a GM crop.

During 2016/2017, the greater clarity achieved on the perceived risks associated with Bt GM technology deployment coincided with increased industry recognition of the devastating effects that eldana has on industry profitability and long-term sustainability, particularly under low rainfall conditions.

In the face of a strong business case, the industry elected to pursue a commercialisation research and development track for a GM Bt variety, which, if all stage-gates are met, will see the release of a Bt GM sugarcane cultivar in 2032.

Sterile Insect Technique

in 2016/2017, industry leadership supported the investigation of an innovative F1 sterility approach to eldana sterile insect technique.

The sterile insect technique (SIT) is considered as a desirable addition to the eldana IPM toolkit, although proof-of-concept remains to be established. The unavailability of a ^{60}Co-source irradiator to provide the γ-rays necessary for male moth sterilisation, a major bottleneck to SIT research at the institute, was overcome during 2016/2017.

An innovative approach to eldana SIT, based on first filial generation (F1) sterility, was developed and implemented in 2016/2017 to compensate for the lack of an irradiation facility in KwaZulu-Natal. In this approach, eldana pupae are transported from SASRI to Citrusdal in the Western Cape for γ-ray irradiation of males at XSIT (PTY) Ltd. Eggs produced at XSIT from the mating of irradiated males with unirradiated female moths are then returned to Mount Edgecombe, where they are hatched and reared to adults in the SASRI Insect Rearing Unit. Hence, it is the sterile offspring that are released as part of the SIT programme, rather than the irradiated adults, as is the case with conventional SIT tactics.

The effectiveness of eldana SIT based on F1 sterility will be tested in 2017/2018 in cage and pilot field release studies.

TECHNOLOGY ADOPTION

Increasing the sustainability of grower and miller livelihoods is the central tenet of the SASRI research programme.

SASRI is arguably only as effective as the extent to which the technology developed by the institute is adopted by target end-users, particularly growers and miller-*cum*-planters. Hence, while considerable focus was placed on improving crop resilience and eldana resistance during 2016/2017, technology adoption was a further critical issue under scrutiny within the research programme.

During 2016/2017, SASRI continued to reflect on ways to encourage and promote stakeholder adoption of the innovations and technologies developed within the research programme.

Supporting the sustainability of grower and miller livelihoods is the central tenet of all SASRI activities, including the research programme. The Agri-flection Model developed by Dr Steve Worth of the Agricultural Extension and Rural Resources Management Programme at the University of KwaZulu-Natal elegantly captures this centrality [**Figure 4**].

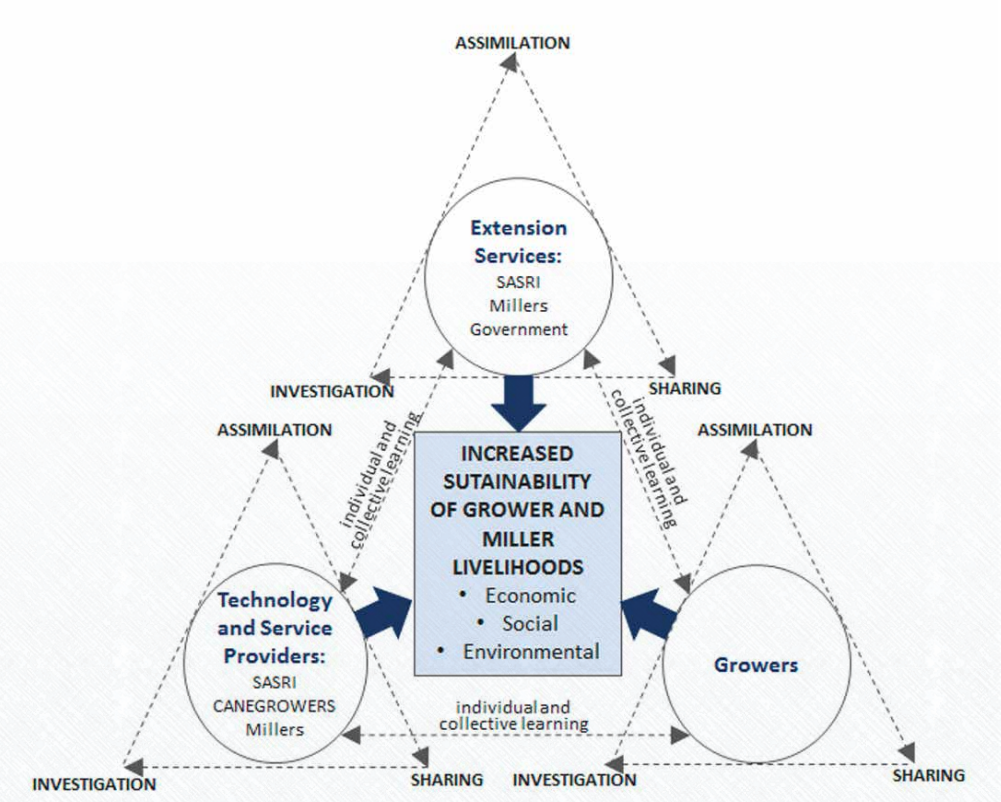


Figure 4. *Agri-flection Model of Agricultural Extension (adapted from Worth [2006] Journal of Agricultural Extension 12: 179)*

In keeping with this principle, 2016/2017 saw the concerted efforts to:

- increase the effectiveness and extent of grower and miller participation in the development and design of the SASRI research programme;
- ensure clarity of communication with industry stakeholders to promote informed decision-making;
- maximise the value and opportunities for broader learning resident in innovations developed by growers, millers and other industry stakeholders;
- portray the economic benefits of SASRI technologies to growers, millers and other industry stakeholders as a means to promote the ease of informed decision-making;
- enhance participation in research projects of industry stakeholders, particularly growers and miller-*cum*-planters, as a means to demonstrate the practical and economic value-addition of SASRI-developed technologies; and
- determine the socio-technical drivers that promote stakeholder adoption of SASRI-developed and recommended technologies.

RESEARCH HIGHLIGHTS

	ADVANCES	VALUE
NEW VARIETIES	New varieties N63 (coastal 15-18 month cutting cycle for average potential soils), N64 (coastal 12-14 month cutting cycle for high potential soils) and N65 (coastal 12-14 month cutting cycle for high potential soils) released to the Industry.	The superior yield and agronomic performance of the three new varieties will enhance stakeholder profitability on the coast, subject to appropriate variety placement.
	Confirmation that new family-based strategies in early selection stages enhance genetic gains in sugarcane breeding.	New breeding tactics result in provision to the Industry of superior, robust, higher-yielding varieties.
	SASRI NovaCane® facility fitment completed enabling the release of new varieties (N63, N64 and N65) as NovaCane® plantlets.	Provision of new varieties as disease-free, true-to-type NovaCane® plantlets in sufficient numbers to meet regional demands for bulking material.
	Confirmation from ongoing analyses that newly released varieties continue to out-perform older varieties on a tons RV per hectare basis. • Under commercial hinterland conditions, newer varieties (N61, N59, N58, N55, N54, N48) delivered higher RV yields than older varieties (N47, N39, N37, N31 and N12). • In the plant crop, N59 outperformed all other varieties in ERC yield on the south coast. • Superior performance of N52 in the midlands confirmed.	Comprehensive and reliable post-release demonstration of superior performance of new varieties increases grower confidence thereby promoting adoption.
CHEMICAL RIPENING	DAFF Agriculture Inputs Control Directorate approved registration of Moddus, a new hormonal ripener, for use on sugarcane in SA.	Moddus has the potential to enable significant %RV increases and satisfy certain niche requirements (e.g. late-season ripening) not currently met by other ripening chemicals.
	Pur*Est*™ smartphone app on Android and iOS operating systems released which, together with a pocket refractometer, empowers stakeholder decision-making.	In addition to aiding ripener decision-making, the stalk %moisture and RV% outputs from Pur*Est*™ may also guide growers in their drying-off and harvest scheduling decisions, respectively.

	ADVANCES	VALUE
GM TECHNOLOGY	SASA Council approved commencement of research to develop a GM Bt variety for future commercial release.	As part of an eldana IPM programme, Bt cane has the potential to significantly reduce economic losses associated with eldana.
	GM pre-commercialisation research commenced in partnership with university collaborators to develop the knowledge base required for eventual commercialisation of a Bt variety resistant to eldana.	Conforming to GM legislative requirements will ultimately ease the regulatory process for commercialisation of future GM sugarcane.
	• Using a SASA / SASRI slow-growth technology, sugarcane plantlets may be retained under specific laboratory conditions for 48 months without adverse effects. • 'Fit-for-purpose' technology developed to enable indefinite storage of valuable sugarcane germplasm at -196°C with a consistent 66 to 78% survival rate.	Ability to store sugarcane plantlets under laboratory conditions or at ultra-low temperatures gives much needed flexibility for sugarcane breeding and GM research and development.
CROP NUTRITION	Advantages confirmed of condensed molasses stillage (CMS) as a potassium source and the low impact of the product itself on soil acidification.	Reassurance for stakeholders that CMS application does not have potential deleterious long-term consequences on soil health.
CLIMATE CHANGE	• Reliable regional estimates of future climate change impacts on cane yield, water use and irrigation requirements. • Confirmation through modelling of the effectiveness of green-cane harvesting, mulching and modification of harvest age as climate change adaptation strategies.	Information enables strategic and tactical planning at industry, mill and enterprise level to exploit positive impacts and cope with negative impacts of predicted climate change scenarios.
TECHNOLOGY ADOPTION	A Systems Dynamics model of the socio-technical drivers of grower adoption of irrigation scheduling completed.	Systems dynamics model enables the design of stakeholder interactions to enhance technology adoption.
TAWNY RUST	• New rust first observed in 2008 described as Macruropyxis fulva (Tawny Rust). • Miscanthidium capense identified as an alternate host. • Two fungicides registered. • Molecular diagnostic test developed.	Resources developed to enable management of this newly emerged fungal disease.

NEW RESEARCH

Due to the prevailing low income environment within the industry ahead of and during 2016/2017, only a restricted number of new projects of particular strategic importance were implemented.

During 2016/2017, external grant funding was received to support research on several issues pertaining to the potential future commercialisation of a GM Bt sugarcane variety by the industry. The outcomes of the research, which is being conducted through several collaborative research partnerships, will inform future application to the Department of Agriculture, Forestry and Fisheries for regulatory approval for the commercial cultivation of the variety.

During the latter part of the year, focus turned to the planning of technology development and research project proposals related to the longhorn beetle outbreak in the Entumeni region.

Pre-commercialisation Research – Bt GM variety

South Africa enjoys a transparent and robust regulatory framework that governs the general release and import of GM organisms, including genetically-engineered commodity crops, which is administered by the Department of Agriculture, Forestry and Fisheries. In addition to regulating the research and development aspects of GM crops being considered for release in South Africa, the framework requires applicants to supply comprehensive sustainability data which necessitate biosafety and viability assessments. Consequently, the sugar industry will be required to conduct such assessments ahead of future application to government for the commercial release of a Bt GM sugarcane variety.

During 2016/2017, the industry, through SASRI, was awarded a significant quantum of grant funding over three years from Biosafety South Africa, an entity within the Department of Science and Technology's Technology Innovation Agency. The funding will facilitate research to gather some of the biosafety and viability data that will be required for the future general release application by the industry for a Bt GM variety. The investigations are to provide information on the environmental safety, food and feed safety, socio-political impacts and economic impacts of the Bt GM technology in sugarcane. Several universities and other research entities that possess the requisite expertise are partnering with SASRI in four research projects.

PROJECTS AND PARTNERS - BT GM PRE-COMMERCIALISATION RESEARCH

- *Ex ante* GM Bt sugarcane socio-economic study [Research Partners. SA Canegrowers' Association and the Bureau for Food and Agncultural Policy, University of Pretoria]
- Developing guidelines for refugia planting in Bt sugarcane [Research Partner. Department of Logistics, Stellenbosch University]
- Bio-geography of indigenous, wild *Saccharum* complex relatives [Research Partner. Unit for Environmental Sciences and Management, North West University]
- Feeding bioassays on *Eldana, Chilo* and *Busseola* [Research Partners Unit for Environmental Sciences and Management, North West University and the Agricultural Research Council - Potchefstroom]

Longhorn Beetle

Nature of the Recent Longhorn Beetle Infestation

The localised outbreak of longhorn beetle infestations during 2016/2017 on several farms in the Entumeni region of Zululand continues to be of particular concern to the industry. Scientists from SASRI, the Agricultural Research Council and Nelson Mandela Metropolitan University confirmed in 2016/2017 that the insect is an indigenous beetle species, *Cacosceles newmannii* Thomson (Coleoptera: Cerambycidae), for which the original host plant species is unknown.

Figure 5. *Adult life stage of the longhorn beetle (Images: Mike Way)*

Risk Posed by Longhorn Beetle Infestation

Based on observation and available information, several aspects of this outbreak remain particularly alarming, including that:

- the effects of the beetle infestations on the farms in Entumeni have been severe;
- factors contributing to the host switch to sugarcane remain unknown;
- the means to sustainably contain and manage the pest are unavailable as the basic biology and ecology of this previously rare insect have never been studied;
- similar localised outbreaks of a related longhorn beetle species (*Dorysthenes buqueti* [Coleoptera: Cerambycidae]) in Thailand and Indonesia spread very rapidly, resulting in ongoing sugar yield losses in Thailand of up to 57% in infested fields, with consequent ongoing severe negative economic impacts on sugarcane production; and
- spread of the Asian longhorn beetle, *Anoplophora glabripennis* (Coleoptera: Cerambycidae), a native of eastern China, Japan and Korea, into Europe has had negative impacts on trees of commercial importance, while, in the USA, it has been estimated that approximately one-third of all trees would have to be destroyed if *A. glabripennis* were to spread throughout the country.

Research and Development for Containment and Sustainable Management of the Longhorn Beetle

Planning was undertaken during late 2016/2017 for the fast-tracking of projects for implementation in 2017/2018. The research will generate critical new knowledge in order to rapidly develop sustainable and effective pest control strategies for the longhorn beetle.

During the latter part of 2016/2017 grave concerns were expressed by sectors of the industry that serious economic consequences, potentially rivalling or exceeding the direct economic costs incurred by eldana, could result from the longhorn beetle, should the current infestation not be contained effectively and long-term IPM tactics not be developed.

In considering the longhorn beetle infestation, SASRI has recognised the need for two parallel lines of investigation: (a) development of containment tactics based on available information (technology development); and (b) expansion of knowledge of the biology and ecology of *C. newmannii* that will form the foundation of a sustainable integrated management programme into the future (research). Consequently, SASRI during 2016/2017 developed proposals for a technology development project and a research project which are to be presented to the industry for funding approval during the course of 2017/2018 with a view to fast-tracking implementation for July 2017.

Planned Technology Development: Envisaged Outcomes

The technology development project planned for implementation in 2017/2018 will seek to deliver the following outcomes: (a) permanent registration of at least two pesticides with different modes of action against the longhorn beetle, detailing effective active ingredient dose, timing of application and application tactics; (b) at least one biocidal compound with demonstrated efficacy against the longhorn beetle; (c) mechanical practices that result in longhorn beetle mortality and which increase pesticide efficacy; and (d) a trap that enables longhorn beetle population size monitoring, based on commercially available products.

The research to be implemented in 2017/2018, will provide essential knowledge of:

- host-plant related variations in the populations of the longhorn beetle in terms of phenology and population genetics, as well as resistance to environmental stressors such as temperature, desiccation and oxygen limitation;
- the manner in which the pest is integrated into its environment, including the microclimate encountered by each life stage in their identified host plants and whether one of the microclimates is more amenable to the larvae than the others;
- food webs to identify precisely what each life-stage feeds on;
- the dispersal potential of adults, complemented with indirect estimates of dispersal determined by analysis of the genetic structure of the populations;
- the complete pheromone of the female adult with a view to enabling the identification of additional semiochemicals (attractants and repellents); and
- the composition of the microbiome associated with the pest with a view to the isolation of additional potential biocidal agents.

The research will generate critical new knowledge in order to rapidly develop sustainable and effective pest control strategies for the longhorn beetle.

CROP PROTECTION RESEARCH

Dr Stuart Rutherford
(Programme Manager)

The goal of the Crop Protection Research Programme is to develop integrated management strategies that minimise the effects of pests, diseases and weeds on crop production in the South African sugar industry in a sustainable manner.

Research is undertaken in five key areas:

BIOSECURITY

CROP RESISTANCE TO PATHOGENS AND PESTS

BIOLOGY AND ECOLOGY OF PATHOGENS AND PESTS

BIOLOGICAL CONTROL, CULTURAL AND ENVIRONMENTAL PRACTICES

AGROCHEMICALS

2016/2017 KEY RESEARCH HIGHLIGHTS

BIOSECURITY

Longhorn Beetle

- Confirmation obtained that the longhorn beetle infesting sugarcane in the Entumeni region is an indigenous beetle species, *Cacosceles newmannii* (Coleoptera: Cerambycidae).

Knowledge at the identity of the pest is critical to the formulation of short-term containment measures and sustainable area-wide integrated pest management tactics

- Temporary emergency registration of products with emamectin benzoate (avermectin) and imidacloprid (neonicotinoid) as active ingredients have been approved for longhorn beetle management by the Registrar of the DAFF Agriculture Inputs Control Directorate.

Studies on management options and the biology and ecology of the insect will be ongoing in 2017/2018.

CROP RESISTANCE TO PESTS AND PATHOGENS

- Molecular diagnostic technology optimised for determining the severity of smut infections as a means to enhance sugarcane smut resistance breeding.

Accurate quantification of smut infection will support the development of a near infra—red spectroscopy method For estimating sugarcane resistance to the disease.

- Potential clarified for a role of near infra-red spectroscopy for high-throughput screening for smut resistance for ultimate application to sugarcane smut resistance breeding.

A rapid and reliable NIRS-based method for quantifying sugarcane response to smut will improve smut resistance breeding.

BIOLOGICAL CONTROL, CULTURAL AND ENVIRONMENTAL PRACTICES

- Innovative first-filial (F1) generation approach to the sterile insect technique (SIT) for eldana management developed and implemented.

Novel F1 strategy will enable proof-of-concept studies on the potential role of ST in eldana IPM in the absence of a local ^{60}Co y-irradiation facility

AGROCHEMICALS

- Promising chemistry for the management of eldana deep stool infestations identified and submitted for full registration, undertaken in collaboration with the relevant agrochemical company and the DAFF Agricultural Inputs Directorate.

This pesticide ancl its application methodology will enable more efficient stool penetration and greater efficacy of the active ingredient.

IRAC compliant pesticide spray programmes for eldana management form an integral part of eldana IPM.

- An integrated weed management manual produced that describes 20 non-chemical and chemical control tactics to assist grower and miller-*cum*-planter decision-making.

Integrated approaches for sustainable weed management will add value to grower and miller-cum-planter farming enterprises.

- Herbicide residue studies indicated that: (a) microbial degradation and leaching are the major dissipative pathways for imazapyr in clay and sandy soils, respectively; and (b) remedial liming of soil has a beneficial effect on these dissipative processes.

Knowledge of practices to manage herbicide residues assists grower and miller-*cum*-planter *planning of weed management programmes.*

OUTCOMES OF COMPLETED RESEARCH

TAWNY RUST

Tawny (African) sugarcane rust: Description, biology and control

- New rust first observed in 2008 identified as *Macruropyxis fulva* (Tawny Rust).
- *Miscanthidium capense* identified as an alternate host.
- Two fungicides registered.
- Molecular diagnostic test developed.

Further investigations planned for 2017/2018

Effect of tawny rust on yield unknown and remains under investigation.

NEMATODES

Investigation of the possible interaction between nematicides and conazole fungicides

- Positive and negative interactions observed amongst nematicides and conazole fungicides.
- Effective and rapid laboratory assay developed to assess nematicide efficacy against nematode communities.

Further investigations necessary

Further confirmation required as to whether insecticide and nematicide efficacy is enhanced when used in combination with conazole fungicides.

Evaluation of nematode sampling methods

- Protocol developed to improve reliability and representivity of soil sampling for nematode research and services.
- In the revised protocol, ten smaller volume soil samples are gathered and pooled from two guard rows surrounding the research trial, as opposed to two larger volume samples taken from one guard row previously practiced.

THRIPS & YSA

Rating commercial varieties for thrips and yellow sugarcane aphid susceptibility

- Evidence indicates that crops may "grow out" of early infestations by thrips and yellow sugarcane aphid (YSA).
- Sugarcane thrips and yellow sugarcane aphid resistance categories developed for all commercial varieties for use by stakeholders in planning Integrated Pest Management interventions.

WHITE GRUBS

Screening and development of entomopathogens as bio-insecticides for South African white grub species

Beauveria brongniartii isolates C17 and HHWG1 demonstrated as suitable for development into biocides for white grub adults and larvae, respectively.

Further investigation necessary

With further technology development, isolate C17 will be useful for a walk-through trap for white grub adults.

Certain green leaf and root volatiles demonstrated to attract white grub adults and larvae.

Further investigation necessary

In conjunction with the relevant pathogenic fungal strain, the volatiles will be useful in the development of species-specific lure-and-kill and/or auto-dissemination traps.

PROGRESS IN ONGOING RESEARCH

FALL ARMYWORM

- Based on the experiences of the Louisiana sugar industry, it appears that the fall armyworm is unlikely to become a major sugarcane pest.
- SASRI advises growers to remain vigilant, however, particularly in cane establishing from NovaCane® plantlets, as well as in plant cane, which may ultimately be more affected than ratoons.
- As a precautionary measure, three insecticides have been granted temporary emergency registration against the insect in sugarcane.

During 2016/2017, an outbreak of the fall armyworm, *Spodoptera frugiperda* [**Figure 6**], had severe negative impacts on the South African maize industry and caused widespread alarm amongst sugar industry stakeholders.

The fall armyworm is a prime noctuid pest of maize on the American continents where it remained confined despite occasional interceptions by European quarantine services in recent years. The pest initially became a new invasive species in west and central Africa where outbreaks were recorded for the first time in early 2016. It was detected in South Africa in February 2017. Even though sugarcane appears in the CABI (Centre for Agriculture and Biosciences International; www.cabi.org) list of plants attacked, American entomologists in Louisiana, part of the home range of the insect, indicate that even though it occurs there and attacks maize and other crops, especially pastures, it is not a major pest of sugarcane.

SASRI is of the view that growers should remain vigilant, particularly in cane establishing from NovaCane®, transplants and in plant cane; which may be more affected than ratoons by any fall armyworm damage that might occur. As a precaution, three insecticides have been granted temporary emergency registration against fall army worm in sugarcane.

Figure 6. *Fall Armyworm*

ORANGE RUST

During 2016/2017, spores of orange rust disease were detected at the SASRI Komati Research Station in a monitoring trap. However, no incidence of the disease has been observed.

During 2016/2017, orange rust spores were detected at the SASRI Komati Research Station by means of a spore trap that monitors spore prevalence on a weekly basis. Spores were detected over the periods 19 April to 17 May 2016 and 5 to 10 October 2016. Alerts were issued to SASRI Extension Specialists and Biosecurity teams, while growers were made aware of the new finding in an article in The Link (McFarlane SA, Stranack RA and Koch A [2016]. Orange Rust Alert. *The Link* 25(3): 10-11). No symptoms of the disease have been observed in a sentinel plot of Q124, an orange rust-susceptible Australian variety, sited near the spore trap.

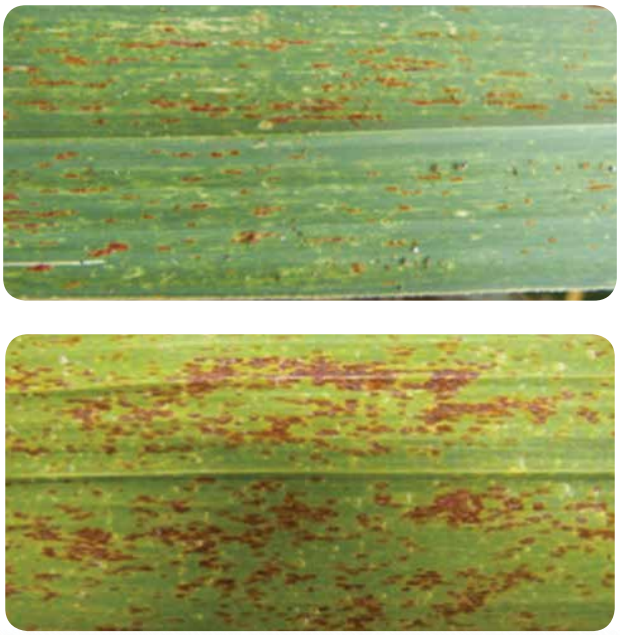


Figure 7. *Orange Rust (Images: Sushma Sood USDA).*

VARIETY RESISTANCE TO RATOON STUNT

- Ongoing studies continue to reveal that varieties may not exhibit significant innate resistance to the RSD bacterium.
- RSD management through the cultivar resistance may not be a viable option, which re-emphasises the over-riding importance of good field hygiene as a primary control measure.

The objective of ongoing research in 2016/2017 sought to establish variety susceptibility to RSD through the screening of sugarcane genotypes in the late stages of the plant breeding selection programme. Six irrigated varieties were screened for their resistance to RSD using the standard tissue blot-enzyme immunoassay technique. The varieties were inoculated with RSD and grown at Mount Edgecombe as single stool plots, replicated twelve times.

Colonisation of the vascular bundles was highest in N46 but levels were only significantly different to N14 (susceptible control) in N53 (P<0.001) [**Figure 8**]. These varieties will be included in an RSD tolerance trial to be conducted in Pongola during 2017/2018 and the assays will be repeated to confirm the results. In addition, the RSD-specific qPCR assay being developed in other SASRI research will be used to indicate the bacterial load per xylem vessel. These data, in combination with the proportion of colonised vascular bundles, may provide a more accurate assessment of variety susceptibility to RSD.

The preliminary data from this and other ongoing research indicate that RSD management through resistance may not be a viable option for RSD control, which will potentially re-emphasise the importance of good field hygiene in control.

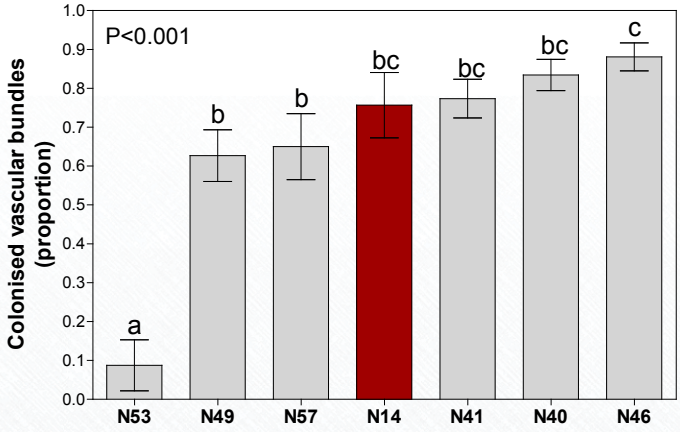


Figure 8. *Colonised vascular bundles as an indication of varietal susceptibility to RSD. The bars represent the standard error and the different letters indicate significant differences (n=12).*

VARIETY RESISTANCE TO NEMATODES

A revised methodology to assess variety resistance to nematodes was developed and implemented during 2016/2017, although further refinements to the method of assessing nematode tolerance are to be investigated in 2017/2018.

A revised methodology to assess variety resistance to nematodes developed and implemented during 2016/2017, primarily as a need to overcome the confounding effects of the naturally uneven distribution of nematode populations in soils and variations in nematode community structure that occur over short distances. In the revised protocol, known numbers of individuals of key nematode species are inoculated into containers of soil of homogenous composition in which the test varieties are cultivated.

Initial data are promising and have revealed that, although nematode numbers infesting the roots of different varieties may not differ significantly, their effects on plant growth may differ significantly amongst varieties. For example, recent assays revealed a significant reduction in root and shoot dry weight due to nematode infestations in varieties N23 and N26, while no significant differences were noted for varieties N43 and N53.

Further refinements to the method of assessing nematode tolerance are under way.

STERILE INSECT TECHNIQUE

The First FAO/IAEA Research Coordination Meeting on 'Improved field performance of sterile male Lepidoptera to ensure success in SIT programmes' was held at the SASRI Mount Edgecombe campus between 31 August and 4 September 2016.

F1 sterility approach to SIT: Advantages and relevance

During workshop discussions, it emerged that the release of F1 sterile insects might potentially meet the need of an eldana SIT programme for male moth release. Conventionally, the efficacy of sterile insect release (SIR) depends on transfer of sperm carrying dominant lethal mutations from irradiated males to wild females. The ability of irradiated males to succeed in mating with wild females is most important. This is particularly relevant when the mating system is complex, as in a species such as eldana, where the males form leks and females are highly stringent in mate selection.

Because Lepidoptera are very radiation resistant, higher doses of radiation may result in less competitive male individuals. In addition, due to the stress and damage incurred during irradiation, handling, shipping and release, SIR programs usually produce males that are of lower quality than wild males. Inherited sterility, or F1 sterility, can be used to counter the negative effects associated with resistance to radiation.

In the F1 approach, a radiation dose is determined that results in partial sterilisation of male moths and as close to full sterilisation of the more susceptible female moths as possible. Radiation-induced deleterious effects are inherited by the F1 generation when partially sterile males mate with wild females. Typically a male bias is then seen in a reduced F1 population, and both F1 male and female offspring are more sterile than the irradiated parents.

F1 sterility SIT: Potential for application

Thus far, progress with eldana SIR has relied on a remote irradiator located at Stellenbosch in the Western Cape province of South Africa. Transport of irradiated moths from this facility to KZN, which retain high enough quality for pilot-release studies, is currently not logistically feasible. In a modified approach, SASRI is investigating the feasibility of transporting separated male and female pupae to Stellenbosch. Male moths would then be irradiated and mated with un-irradiated female moths and eggs will be returned to KZN. Emerging larvae will be mass reared for F1 release. It is envisaged that F1 male will be of greater 'fitness' than its' irradiated male parent, in part due to reduced handling, since there will be no irradiation step immediately prior to release. A male bias is also expected, which should reduce the overall costs of rearing and release (since female moths are approximately twice the mass of males). Ultimately, this approach may lead to a single centralised irradiator and parental insect colony facility, serving a number of mass rearing nodes located in the remote mill areas of the South African sugar industry.

BIOLOGICAL CONTROL OF BORERS WITH FUNGAL ENDOPHYTES

Ms Nongcebo Memela, a SASRI Assistant Research Officer specialising in IPM research, was awarded a European Union INSPIRE scholarship to undertake research in the laboratory of Professor Stefan Vidal at the Georg-August University in Göttingen. Professor Vidal's laboratory, which is in the Department for Crop Sciences and Agricultural Entomology, specialises in plant-insect interactions and how these might be harnessed to develop sustainable IPM tools. Ms Nongcebo gained invaluable experience and expertise during her time in Germany which will give further impetus to SASRI research that aims to use sugarcane fungal endophytes as an additional IPM tool to control eldana and other insect pests.

Eldana Management ~ Agrochemicals

- In an ongoing quest to ensure sustainable agro-chemical efficacy within eldana IPM programmes, promising new active ingredients against the insect are routinely sought and tested.
- Of the three new products tested during the reporting period, two show promise, while the third requires further preliminary screening.
- The new products have the potential add five new modes of action against eldana, which will be advantageous in preventing the emergence of agro-chemical resistance.

During 2016/2017, three new products representing five additional modes of action (to the three modes of action currently registered) were tested in a standard carry-over trial at Gingindlovu. Of the new combinations, methoxyfenozide + spinetoram and emamectin + lufenuron, were applied at rates suggested by the manufacturers. The emamectin + lufenuron combination appeared to be as effective as the two registered products, chlorantraniliprole + cyhalothrin and chlorantraniliprole (Table 1).

The results of this trial are promising, indicating a possibility for the potential registration of insecticides with additional modes of action.

Table 1. *Eldana insecticide testing in a standard carry-over trial located in Gingindlovu.*

Insecticide Treatment	Pre-application		Survey	
	1 August 2016		17 January 2017	
	%IB	E/100	%IB	E/100
control	8	29	15	29
methoxyfenozide + spinetoram	9	25	9	11
chlorantraniliprole + cyhalothrin	8	19	7	5
emamectin + lufenuron	9	33	7	5
chlorantraniliprole	8	17	6	2

CROP PERFORMANCE & MANAGEMENT RESEARCH

Dr Riekert van Heerden
(Programme Manager)

The goal of the Crop Performance and Management Research Programme is to develop models and better management practices to enable stakeholders to enhance sustainable crop production.

Research is undertaken in six key areas:

CROP PHYSIOLOGY

CROP NUTRITION

SOIL HEALTH

CROP RIPENING

WATER MANAGEMENT

CLIMATE CHANGE

KEY 2016/2017 RESEARCH HIGHLIGHTS

CROP MODELLING

Web-based DSP developed that will enable the calculation of monthly growth increments to assist growers and miller-*cum*-planters with harvesting and ripening decisions, as well as in crop estimation.

Better harvest and ripener decisions will improve profitability, while improved accuracy of production estimates is of benefit along entire sugar value chain.

CHEMICAL RIPENING

- DAFF Agriculture Inputs Control Directorate approved registration of Moddus®, a new hormonal ripener, for use on sugarcane in SA.

Moddus has the potential to enable significant %RV increases and satisfy certain niche requirements (e.g. late-season ripening) not currently met by other ripening chemicals.

Variety-specific recommendations assist grower decision-making regarding ripener application.

- A series of trials established to evaluate variety-specific responses to the new ripener, Moddus®.

In addition to aiding ripener decision-making, the stalk %moisture and RV% outputs from PurEst™ may also guide growers and miller-*cum*-planters *in their drying-off and harvest scheduling decisions, respectively*

Pur*Est*™ smartphone app on Android and iOS operating systems released which, together with a pocket refractometer, empowers grower decision-making.

Adoption of chemical ripening recommendations promotes grower and miller profitability.

- Eleven grower days held throughout the Industry to increase adoption of chemical ripening recommendations and buy-in into ripener schemes subsidised by the miller.

CROP NUTRITION AND SOIL HEALTH

- Potential advantages clarified of inter-row ripping as a means to improve water infiltration and associated nutrient uptake during periods of low rainfall.

Inter-row ripping of ratoons to improve rainfall and fertiliser infiltration is beneficial particularly in low rainfall years.

- Advantages confirmed of CMS as a potassium source and the low impact of the product itself on soil acidification.

Reassurance to be provided to growers and miller-*cum*-planters *that CMS application does not have potential deleterious long-term consequences on soil health.*

- A Soil Health Index progressed towards becoming part of the standard FAS analytical package.

Knowledge of soil health will assist grower and miller-*cum*-planter *decision-making regarding fertiliser regimes and soil rehabilitation tactics*

CLIMATE CHANGE

- Reliable regional estimates of future climate change impacts on cane yield, water use and irrigation requirements.

- Confirmation through modelling of the effectiveness of green-cane harvesting and modification of harvest age as climate change adaptation strategies.

Information enables strategic and tactical planning at industry, mill and enterprise level to exploit positive impacts and cope with negative impacts of predicted climate change.

OUTCOMES FROM COMPLETED RESEARCH

CROP MODELLING

Resource use efficiency of biomass genotypes

- Improved Canegro and Canesim™ models now have enhanced capability for simulating crop growth and yield for diverse genotypes under present and future climates.
- Quantitative spatial estimates obtained for biomass, cane and ethanol yield potential and crop water use at sub-catchment level for areas in South Africa where sugarcane can be grown at present and in the future (raw and processed data, maps)

Genetic trait model parameters for SASRI varieties

- Three traits identified which impact on cane yield under irrigated conditions: maximum radiation conversion efficiency; stalk partitioning fraction; and thermal time required for the commencement of stalk elongation.
- Simulations suggest that combining the optimal values for these traits into one genotype could increase cane yield under irrigation beyond the highest yields of genotypes with only a single trait optimised.
- The model will ultimately find application in future sugarcane breeding tactics.

Further investigations planned for 2017/2018

- The model is currently unsuited for the exploration of trait impacts on canopy development, a key process in sugarcane yield formation, which needs to be addressed before the model may be considered for full-scale trait modelling. This is a focus of a research project currently being led by SASRI under the auspices of the International Consortium for Sugarcane Modelling.
- The development of a high throughput phenotyping technology for measuring stomatal conductance, which may ultimately influence model prediction of sugarcane yield, is currently under investigation in another SASRI project.

Regional monthly growth increments

- Location- and management-specific monthly growth rate information is now available for internal and external stakeholder use.
- These data support a multitude of applications directly and may be incorporated into future decision-support systems (DSSs) to address specific applications, including field-level assessment of yield gains when harvesting is delayed and exploration of ripening tactics.
- Web-based DSP software was developed.

CROP NUTRITION

Nitrogen nutrition of sugarcane: using soil tests to predict nitrogen contributions from the soil organic matter

- Anaerobic N mineralisation, short-term CO_2 release and total soil N are more strongly related to crop responsiveness to N than the conventional soil N categories.
- The strong relationship detected between total soil N and yield responsiveness to applied N is a noteworthy development.
- This development, together with the associated deployment of mid-infrared reflectance spectroscopy, has the potential to improve the reliability of FAS N recommendations for ratoon crops with no cost implications or additional analytical demands.

Identifying genotype differences in nitrogen-use efficiency in sugarcane for commercial application

- Evidence indicates that variety-specific recommendations for N application, based on nitrogen-use efficiency, are unwarranted.
- FAS recommended rates of N application were demonstrated to be consistently effective in maximising crop yield in all field trials across all seasons.
- No significant yield benefit to N application above FAS recommended rates.

SOIL HEALTH

A laboratory-based Soil Health Index system for the SA Sugar Industry

- On a particular site, certain soil health indicators, including CO_2 release, effectively discriminate amongst long-term land management practices, whereas total C (organic matter) levels are generally not discriminatory.
- However, it is not possible to identify universally-applicable threshold soil health indicator values for various land management systems.
- This is an important constraint in terms of the possible use of CO_2 release as a routine soil health test.

Further investigations necessary

Relationships amongst biological soil health indicators and soil properties require further research, with a view to the identification of usable thresholds.

CLIMATE CHANGE

Assessing some impacts of projected climate change scenarios on the South African sugarcane industry

- Projected future daily weather data for five global circulation models (GCMs) at homogenous climate zone scale.
- Detailed insights into climate change impacts on the South African sugar industry, at regional (homogenous climate zone) and industry scales, have been developed.
- Exploration of management-related adaptations provide insights into the types of changes to farming systems that may need to be implemented regionally over the next 30 years.
- The DSSAT-Canegro model updated with improved algorithms for simulating climate change impacts more accurately.
- The combination of this model and the climate change impacts and adaptations assessment protocols provide SASRI with greatly enhanced capacity to conduct climate change-related research into the future with a view to supporting stakeholder needs.

Influence of elevated CO_2 on the growth, yield and photosynthesis of sugarcane

NORTH-WEST UNIVERSITY
YUNIBESITI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT

Elevated CO_2 conditions in the absence of soil water deficit lowers the stomatal conductance in sugarcane, but does not significantly affect biomass and sugar yield.

- The objective of research conducted in 2016/2017 was to determine the direct effects of elevated CO_2 on the physiology, growth, sugar production and yield of two contrasting varieties: NCo376 (high sucrose variety) and N31 (a high biomass variety).
- The varieties were grown in open-top chambers located on the Potchefstroom campus of North West University in which CO_2 levels were maintained at 400 ppm (ambient) and 750 ppm (elevated) for a period of seven months.
- Soil water deficit conditions were avoided through precise irrigation scheduling.
- The effects of CO_2 levels on photosynthesis, stomatal conductance, chlorophyll a fluorescence, biomass and stalk sucrose content were determined.
- Different varietal stomatal conductance responses were observed: a reduction of 40% in N31 and 30% in NCo376.
- Despite these responses, the increased CO_2 conditions did not have an effect on sugar production, cane quality, green leaf area and dry biomass.
- No significant effects of elevated CO_2 on the rate of photosynthesis were observed.
- The study revealed that elevated CO_2 conditions in the absence of soil water deficit lowers the stomatal conductance in sugarcane, which significantly increases single leaf-level water use efficiency. Hence, it is hypothesised that elevated CO_2 could increase sugarcane performance during periods of drought.

Further investigations planned for 2017/2018

Follow on investigations are to examine the effects of soil moisture deficit on the response of sugarcane to elevated CO_2 levels. It is hypothesised that elevated CO_2 enables enhanced sugarcane performance during drought. The study will provide invaluable information to enable modelling of the impacts of predicted climate change scenarios on crop production in the industry.

PROGRESS IN ONGOING RESEARCH

CROP NUTRITION – VARIETY LEAF N THRESHOLDS

Good progress was made in 2016/2017 in the development of a practical methodology to enable the provision of appropriate and more accurate N fertilisation advice to stakeholders based on standing crop biomass.

The sugarcane crop has a high demand for nutrients due to its rapid growth rates, high biomass production and the appreciable nutrient removals in harvested material. Leaf analysis is a widely-used diagnostic tool in the management of the nutrition of sugarcane, with the critical nutrient concentration (CNC) approach being the most commonly used method of interpreting the nutrient data. In the use of the CNC approach, a specific physiological age is stipulated for leaf sampling to minimise the complications of ageing effects on the interpretation of data. Given the typical decline in N concentrations with crop age (biomass accumulation), the use of single threshold values for interpretive purposes appears to be flawed.

The objectives of this research are to unravel the effects of crop age (biomass accumulation) on the variation in the critical leaf-N concentration and determine the critical leaf-N concentration based on sugarcane yield.

Results obtained during 2016/2017 revealed that the critical N concentration for yield optimisation varies markedly with crop age, and ranges from >2.09% at an age of 3 to 4 months, to 1.62% at 7 months. These findings suggest shortcomings in the current approach to the interpretation of leaf nutrient data and imply that the use of single threshold value for interpretive purposes may be flawed.

Research will continue in 2017/2018 to develop a practical methodology to enable the provision of appropriate N fertilisation advice to growers based on standing crop biomass.

SOIL HEALTH - AMELIORATION OF TOP- AND SUB-SOIL ACIDITY

In the coastal areas and Midlands, severe subsoil acidity problems and associated poor root growth frequently occur under ratoon crops.

The objective of this research is to identify cost-effective approaches to address these problems.

Investigations were continued in 2016/2017 in a trial conducted on a 'weak' Cartref sand in the Stanger area, in which the effects of lime and gypsum (applied as topdressings; no soil incorporation) on soil properties, root growth and sugarcane production were studied. Treatments were applied in December 2011 at rates of 0, 2.5 and 5.0 t/ha each of lime and gypsum, respectively, with nematicide application included as an additional treatment. The trial was harvested for the third time in May 2015 (in the midst of severe drought conditions) and in this report, a brief overview of current observations is presented.

A poor response to the amendments was observed in the trial, suggesting a potential limitation to the application of lime and gypsum treatments as top-dressings without incorporation. In previous research on soils with similar acidity levels, significant responses to lime and gypsum were obtained following the incorporation of these products at high rates prior to planting.

In the light of these findings, a re-evaluation of approaches to the correction of soil problems in ratoons on 'weak' sands appears warranted. Consequently, research to be conducted in 2017/2018 will include a trial treatment involving complete profile modification.

WATER ALLOCATION DECISION SUPPORT TOOL

SWOP is a decision support program (DSP) designed for farm managers to advise them of the most profitable way of allocating water on the farm during times when water supply is limited. Case studies conducted in 2016/2017 revealed SWOP to be a powerful tool for exploring irrigation options during times of limited water supply.

The goal of this research is to develop a decision support program (DSP) for farm managers that will advise them of the most profitable way of allocating water on the farm during times when water supply is limited. Envisaged is that the DSP will account for current crop and soil conditions, irrigation system constraints, and expected future climate and water supply. During 2016/2017, progress was made in developing expert rules for the DSP by combining crop simulation modelling with an economic calculator to predict farm level gross margin responses to irrigation practices.

Reported here is progress made in the development and testing of SWOP (Sugarcane Water Optimisation Program), a spreadsheet system to simulate yield response to irrigation for multiple fields on a farm, and to calculate the resultant whole-farm gross margin.

In a case study, SWOP was applied to a hypothetical scenario on a farm situated in Komatipoort, over the milling seasons from April 2006 to December 2008 and then repeated for the period April 2012 to December 2014. Two water allocation scenarios were explored, *viz*. 100% of the normal weekly allocation and 60% of the full allocation for the period December 2006 to March 2008 and 100% for all other weeks over the three year period.

The study revealed that the ideal strategy under most circumstances was to fill the profile at the start of the crop, to then use a soil water refill level of 30% and 60% of soil total available moisture (TAM) for the tillering and stalk growth phases, respectively, and then to withhold irrigation during the maturation phase. This strategy resulted in higher gross margins for abundant and limited water supplies, than strategies that used a refill level of 60% or 30% for the tillering and stalk growth phases. In a dry rainfall regime, the best option was to cease irrigation from December 2006 on the five worst performing fields, and to apply the available water on the 13 other fields. Cessation of irrigation on more fields caused a decline in farm profitability, while attempting to irrigate more fields also reduced farm profit.

The case study revealed SWOP to be a powerful tool for exploring irrigation options during times of limited water supply.

VARIETY-SPECIFIC RIPENER EVALUATION

Data obtained during 2016/2017 confirmed the significant economic advantage to growers and miller-*cum*-planters of ripening sugarcane cultivated under irrigated conditions.

In Pongola, the overall dataset accumulated over the past three seasons revealed that all of the variety x ripener treatments were effective in significantly increasing RV% by between 0.90 and 2.48 percentage points across varieties. All the varieties in the trial (N36, N49, N53 and N57) were shown to respond positively to Ethephon and Fusilade Forte, as well as the Ethephon/Fusilade Forte combination treatment, although the degree of response was relatively moderate.

Economic analysis of the dataset revealed that the return on investment (increase in gross margin) for N49 was at a maximum when applying only individual ripener treatments (R4,529 – R6,885/ha) rather than the combination treatment, where increase in gross margin at a 10 t/ha cane yield reduction was only R3,023/ha. In N36, N53 and N57, return on investment was shown to be at a maximum with the combination treatment (R12,237/ha, R12,821/ha and R13,275/ha, respectively) compared to the single treatments (N36: R7,291 – R9,801/ha; N53: R5,553 – R8,662/ha and N57: R6,583 – R11,148/ha).

MODELLING VARIETY GXE INTERACTIONS

Modelling may assist in the development of an understanding of genotype by environment (GXE) interactions and the underlying physiological mechanisms, thereby enhancing the potential value of crop models as tools in research and in the management of sugarcane production. Such a model-based approach to understanding GxE interactions requires: (a) models that are realistic and biologically robust and that are capable of distinguishing between genetic and environmental impacts; (b) reliable values of genetic trait parameters for different genotypes; and (c) appropriate experimental data.

The objective of this collaborative research is to monitor and model key plant processes contributing to yield and cane quality in a set of cultivars of different origin grown in diverse environments around the world. Members of the International Consortium for Sugarcane Modelling (ICSM) are collaborating in this research to gain a better understanding of the physiological mechanisms underlying the genetic variation in crop response to environmental factors and to translate this knowledge into improved mathematical models that could be used to aid sugarcane variety improvement.

Key plant processes contributing to yield, such as canopy development, radiation interception, biomass accumulation and partitioning are being monitored using a common methodology in an identical set of diverse cultivars that are grown in diverse environments around the world.

Plant crop experiments have been completed in France (La Mare in Reunion Island), South Africa (Pongola), USA (Belle Glade, Florida), and Zimbabwe (Chiredzi), while ratoon crop experiments have also been completed in South Africa, USA and Zimbabwe.

Noteworthy aspects of the different experiments completed so far include the following:

- In South Africa, the ratoon crop experienced some drought stress due to restricted water supply and cane yields were relatively low (60-100 t/ha) with cultivar N41 producing the highest yield.
- Belle Glade produced the highest yields in the plant and ratoon crop compared to the other sites, with cultivar CP88-1762 yielding the highest. Yields in the ratoon crop were lower than in the plant crop.
- In Zimbabwe yields were higher in the ratoon crop than the plant crop, with cultivar ZN7 yielding the highest.

Interesting trends emerging from the global data set are as follows:

- Cultivar N41 generally produced the highest stalk population and R570 the lowest.
- Cultivar Q183 developed canopy cover the quickest.
- Cultivars often produced the highest cane yield in the environment for which they were developed (N41 in South Africa, CP88-1762 in Belle Glade and ZN7 in Zimbabwe).
- Although differences in yield at a given site were often not statistically significant, the ranking of cultivars in Pongola and Chiredzi differed from that in Belle Glade and La Mare.

Sufficient data are now available to enable global analysis and modelling with a number of sugarcane models (APSIM, Canegro and Mosicas) to gain a better understanding of genetic control of growth and development responses to environmental factors.

SYSTEMS DESIGN & OPTIMISATION RESEARCH

Dr Rian van Antwerpen
(Programme Manager)

The goal of the Systems Design and Optimisation Research Programme is to investigate, develop and transfer innovative systems for use by growers and miller-*cum*-planters to optimise performance.

Research is undertaken in three key areas:

PRODUCTION SUSTAINABILITY

WATER MANAGEMENT

TECHNOLOGY DEVELOPMENT

KEY 2016/2017 RESEARCH HIGHLIGHTS

PRODUCTION SUSTAINABILITY

Sustainable Sugarcane Farming Systems

SUSFARMS® progress tracker central database tool was developed to extract, aggregate, display and report on individual sustainability indicators, which is to be used by Extension Specialists in reporting on grower and miller-*cum*-planter progress towards implementation of best practices in each ecozone, while mills may use the tool to provide aggregated evidence of selected sustainability targets to their key customers.

Progress tracker database tool will increase value derived from SUSFARMS®.

Economic Implications of Recommendations

The SASRI developed economic conversion tool (CaneTEC) that enables the communication of recommendations in terms of their economic benefits to growers and miller-*cum*-planters was validated.

Reporting on the economic benefits of recommendations will contribute to improving technology adoption.

Optimisation of In-field Traffic

Quantification was completed of the position and extent of in-field traffic in typical harvesting and extraction systems and the description of alternative scenarios that will minimise the impact of in-field traffic on the crop and permit the estimation of yield impact in order to derive a more realistic economic analysis of available systems.

Outcomes enable scenario planning to compare alternative practices in terms of yield loss and economic value and optimise infield traffic practices and design of improved systems.

Cane Loading and Transport

Resources developed to assist stakeholder decision-making regarding the suitability of cane receiving environments for Performance Based Standards (PBS) vehicles (Smart Trucks) deployment at 13 South African sugar mills and formulation of recommendations on the potential changes that might be required to accommodate these vehicles.

Resources will support stakeholder decision-making regarding potential deployment of Smart Trucks.

Remote Sensing

Confirmation obtained that sugarcane canopy cover can be reliably estimated at field level from Landsat 8 satellite imagery.

Improved crop forecasting accuracy at very little additional cost, with consequent benefit to the entire value chain.

WATER MANAGEMENT

Irrigation Systems

Preliminary best management guidelines developed for the deployment and management of drip irrigation.

Under drought conditions, observations confirm superior sugarcane appearance and growth under drip irrigation, compared with other irrigation systems.

TECHNOLOGY DEVELOPMENT

MyCanesim® Model

MyCanesim® updated to include a sophisticated multi-layered water balance with improved simulation of water stress and crop growth that accounts for atmospheric CO_2, crop lodging and variety differences.

MyCanesim® may be applied for strategic evaluations (e.g. for researching climate change impacts) and for operational support (e.g. crop forecasting and irrigation scheduling).

OUTCOMES FROM COMPLETED RESEARCH

TECHNOLOGY ADOPTION

Using system dynamics to explore the poor uptake of irrigation scheduling technology in a commercial sugarcane farming community in South Africa

- The project delivered two system dynamics models on the STELLA V 10.1 software: (a) Word-of-Mouth model; and (b) On-farm Testing model.
- Models enabled the exploration of socio-technical factors impacting on grower adoption of best management practices (BMPs), in this case those pertaining to irrigation.
- Model-facilitated explorations enabled the identification and mapping of the strength of key factors and points of leverage which influence or drive decision-making processes and/or behavioural patterns of irrigators.
- Learning from the research is informing SASRI knowledge exchange and technology diffusion strategies with a view to enhancing adoption of SASRI technologies by stakeholders.

PROGRESS IN ONGOING RESEARCH

REFINEMENT OF INDUSTRY DRY-OFF RECOMMENDATIONS

Collaboration and data-sharing with Industry stakeholders has greatly aided a critical assessment of current dry-off recommendations, which will ultimately inform an expansion of the Canesim model to encompass calculation / simulation of customised dry-off recommendations for all industry regions.

To assist growers and miller-*cum*-planters with the important management practice of determining the correct number of dry-off days, a number of tools (internet based DSP, look-up tables and dry-off wheel) have recently been developed as part of the SASRI research programme. Recommendations are available for both ripened (using chemicals) as well as non-ripened (water-stress induced) sugarcane. However, these new recommendations require further refinement and validation before the information can be distributed amongst growers with complete confidence.

As part of the validation process, SASRI data have been supplemented and complemented with mill quality data obtained from RCL Foods Sugar and Milling (Pty) Ltd, which manages drying-off on a large scale in the irrigated regions of the Industry.

As part of the validation process, SASRI data have been supplemented and complemented with mill quality data obtained courtesy of RCL Foods Sugar and Milling (Pty) Ltd, which manages drying-off on a large scale in the irrigated regions of the Industry.

Previous reports indicated that a good correlation (R^2 = 0.96) existed in the RCL production data between stalk moisture content and cane quality (tons RV/ha/annum). During 2016/2017, additional analyses revealed that the optimum moisture content resulting in the highest RV yield was 70.96% and 69.85% for non-ripened and ripened cane, respectively. However, as these two optimum moisture values however do not differ statistically from each other, one value of 70.4% may be used for both.

The optimum moisture values were used as inputs into the Canesim crop model to calculate the corresponding dry off periods for different total available water (TAW) categories (TAW= 60 mm, TAW= 80 mm and TAW= 100 mm) and months of the cutting cycle (March to December). These simulated values were compared to the corresponding measured data obtained in the RCL production database. For non-ripened cane, a fairly good correlation was obtained between measured and simulated dry off periods, but only for the "All" category and the "TAW80" category. For ripened cane, good corrrelations were obtained for the "All" and "TAW100" categories.

During 2017/2018, activities are to focus on model calibration to improve these correlations. Only once this is accomplished, may the Canesim model be used to calculate / simulate dry off recommendations for other areas of the industry, as per the research objectives.

TECHNOLOGY TO MANAGE SOIL SALINISATION UNDER IRRIGATION

When calibrated, the electromagnetic induction scanning technology will enable mapping of in-field saline and sodic regions and it is likely that the research will enable the establishment of an independent user-pays field mapping service.

Approximately 90 793 ha of sugarcane is irrigated in SA and the development of saline/sodic conditions is a constant threat. Quality of irrigation water (especially in winter) is suspect and the application of salts on soils via irrigation leads to soil health deterioration and eventually the development of saline or sodic soils.

The objective of this research, which is funded by the Water Research Commission and conducted as a collaboration between the University of the Free State (UFS) and SASRI, is to develop an irrigation decision support system to enable growers to sustainably manage salts in soils.

Electromagnetic induction meter.

During 2016/2017, two field trials were established in the irrigated region of the sugar industry: one each in the Mkuze and Heatonville regions. Both trials have been scanned with an electromagnetic induction meters (EMIs) and soil samples collected to calibrate the instruments for depths 0 – 380 mm, 0 – 750 mm and 0 – 1500 mm. Ground work has been completed and samples have been analysed by means of mid-infrared spectroscopy (MIR). All samples are to be analysed using conventional wet chemistry at UFS.

The research collaboration with the University of the Free State is funded by the Water Research Commission

Maps developed using data from the uncalibrated EMI instruments revealed zones in the study sites that are highly variable in apparent electrical conductivity (ECa). MIR derived data revealed that the variable ECa values are due to variable concentrations of sodium and large portions of the trial sites were classified as sodic. It is envisaged that the EMI technology will enable mapping of in-field saline and sodic regions and it is likely that the research will enable the establishment of an independent user-pays field mapping service.

REMOTE SENSING

Studies conducted in Pongola and Sezela demonstrated that a combination of satellite-based remote sensing and crop modelling holds promise for increased accuracy of sugarcane crop monitoring and yield forecasting.

Investigation of the cost-effectiveness of remote sensing data revealed that the Sentinel-2 satellite holds promise as: (a) it provides 10 m multispectral resolution; (b) has a revisit time of ten days, which is to be improved to five days upon the launch of the second satellite in 2017; and (c) the data are available free-of-charge.

More accurate crop forecasts are required within the Industry as they supply essential information for planning and effectively managing the sugar supply chain, from sugarcane production to sugar delivery.

Previous SASRI research demonstrated that incorporating remote sensing (RS) data (specifically canopy cover) into Canesim crop forecasts improved the accuracy of these forecasts significantly. However, as the SEBAL RS data examined previously are too costly, other sources (e.g. Landsat 8 data at 30 m resolution, available *gratis*) are examined in this current research for application on a wider scale for improved quality of weather-based crop forecasts.

SASRI appointed the Centre for Geographical Analysis (CGA) of Stellenbosch University as an external collaborator in this research, with the following brief:

- obtain satellite imagery for the study areas (Pongola and Sezela mill supply areas) from LANDSAT 8 at two-month intervals from January 2014 to August 2016;
- process the images to produce spatial data for various vegetation indices (e.g. NDVI) for selected dates in the two study areas; and
- statistically analyse and evaluate these features against fractional interception (FI) (canopy cover) ground truth data for usefulness and accuracy.

The Centre for Geographical Analysis (CGA) at Stellenbosch University was appointed as a research service provider.

During 2016/2017, the CGA provided an initial evaluation report on the work undertaken to address the three objectives.

Since it is known that satellite-derived vegetation indices (VIs) can monitor vegetation vigour, it was hypothesised that FI data and VIs are related in some way and the report delineated the underlying relationships between FI data and VIs through an empirical analysis using machine learning methods and regression modelling. The regression modelling performed reasonably well, considering the observed large variations in the data. The R^2 of 0.76 obtained suggested that the model developed may be of value and it is of note that multiple regression did not lead to substantially stronger models. Best overall accuracies were recorded in the Pongola region, suggesting that remotely sensed imagery is more effective in irrigated areas.

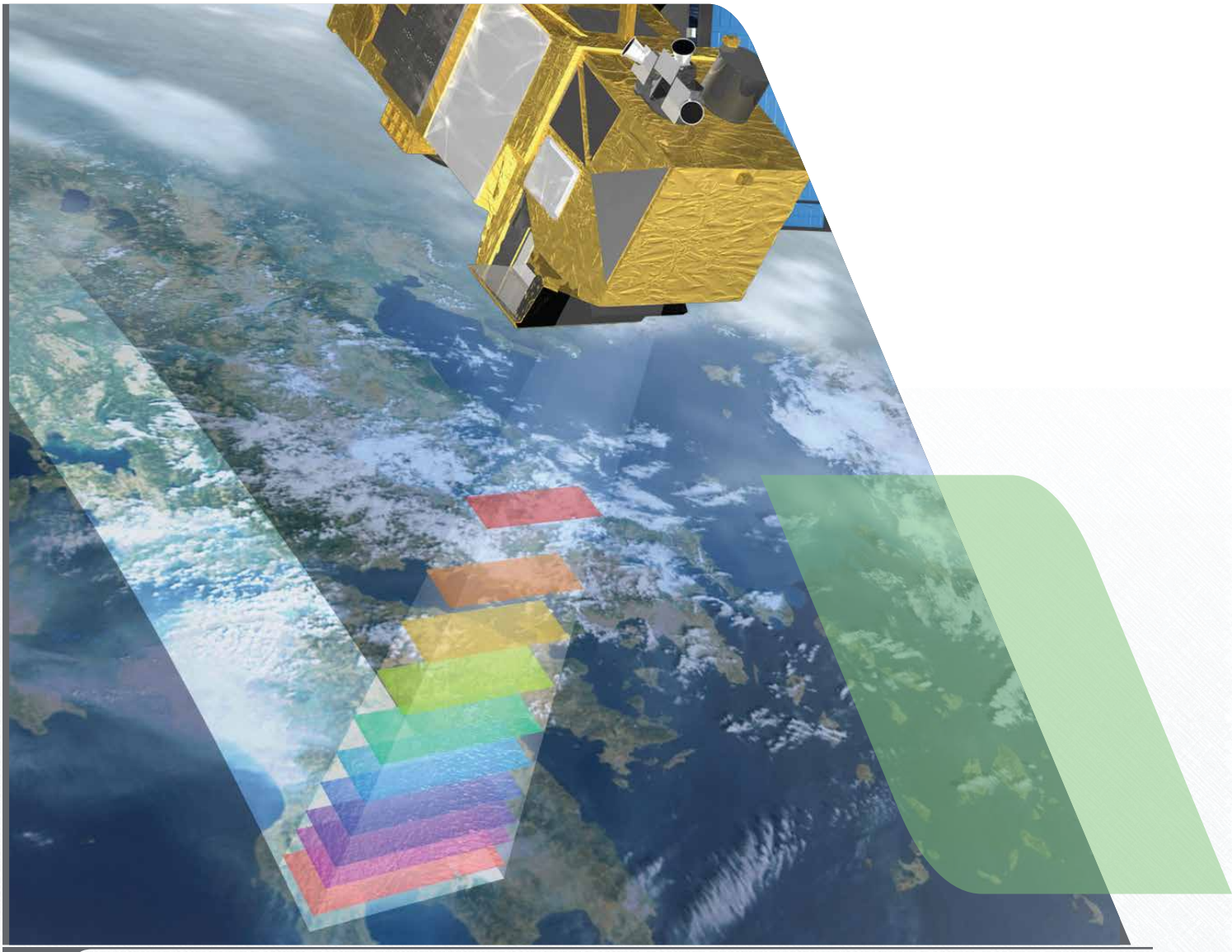
Data from the Sentinel-2 satellite are being investigated for modelling canopy cover, as the imagery has a higher (10 m) spatial multispectral resolution than Landsat 8 imagery (30 m, pan-sharpened to 15 m).

The report further indicated that satellite imagery with a higher temporal resolution might also result in a more accurate model, as cloud interference was problematic in this study. The report recommended that Sentinel-2 data be investigated for modelling FI, as this imagery has a higher (10 m) spatial multispectral resolution than Landsat 8 imagery (30 m, pan-sharpened to 15 m). Of note is that Sentinel-2 data has become freely available as of December 2015. A further advantage is that Sentinel-2 imagery currently has a revisit time of 10 days (to be reduced to five days upon the launch of the second satellite in 2017), which will improve the temporal matching of the FI measurements and satellite imagery.

Stellenbosch University also provided data sets of the field level vegetation indices (VIs) that showed the highest correlation to fractional interception for the period January 2014 to October 2016. The two VIs are the normalised difference vegetation

index (NDVI) and the aerosol-free vegetation index based on the short wave infrared band (AFRI-SWIR).

Professor Adriaan van Niekerk from the CGA at Stellenbosch University presented a seminar entitled "Applications of satellite imagery for sugar cane production, crop health monitoring and other agricultural applications" at SASRI on 15 February 2017.



VARIETY IMPROVEMENT RESEARCH

Dr Sandy Snyman
(Programme Manager)

The goal of the Variety Improvement Research Programme is to conduct research and implement strategies for the continual release of high sucrose yielding, adaptable and pest and disease resistant varieties that add value and enhance the productivity of the South African sugar industry.

Research is undertaken in four key areas:

BREEDING AND SELECTION

VARIETY CHARACTERISATION

NOVEL AND IMPROVED TRAITS

GENOMICS AND BIOINFORMATICS

2016/2017 KEY RESEARCH HIGHLIGHTS

BREEDING AND SELECTION

Commercial Breeding

- New varieties N63 (coastal 15-18 month cutting cycle for average potential soils), N64 (coastal 12-14 month cutting cycle for high potential soils) and N65 (coastal 12-14 month cutting cycle for high potential soils) released to the Industry.

The superior yield and agronomic performance of the three new varieties will enhance stakeholder profitability on the coast, subject to appropriate variety placement and management.

- Revised breeding tactics implemented to enable pest and disease resistance breeding in the early stages of the breeding process.
- Early selection for eldana resistance demonstrated to result in genetic gains for this critically important trait.

Improved variety resistance forms an essential component of integrated pest and disease management tactics.

- Confirmation that novel family-based strategies in early selection stages enhance genetic gains in sugarcane breeding.

New breeding tactics result in provision to the Industry of superior, robust, higher-yielding varieties.

Introgression Breeding

- Eight selected SASRI sugarcane genotypes dispatched to Barbados for crossing with noble and ancestral sugarcane species.

Successful crossing of noble and ancestral canes with commercial varieties will ultimately lead to varieties with improved yield, stress tolerance and pest and disease resistance.

VARIETY CHARACTERISATION

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

- Under commercial hinterland conditions, newer varieties (N61, N59, N58, N55, N54, N48) delivered higher RV yields than older varieties (N47, N39, N37, N31 and N12).
- In the plant crop, N59 outperformed all other varieties in ERC yield on the south coast.
- Superior performance of N52 in the midlands confirmed.

Comprehensive and reliable post-release demonstration of superior performance of new varieties increases grower confidence thereby promoting adoption.

NOVEL AND IMPROVED TRAITS

Mutagenic Breeding

- Tolerance of three mutant N12 lines to imazapyr without yield penalties confirmed under field conditions.

Mutagenic breeding provides an attractive alternative to GM in conferring desirable traits, such as herbicide tolerance.

GM Technology

- SASA Council approved commencement of research to develop a GM Bt variety for future commercial release.

As part of an eldana IPM programme, Bt cane has the potential to significantly reduce economic losses associated with eldana.

- GM pre-commercialisation research commenced in partnership with university collaborators to develop the knowledge base required for eventual commercialisation of a Bt variety resistant to eldana.

Conforming to GM legislative requirements will ultimately ease the regulatory process for commercialisation of future GM sugarcane.

GENOMICS AND BIOINFORMATICS

SASA / SASRI's genomics and bioinformatics research has redefined the origins of modern commercial sugarcane varieties.

Knowledge of the origins of modern sugarcane hybrids empowers effective commercial and introgression breeding for improved resistance and yield traits.

OUTCOMES FROM COMPLETED RESEARCH

GERMPLASM CONSERVATION

Medium and long-term conservation of strategically-important transgenic germplasm

- Slow-growth *in vitro* technology developed to enable the retention of sugarcane plantlets under specific laboratory conditions for 48 months without adverse effects.
- 'Fit-for-purpose' technology developed to enable indefinite storage of valuable sugarcane germplasm at -196°C with a consistent 66 to 78% survival rate.
- Ability to store sugarcane plantlets under laboratory conditions or at ultra-low temperatures gives much needed flexibility for sugarcane breeding and GM research.

GENETIC ENGINEERING

Tissue-specific transgene expression in the SA sugarcane germplasm: do we have functional promoters?

- A synthetic bovine lysozyme (*BvLz*$_m$) gene, obtained from the TAMU AgriLife Research and Extension Centre in Texas under the terms of a material transfer agreement, was used to test the functionality of tissue-specific gene promoters isolated in previous SASRI research.
- Functionality was demonstrated *in vitro* for three leaf-specific promoters, two root-specific promoters and three mutated and synthesised root-specific promoters.
- The functional promoters are not IP protected so there is freedom to operate in any future development of GM sugarcane requiring leaf- or root-specific expression of a foreign gene in sugarcane.

Further investigations planned for 2017/2018

Confirmation of the efficacy of the eight promoters in driving tissue-specific gene expression in transgenic sugarcane plants (*in planta* efficacy testing) is required. To accomplish this goal, follow-on investigations are to commence in 2018/2019 on 38 transgenic generated during previous SASRI research.

MUTAGENIC BREEDING

Agronomic evaluation of several imazapyr-tolerant lines and characterisation of resistance mechanism

- Tolerance of three mutant N12 lines to imazapyr without yield penalties confirmed under field conditions.
- Mutagenic breeding provides an attractive alternative to GM in conferring desirable traits, such as herbicide tolerance.

Further investigations planned for 2017/2018

A follow-on investigation is in progress to develop an integrated weed management package based on the outcomes of previous research.

PROGRESS IN ONGOING RESEARCH

COMMERCIAL BREEDING

Good genetic gains were made in the midlands breeding programme for cane yield, sugar yield and eldana resistance.

Genetic gains for yield continue to be realised in 2016/2017 in the midlands selection programme. Data for yield, quality and pest and disease occurrences were analysed for populations in early selection trials (single lines stage) for humic and sandy soils that occur in the region. Overall, the genotypes recently progressed in the early stages of the programme were observed to:

- produce higher cane yield and possess fewer eldana bored stalks than the older control varieties;
- demonstrate gains in sugar yield of 54% compared to N16 for humic soils and 14% compared to N12 for sandy soils; and
- display a trend towards higher fibre, indicating that the observed eldana resistance might be primarily controlled by fibre content and, as such, provided further support to current priority initiatives to identify alternative sources of resistance.

High Throughput Phenotyping Technology for Sugarcane Breeding

The SASRI Senior Breeder and Manager of the Industry's Breeding Programme, Dr Marvellous Zhou, received travel funding from the National Research Foundation to participate in the European Plant Breeders' Association (Eucarpia) congress held from 29 August to 1 September 2016 in Zürich.

One of the topics under discussion at congress was the adoption of high throughput phenotyping (HTP) by international plant breeding programmes in which the technology is used to identify markers useful for plant breeding. The markers developed are expected to be stable and able to predict phenotype in plant breeding at different stages of crop development. This approach is expected to reduce the impact of GxE on variety development. The conference highlighted the extensive collaboration that is required between breeders and agronomists to develop and deploy HTP for breeding purposes.

Dr Zhou will play a key role in a SASRI project on HTP platform development that is to commence in 2017/2018.

INTROGRESSION BREEDING

With a view to broadening the genetic base of the industry's sugarcane breeding population, crosses amongst selected SASRI pre-release genotypes and ancestral sugarcane species are to be conducted at the West Indies Central Sugar Cane Breeding Station (WICSCBS) in Saint George, Barbados.

The primary objective of introgression breeding is to increase the genetic diversity of parent breeding populations through introduction of new traits (e.g. high cane yield, high levels of eldana and nematode resistance, high fibre and biomass yields) by crossing sugarcane varieties with ancestral species and wild relatives. Notable during 2016/2017 was the export of eight suitable pre-release genotypes from the SASRI breeding programme to the West Indies Central Sugar Cane Breeding Station (WICSCBS) in Saint George, Barbados, where the crossing will take place under the direction of Dr Anthony Kennedy. These SASRI pre-release genotypes are to be crossed with selected ancestral and related species in the extensive WICSCBS germplasm collection, a process which is easier under the tropical Barbadian conditions. Many of the related or ancestral species either do not flower in South Africa or do so at a different time to that of the commercial varieties that are desirable for introgression breeding. The exported seedlings will be planted in Barbados in 2016 and crossed in 2018, with the resulting seed imported back into South Africa in 2019.

MUTAGENIC BREEDING

Mutagenic breeding tactics provide the means to develop drought- and stress-tolerant varieties that are not attainable through conventional breeding.

Mutagenesis studies conducted at SASRI aim to develop methods to generate mutants and screen for increased resistance to drought and heat tolerance. The production of toxic metabolites by plants is a symptom of stress and a component of plant stress resistance relies on their rapid and effective detoxification. Investigating the use of these same metabolites as *in vitro* selective agents requiring improved detoxification is a novel approach for improving stress tolerance. Research undertaken during 2016/2017 involved the *in vitro* screening of N41 and NCo376 plants possessing potential tolerance of three chemicals that induce severe oxidative stress. Potentially stress tolerant plantlets passing through the screening process will be acclimated and used in drought tolerance trials to be conducted in 2017/2018.

A gas chromatography-linked mass spectrometry protocol was developed to assess the capacity of mutant varieties to detoxify harmful stress-induced biochemicals.

During the drought tolerance trials, mutant lines will be assessed for their capacity to detoxify deleterious biochemicals that are produced in response to drought and heat stress. To facilitate metabolic profiling of the putatively stress-tolerant sugarcane plant material, a protocol was optimised in 2016/2017 for gas chromatography-linked mass spectrometry (GC-MS). The use of GC-MS in sugarcane is complicated by the high levels of sugars that overload the chromatography column and deplete the derivitisation reagents resulting in non-detection of metabolites that are in low quantities. The modified protocol, which overcomes this challenge, has permitted the detection of over 50 metabolites that have been identified by matching to metabolite databases. The metabolites detected include amino acids, organic acids, sugars, sugar alcohols and flavonoids.

VARIETY PERFORMANCE

Implementation of a Pur*Est*™-based approach for the estimation of RV% might ultimately lead to significant cost savings for variety trials, as reliance on expensive mill room analyses would be reduced.

At harvest in 2016/2017 of a variety evaluation trial conducted in Eshowe, RV% was estimated by the analysis of in-field brix measurements taken with a refractometer and application of the recently released SASRI Pur*Est*™ tool. As part of ongoing initiatives to promote stakeholder adoption of new variety releases, the RV% values determined with the calculator were presented to growers at a field day. Stakeholders found the results to be informative and supported the communication

of data derived from the application of the tool during grower communication events. Implementation of a Pur*Est*™-based approach for the estimation of RV% might ultimately lead to significant cost savings for variety trials, as reliance on expensive mill room analyses would be reduced.

Newer SASRI varieties (N61, N48, N59, N54, N58, and N55) display excellent RV yield performance on good soils in the hinterland, compared with the most commonly cultivated varieties (N37, N47, N39, N31, and N12). Private growers and miller-*cum*-planter estates stand to benefit significantly through the adoption of these more recent releases.

During 2016/2017, the plant crop of an Eshowe variety trial under commercial hinterland conditions on good soils was harvested. The trial contained all new coastal long cycle and midlands varieties. The newer SASRI varieties (N61, N48, N59, N54, N58, and N55) displayed excellent RV yield performance, compared with standard varieties used under these conditions commercially (N37, N47, N39, N31, and N12). The results confirm the high yield potential of SASRI's latest variety releases and highlight the benefits that may be realised by growers through the adoption of newer varieties.

Data obtained in 2016/2017 have revealed that variety N59, outperforms all other varieties tested (e.g. N12, N27, N41 and N39) on the south coast in terms of ERC yields.

In 2015, a variety trial was established at Umzumbe to expand variety evaluation under south coast conditions. The plant crop from the trial was harvested in 2016 at 13.5 months of age. The results revealed that variety N59, in particular, outperformed all other varieties tested (e.g. N12, N27, N41 and N39) in terms of ERC yields. This variety was released to the industry as a coastal long cutting cycle variety and had not been previously evaluated on the south coast. Hence, N59 may hold some promise for growers on the south coast.

N52 produced up to 5 tons RV/ha more than N12 in the midlands, when averaged over three crops. The trial data also revealed that the ratooning ability of N52 was superior to most other midlands varieties.

A variety trial harvested in the midlands area (New Hanover) during 2016 has confirmed the superior performance of N52 compared with other midlands varieties. This variety produced up to 5 tons RV/ha more than N12 when averaged over three crops. The trial data also revealed that the ratooning ability of N52 was superior to most other midlands varieties. Growers and miller-*cum*-planter estates in the midlands may confidently adopt this variety, as it has shown superior performance under a wide range of conditions.

Data obtained during 2016/2017 suggest that N52 possesses some degree of drought tolerance compared with other varieties. Target environments for this variety may, therefore, include marginal growing conditions that are prone to water-deficit stress.

The unfavourable climate experienced in 2016/2017 provided an opportunity to assess the relative performance of varieties under low rainfall conditions. For example, in each of the five trials examined, the ranking of N52 in early crops under normal rainfall was relatively low compared with other varieties. However, in seasons affected by the drought, such as 2016/2017, the relative ranking of N52 improved across all five trials, suggesting that N52 possesses some degree of drought tolerance compared with other varieties. Target environments for this variety may, therefore, include marginal growing conditions that are regularly affected by drought. Additional data analysis is to be undertaken in 2017/2018 to examine the possible mechanisms associated with the observed relative drought tolerance of this variety.

NOVACANE® TECHNOLOGY

Performance of NovaCane®-derived cane does not differ significantly from that of cane propagated by conventional practices, although additional evidence will be forthcoming from ongoing experimentation.

A field trial has been conducted under rainfed conditions at the SASRI Mount Edgecombe site to assess whether the NovaCane® *in vitro* micro-propagation process affects variety performance and, if so, whether the differences might be mitigated through manipulation of plant spacing. The trial evaluated four varieties (N12, N31, N41, and N48) with four combinations of propagation methodologies and plant spacing: (a) NovaCane® plants spaced 30 cm apart (NovaCane® 30); (b) NovaCane® plants spaced 50 cm apart (NovaCane® 50); (c) conventional hot water treated seedcane (Con); and (d) speedlings/transplants planted 50 cm apart (SP50). The results at harvest revealed that:

- no significant differences exist in cane and ERC yields between propagation methods for all varieties;
- no significant differences exist in stalk height, stalk mass, stalk population and number of buds per hectare between propagation methods in all varieties;
- stalk diameter was significantly reduced in the NovaCane® treatments for varieties N12, N31 and N41, but not for N48;
- generally, the NovaCane® 50 and SP50 treatments did not differ significantly in any parameter, indicating that there were no secondary effects of the NovaCane® process on plant phenotype; and
- the NovaCane® 50 and NovaCane® 30 treatments did not differ significantly for any parameter indicating that different plant spacing had no effect at harvest.

The study demonstrated that NovaCane®-derived plants are agronomically comparable to conventionally propagated plants in the plant crop under rainfed conditions.

Research to be conducted in 2017/2018 will assess potential impacts of the micro-propagation technology on cane performance in the first ratoon and in the second propagation stage.

BIOINFORMATICS AND GENOMICS

A novel bioinformatics pipeline developed at SASRI enables a snapshot view of genes being expressed in response to particular stimuli (e.g. eldana boring), which will ultimately inform marker-assisted breeding of eldana-resistant varieties.

Data generated by Next Generation Sequencing (NGS) technologies consist of vast numbers of nucleotide (DNA and RNA) sequences that can only be analysed by computational means.

SASRI is involved in several projects that produce and analyse NGS data. The value of these data resides in the sequence information and the way in which such information is mined and interpreted. SASRI research in this technology arena aims to establish generic pipelines to process the data and offer a local graphical user interface to enable easy access by SASRI scientists to tools, data and data viewing. During 2016/2017, progress continued steadily in the expressed sequence tag (EST) build pipeline. These ESTs represent a snapshot of the genes expressed by the sugarcane plant at a certain point of time and in response to specific internal and external stimuli.

A major objective of current SASRI bioinformatics research is to catalogue ESTs produced in response to eldana infestations, which is undertaken as a means to improve eldana resistance breeding. Using the novel bioinformatics pipeline developed, SASRI scientists engaged in the thirteenth round of EST building as follows:

- 29,573 sequences were completed within the building process;
- 16,372 “near complete” transcript sequences were extended;
- 11,517 transcript sequences were built to the stage where they can no longer be extended with the current pipeline data; and
- 1,684 sequences were manually removed from the pipeline due to no progress in alternate builds.

In 2016/2017, the pipeline ran on the SASRI local genomics server, which meant that initial build rounds of the pipeline were taking approximately six weeks to complete. Fortunately, SASRI, as a DST/NRF-accredited institution, has been able to register with the DST/CSIR Centre for High Performance Computing (CHPC) in Cape Town. Cost-free access to these state-of-the-art computing resources will greatly enhance the efficiency of the next phase of the SASRI bioinformatics pipeline build.

As a DST/NRF-accredited institution, SASRI secured free access to the services of the DST/CSIR Centre for High Performance Computing (CHPC) for bioinformatics data processing and analysis.

At inception, one of the primary goals of the industry’s genomics and bioinformatics research at SASRI was to further DNA marker-assisted breeding of N varieties by using available sugarcane genome sequences and querying these against the sorghum genome, which at that stage was partially sequenced. At the time, it was postulated that examination of the sorghum genome sequence would facilitate access to sugarcane sequence information by exploiting genomic regions syntenic (identical) between sugarcane and sorghum, thereby enabling the development of genetic markers associated with important sugarcane traits (e.g. pest and disease resistance, stress tolerance). However, genomic and transcriptomic data of the Brazilian sugarcane cultivar, SP80-3280, have been released recently. Access to these data has enabled a more rapid pipeline assembly of sugarcane genes in the project. Currently, 200 stress-associated sugarcane genes are being re-assembled using the SP80-3280 genome data.

The Brazilian Bioethanol Science and Technology Laboratory is gratefully acknowledged for the generous sharing of SP80-3280 genome data.

RESEARCH

CONTRACTS, GRANTS & STRATEGIC RELATIONSHIPS

To fulfil the research mandate from the sugar industry, SASRI commissions contract research with external service providers, seeks external grant funding for research projects and participates in international science meetings and maintains a network of strategic national and international collaborations and partnerships

2016/2017 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 the required resources.

- One new research contract was established in 2016/2017.

Water and Soil Conservation Structures

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.

- Four research contracts were ongoing from 2015/2016 into 2016/2017.

Genetic Engineering Enhanced Sucrose Levels

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, the research at the IPB has been directed by Professor Jens Kossmann. 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.

Modelling Sterile Insect Technique Release Tactics

The sterile insect technique (SIT) may ultimately form an essential component of the eldana integrated pest management toolkit, once proof-of-concept has been established. In preparation for future field trial assessment of SIT efficacy for eldana suppression, Dr Linke Potgieter of the Department of Logistics at Stellenbosch University has been contract by the industry, through SASRI, to conduct modelling studies to prepare release tactics for sterilised male eldana moths. The contract with Dr Potgieter, entitled "*Modelling to aid release strategy and cost benefit decisions for Sterile Insect Technique (SIT)*" runs until March 2017.

Genetic Engineering Drought Tolerance

In response to persistent drought conditions over the past few growing seasons and recognition of the predicted impacts of future climate change scenarios, the industry elected in 2015/2016 to contract the IPB to commence investigating the potential that biotechnology may hold for enhancing sugarcane drought tolerance. The contract with Stellenbosch University is entitled "*Biotechnological investigations to improve sugarcane drought stress tolerance*", on which Dr Christell van der Vyver serves as the Principal Investigator. The current contract runs until March 2018.

Elevated CO_2 Effects on Sugarcane

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_2 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_2 concentration on local sugarcane varieties*". North West University was selected as research partner due to the availability of open-top CO_2 chambers on the Potchefstroom campus.

- Two research contracts were finalised during the course of 2016/2017.

Mill Supply Chains

The contract with Professor Carel Bezuidenhout of the UKZN School of Engineering was finalised for the project "*Profiling, Issue identification and comparing different sugar milling areas in SA*".

Key outcomes from the research include: (a) knowledge of key pressure points on mill supply chain efficiencies; and (b) tools to facilitate improvements (social science-based engagements).

Dr Bezuidenhout subsequently relocated to New Zealand, although he maintains an honorary affiliation with UKZN.

KEY OUTCOMES

- *knowledge of key pressure points on mill supply chain efficiencies; and*
- *tools to facilitate improvements (social science-based engagements).*

Eldana SIT – Moth Rearing, Sterilisation and Transport

The second contract for which research was finalised in 2016/2017 was with Dr Pia Addison of the Department of Conservation Ecology and Entomology at Stellenbosch University for the research project "*Integration of area-wide pest management methods for arthropod pests in SA*".

Key outcomes from the research include: (a) radiation dosage required to sterilise eldana moths; (b) quality control parameters of eldana moth rearing for the sterile insect technique (SIT); (c) conditions and parameters required for the transport of eldana moths to release sites; and (d) a preliminary test of SIT on eldana (enclosure studies on potted plants).

The work conducted by Dr Addison forms the foundation of the novel F1 sterility approach that SASRI implemented in SIT proof-of-concept during 2016/2017.

KEY OUTCOMES

- *radiation dosage to sterilise eldana moths;*
- *quality control parameters of eldana moth rearing for SIT;*
- *transport of eldana moths to release sites; and*
- *a preliminary test of SIT on eldana (enclosure studies on potted plants)*

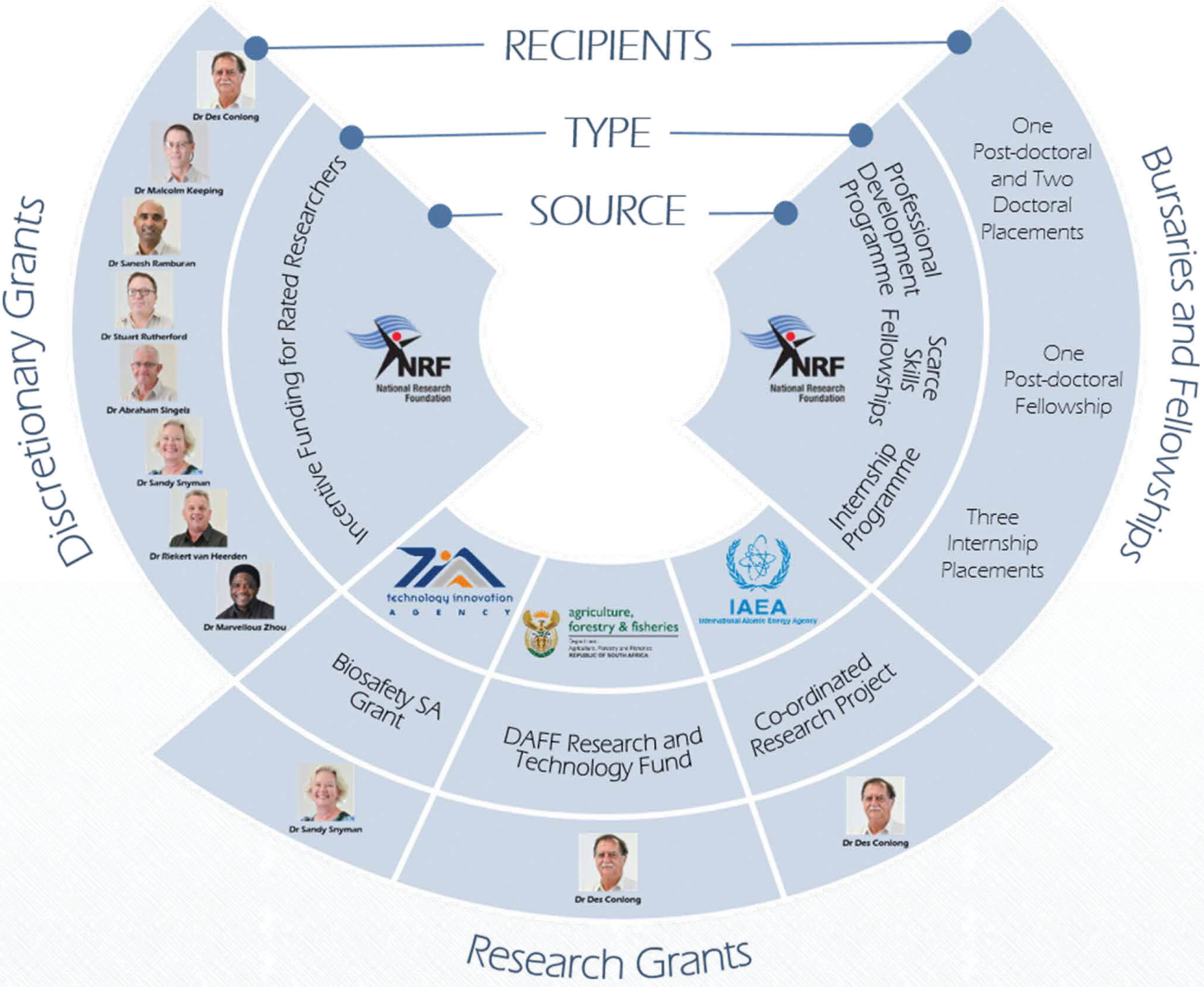
2016/2017 GRANT AWARDS

During periods of low income within the industry, such as those resulting from the 2016/2017 drought, SASRI researchers are particularly aware of the importance of securing external grant funding to support post-graduate bursaries, post-doctoral research associate fellowships and participation in key international science meetings.

BURSARIES, FELLOWSHIPS AND RESEARCH GRANTS

In 2016/2017, SASRI researchers were awarded several grants for bursaries, fellowships and research costs. The eight SASRI scientists who are rated by the National Research Foundation (NRF) received discretionary funding from the Incentive Funding for Rated Researchers programme.

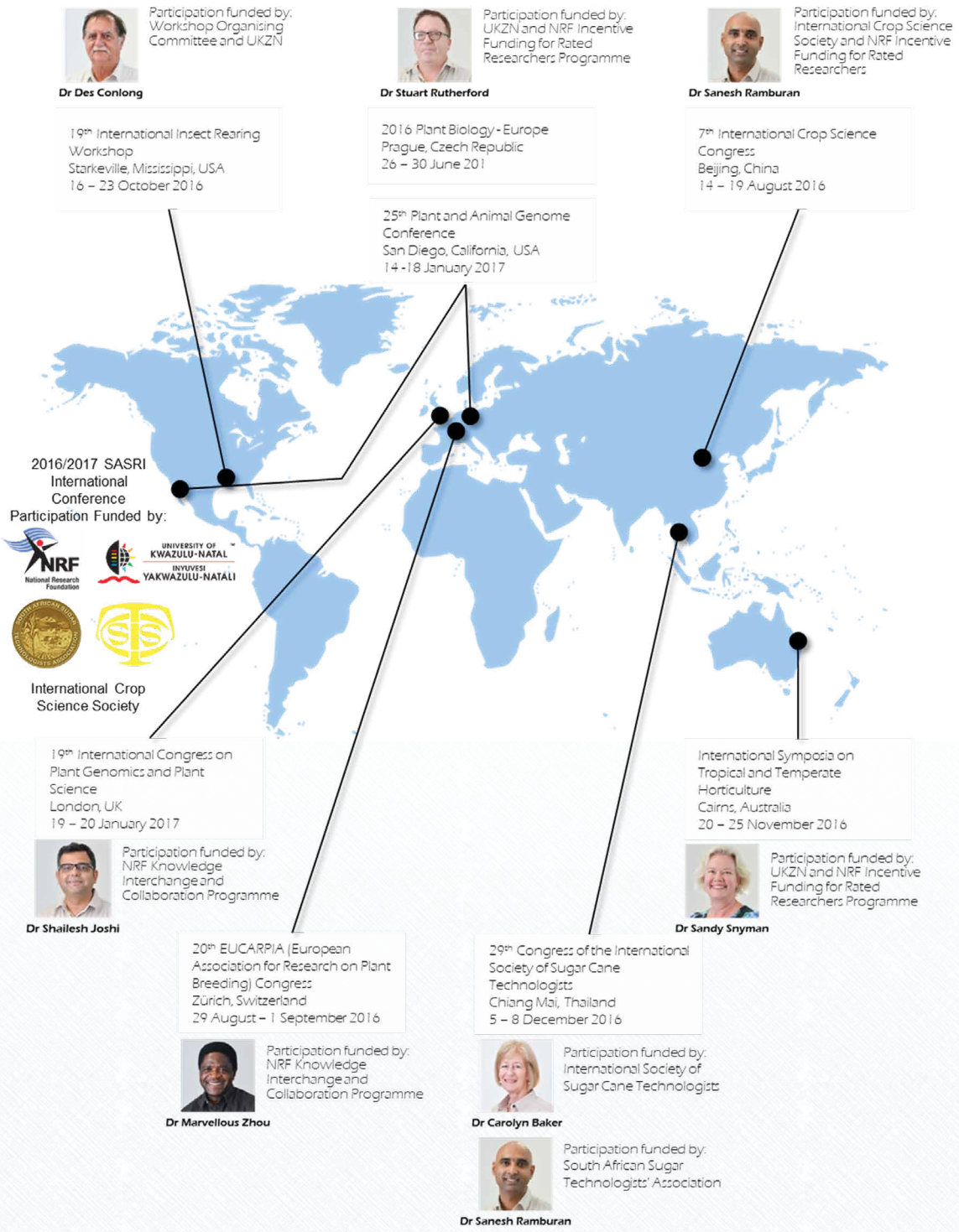
The grant funding received during 2016/2017 from the NRF, Technology Innovation Agency (TIA) (through Biosafety SA), the Department of Agriculture, Forestry and Fisheries (DAFF) and the International Atomic Energy Agency (IAEA) is gratefully acknowledged.



2016/2017 International Conference Grants

During 2016/2017, SASRI researchers sourced external grant funding to secure participation in key international science meetings of strategic relevance to the research programme.

Grant funding from the NRF (Incentive Funding for Rated Researchers and Knowledge Interchange and Collaboration programmes), UKZN (productivity grants for individual SASRI researchers holding honorary university positions), the South African Sugar Technologists' Association, the International Society of Sugar Cane Technologists and the International Crop Science Society is gratefully acknowledged.



STRATEGIC COLLABORATIONS AND PARTNERSHIPS

To promote and support innovation within the research programme, both SASRI as a research institution and individual researchers cultivate formal and informal relationships with national and international research agencies, consortia, institutions and organisations.

Centre de Coopération Internationale en Recherche Agronomique pour le Développement (Franc
Commonwealth Scientific and Industrial Research Organisation (Australia)
International Consortium for Sugarcane Biotechnology
Institut de Recherche pour le Développement (France)
International Centre of Insect Physiology and Ecology
International Consortium for Sugarcane Modelling
Mauritius Sugar Industry Research Institute
International Atomic Energy Agency
Sugar Research Australia

University of Pretoria
North West University
Stellenbosch University
University of the Free State
University of KwaZulu-Natal
SA Canegrowers' Association
Agricultuural Research Council
Sugar Milling Research Institute

ACHIEVEMENTS & AWARDS


Dr Sanesh Ramburan


Prof Marvellous Zhou


Dr Shailesh Joshi


Dr Dyfed Evans


William Gillespie


Adriaan Serfontein


Dimpho Elephant


Dr Neil Miles


Dr Peter Tweddle


Dr Peta Campbell

Dr Sanesh Ramburan was appointed as an Affiliated Senior Lecturer in the Faculty of Natural and Agricultural Sciences at the University of the Free State. Dr Ramburan was also further appointed as an Associate Research Fellow in UKZN's School of Agricultural, Earth and Environmental Sciences (Crop Science). This is in addition to his appointment by UFS as Affiliated Senior Lecturer in the Department of Plant Sciences (Plant Breeding Division).

In addition, he was awarded a travel grant by the Organising Committee of the 7th International Crop Science Congress. The grant covered all costs associated with his participation in this important international congress, which was held in Beijing.

Prof Marvellous Zhou was awarded an international travel grant from the NRF Knowledge Interchange and Collaboration programme to attend the European Plant Breeders' Congress in Zurich.

Dr Shailesh Joshi was awarded an international travel grant from the NRF Knowledge Interchange and Collaboration programme to attend the *Nineteenth International Conference on Plant Genomics and Plant Sciences*, London, United Kingdom.

He was awarded the certificate of best presentation for presenting an outstanding work entitled "Plastid phylogenetics reveals sugarcane hybrids are derived from a novel species."

Dr Dyfed Lloyd Evans and Dr Shailesh Vinay Joshi were recipients of the Taylor and Francis award 2016 for publishing an outstanding paper entitled "Complete chloroplast genomes of *Saccharum spontaneum*, *Saccharum officinarum* and *Miscanthus floridulus* (Panicoideae: Andropogoneae) reveal the plastid view on sugarcane origins" in the *Systematics and Biodiversity* journal.

William Gillespie (SASRI Small-scale Extension Specialist) won the "Best Poster" award for his poster titled "The cost-benefit of technology transfer regarding knowledge of soil type and herbicide selection to commercialise emerging sugarcane farmers" at the South African Society for Agricultural Extension (SASAE). He co-authored the paper with FJ Mitchell (Scientific Manager Natural Resources DARD) and Dr PL Campbell (SASRI Weed Scientist).

Adriaan Serfontein was awarded the student prize in Agriculture at the 88th SASTA symposium. The paper he presented was titled, "Development of handling and transport protocols for *eldana saccharina* for Sterile Insect Technique". This paper was co-authored with Dr Pia Addison (University of Stellenbosch) and Dr Des Conlong (SASRI).

Dimpho Elephant and co-author ***Dr Neil Miles*** were awarded the Kynoch prize for their paper titled, "Prediction of the potassium requirement factor for soils of the South African sugar industry".

Dr Peter Tweddle, was awarded the prize for his poster titled, "Payload determination for vehicle combinations" at the 88th SASTA symposium.

Dr Peta Campbell, and her co-authors, Aresti Paraskevopoulos and Surashna Huripurshad, were also recipients of the 88th SASTA poster prize for their poster titled, "Practical measurement of granular Servian® for knapsack application to control *Cyperus rotundus".*

SPECIALIST ADVISORY SERVICES

Kerry Redshaw
(Operations Manager)

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). This expertise and experience is offered as specialist advisory services to external clients for a consultancy fee when specialist capacity is available. 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 94 Specialist Advisory Requests (SARs) during 2016/2017. After evaluating capacity and relevance to SASRI, 79 of these requests were addressed by the end of March 2017.

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 28 Extension Requests for Advice (ERA) during 2016/2017. 17 of these ERAs were for Land Use Plans (LUPs) and farm maps. Due to limited staff capacity in GIS, SASRI had a backlog of LUP requests from previous years. These requests are being 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 the growers' 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. During 2016/2017 FAS focused on introducing and implementing a Laboratory Information Management System that will improve efficiencies in the delivery of accurate and reliable results to customers.

While soil and water sample submission numbers during 2016/2017 were similar to 2015/2016, fertiliser sample numbers increased and leaf sample numbers decreased relative to the previous season. A breakdown in sample numbers for 2016/2017 are captured in the following table:

	2016/2017				2015/2016
	SA Growers	SASRI Research	Outside SA	Total	Total
Soil	19150	1818	3765	24733	24467
Leaf	1365	2937	3374	7676	9909
Fertiliser	3799	7	293	4099	3506
Water	56	2	94	152	145

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, one of the main focus areas of the disease diagnostic services is Ratoon Stunt Disease (RSD) and Yellow Leaf Virus (YLS). During 2016/2017, a total of 11867 RSD samples were analysed with 9578 of these samples coming from SA growers and 2127 from other countries. The remaining number of samples (150) were from SASRI research trials. The number of RSD samples analysed for SA growers increased by 1800 samples in the 2016/2017 season. SASRI also conducted training on a user pays basis, in Malawi, Mozambique 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 in order to protect SASRI's Plant Breeders' Rights. SASRI are responsible for obtaining phytosanitary certificates for the export of any sugarcane from South Africa from the division of Plant Health from the Department of Agriculture, Forestry and Fisheries.

During 2016/2017, a number of different disease-free varieties were exported to 9 countries, namely Barbados, Burundi, Cameroon, Mauritius, Mozambique, Nigeria, Tanzania, Zambia and Zimbabwe. Sugarcane fuzz was exported to Zimbabwe. 18 Phytosanitary clearance certificates were issued.

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 identified invasive alien plant species for the Natural Resource Management Programmes.

During 2016/2017, SASRI mass reared and distributed 151 764 biological agents. The agents are effective for the control

of *Pereskia aculeate* (Barbados Gooseberry), *Parthenium hysterophorus, Salvinia molesta* (Kariba Weed), *Eichornia crassipes* (Water hyacinth) and *Pistia stratiodes* (Water lettuce).

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 2016/2017, a total of 1243 DNA sequences and 2870 DNA fragment analysis runs were conducted. All South African commercial varieties have been fingerprinted and this service is regularly used by researchers, Quarantine and Biosecurity 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 then made available on the SASA Website.

Many stakeholders make use of these mechanisation reports. Growers use these reports 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.

When necessary, SASRI investigates the need for machinery development and, where appropriate, initiates and collaborates in the development of new machinery.

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. This data and related weather applications can be accessed via SASRI's WeatherWeb (www.sugar.org.za/sasri). It is possible to view and download all information in the form of maps, graphs or reports.

Users are able to 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.

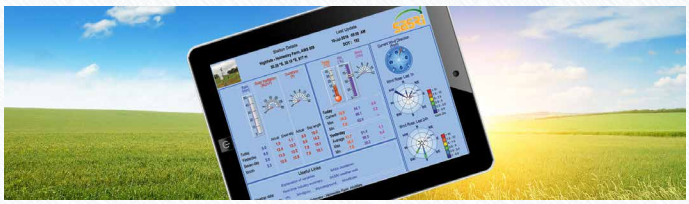
SASRI offers an Automatic Weather Station (AWS) installation and maintenance service both within and outside the borders of South Africa. A service agreement between Mondi and SASRI was finalised for the installation, set-up, calibration and activation of 29 new AWS weather stations during 2016/2017. This AWS service was also provided to customers in Mozambique, Swaziland and Tanzania. 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, any repairs or replacements required and general site maintenance. Calibration reports and certificates of compliance are issued with each visit.

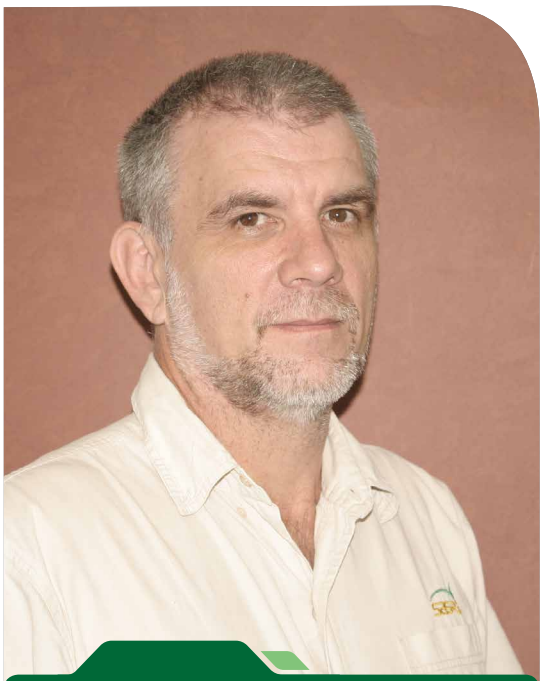
Crop forecasting

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 the available weather data and robust and reliable crop models to determine these forecasts. This crop forecast estimates homogeneous climate zone and mill level yields for registered users. Mill level and industry estimates of cane production are provided to the SASA Executive regularly.

The RV Canesim forecast model is used to generate information for the SASA RV Forecast Committee. This Committee provides monthly forecasts of seasonal average RV% for each mill area to guide mill group boards. These estimates become the official RV% forecast for the industry.



BIOSECURITY & EXTENSION



Rowan Stranack
(Extension & Biosecurity Manager)

Biosecurity

The SASRI Biosecurity inspectorate successfully completed its second year under centralised industry management within SASRI. The twelve Local Pest Disease and Variety Control Committees (LPD&VCCs) across the industry, supported by 24 inspection teams, attendant officers and technicians, successfully navigated a challenging year. This despite the carryover effects of the recent droughts which drove up eldana and smut levels as well as put significant pressure on supplies of seedcane. Overall, LPD&VCCs rose to the challenge and successfully managed to contain pest and disease levels thereby contributed to maintaining the economic viability of the grower community.

A new addition to the LPD&VCCs was the formation of a local committee to represent and serve growers in the Mkuze and Makhatini region. This committee is unique as it has only one large-scale grower farming in the control area, with the remainder of the growers being small-scale. Gaining representation from the diverse, widely scattered communities in the area was a challenge initially. However, with three meetings being successfully held, as well as a number of other field events involving the communities, these challenges have been overcome.

Moving from a previously grower-funded and operated process, obtaining miller representation on LPD&VCCs was a particular focus during the reporting period. In most areas, involvement of the milling companies has been successfully achieved and they are vital role-players in the wider pest, disease and variety control effort. Often contributing land for seedcane schemes or financial support to source and purchase good seedcane, the role of the milling companies is key to ensuring effective biosecurity in the future.

Regular meetings of LPD&VCCs enable growers to remain abreast of new outbreaks. Committee members, in leading by example, exercise peer pressure on their neighbours to carry out control measures. This very important role is one only they can carry out. With committees now free of financial and operational issues of inspection teams and staff, they can focus solely on biosecurity threats facing their respective regions. In this regard, 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 eight years. This is to ensure that all commercial plantings are made with either of these grades of seedcane. 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 into the future.

The value of the centralisation of the industry's biosecurity effort was highlighted this year with the response to a new incursion of the longhorn beetle. Changes in legislation, the approval of containment and research programmes and support for the affected LPD&VCCs was effectively and rapidly enabled through the single channel afforded by the oversight of SASA and SASRI in particular.

LPD&VCCs also regularly promote awareness of pests and diseases amongst local growers. In addition to various training courses, growers are encouraged to employ their own scouting teams. This practice has been met with considerable success lately in the KZN midlands where eldana has become an ever-increasing threat and direct grower involvement has contributed significantly to effective control of this pest. In the irrigated northern regions where smut is an on-going problem, farm-based roguing teams are essential in the fight against this disease and the SASRI Biosecurity teams are continuously training farm staff in effective roguing techniques. In some instances, larger organisations employ their own inspection teams, reducing reliance on the SASRI Biosecurity teams for generating results.

LONGHORN BEETLE

In late 2015, during a routine eldana survey on a farm in the Entumeni area, an unknown longhorn beetle larva was found in sugarcane. Having not been seen before, this led to a wider survey of in the area resulting in more fields being found to be infested. During 2016 it became apparent that the larvae were causing extensive damage to the crop and in some cases stalk mortality. Yield reductions of up to 50% were noted. The pest appeared to have no preference for variety or ratoon and by autumn of 2017, some 400 hectares on four farms in the area were confirmed to be infested.

Following a widespread flight of adult longhorn beetles which 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 and the application of insecticides. 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.

At the same time, a widespread awareness campaign across the industry was launched. All Biosecurity field staff were trained in the identification of the longhorn beetle adults and larvae as well as how to identify damage in the field. Farm staff in the areas most threatened were also trained in the identification of the pest. Posters and pamphlets were distributed and a number of articles were written for industry publications to alert as many people as possible to the threat.

The threat posed by this pest is arguably one of the most serious to face the industry in a long while. Sugarcane in the Far East is also affected by similar longhorn beetle species and damage to the crop in these countries has been widespread and devastating.

Despite the affected growers eradicating heavily infested fields, the pest continued to spread locally. Initial chemical insecticide trials met with limited success and despite a wide range of products being tried, it is likely long-term containment will only be achieved through removal of the host sugarcane and a long fallow, probably at least two years. The industry is currently considering various containment strategies, implemented by means of orders of the Entumeni LPD&VCC in an attempt to contain the spread of this pest. A long-term research programme was also approved and will be implemented from 2017. A dedicated SASRI Entomologist has also been assigned to the containment project and associated research.

ELDANA

As a consequence of the protracted drought of 2014/2015, many areas still had to deal with high eldana levels. The drought also resulted in some increased movement of the pest into the cooler KZN midlands regions where it was not commonly found. With a longer cutting cycle the norm in these regions, early harvesting would be economically damaging to growers. However, with the arrival of additional chemistries to control eldana, growers have been enabled to largely maintain their long cutting cycle without undue increase in overall eldana levels. However, in order to carry out an effective spraying and carryover strategy, certain amendments were needed in local rules and hazard levels to accommodate spraying.

Across the industry there was great emphasis on surveys during 2016. All committees exceeded their minimum requirement for eldana surveys and some regions surveyed almost double the required norm. These surveys revealed that overall, across the industry, only 7% of fields were above local hazard levels requiring action, either in the form of spraying or premature harvest. This is an indication that growers are managing this pest effectively. Even in the northern irrigated regions it was found that eldana levels were relatively high for those parts, requiring an increased area to be surveyed and remedial action in some instances. Varietal susceptibility to eldana is more evident in times of extreme stress. It was noted that varieties N31, N35, N37, N46 and N48 in particular showed relative susceptibility and the need for careful monitoring and management.

Under the guidance of SASRI Extension Specialists an Integrated Pest Management (IPM) approach to eldana control continued to be promoted in areas where eldana is a 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 and N59 have all proved their worth as promising replacements for older, more susceptible varieties. There was also focus on green cane harvesting, crop nutrition management, improved biodiversity and chemical spraying as vital components of an IPM approach. Where successfully combined, these practices contributed to significant yield and cane quality improvements, more than justifying any additional cost.

In June 2016, an eldana summit was held at Mt Edgecombe to which the major role players involved in combatting the pest were invited. Representatives from LPD&VCCs, SASRI Extension and Biosecurity, and the trade discussed some of the challenges around the usage of the new chemistries and general management of the pest. Compliance with the Insect Resistance Action Committee (IRAC) guidelines on the use of pesticides to prevent resistance build-up was of particular concern. For example, certain product label requirements needed to be changed and this was duly done over the course of the year. In particular the protection of the highly effective diamide chemistries is of prime importance and growers and the trade were encouraged to adhere to the guidelines. As eldana was increasingly evident in young ratooning cane, this aspect also came under discussion and the necessity to be able to spray legally at the first sign of eldana. In all matters relating to product registrations, SASRI maintains a very close relationship with the Registrar to ensure that all agrochemical products are used safely and effectively.

SMUT AND MOSAIC

These diseases continue to remain at low levels across the industry. Surveys in commercial fields were not as extensive as previous seasons due to the pressure to carry out more eldana surveys. A total of approximately 34 000 hectares was surveyed, of which 900 hectares was above the local hazard level. Of these hazard fields, 70% were due to high smut levels, requiring remedial action; either roguing or plough out. Of the balance, action was required for high mosaic levels as well as illegal varieties such as NCo310 and 376. Issues of concern included the apparent increase in smut in the popular variety N41, resulting in SASRI sending out a cautionary note to growers.

RSD

Of the 6 100 RSD samples taken from commercial cane, 5% were found to be infected. This was lower than the average infection found in previous seasons which has risen as high as 10%. The disease is more prevalent in the irrigated northern regions but with more frequent and wider testing in the southern rainfed regions, particularly the midlands areas, the disease is being detected there as well. Compulsory testing of all seedcane fields has largely prevented any infected seedcane being planted out and this requirement should contribute to an overall reduction in RSD as seedcane sources are improved over time.

SEEDCANE

Due to the drought there was a general shortage of seedcane across the industry. Most areas had to source emergency seedcane to supplement their requirements. Although the situation improved later in the year, the overall shortage of good quality seedcane needs to be addressed. It was therefore fitting that seedcane was one of the key focus areas during the annual LPD&VCCs Chairman's meeting. Committees were challenged to ensure all commercial planted seedcane are either LPD&VCC Certified or Approved within the next eight years, as per the requirements in the LPD&VCC Rules.

OTHER PESTS AND DISEASES

Orange rust (*Puccinia kuehnii*) was detected in a spore trap in the Lowveld, possibly indicating the arrival of this serious fungal disease of sugarcane. Biosecurity teams were alerted and suspicious symptoms were reported and examined. However, to date, the disease has not manifested in any cane. To facilitate control if it should arrive, a fungicide has been registered for control of orange rust and South African varieties are being tested in environments where orange rust is prevalent in order to rate their disease susceptibility .

An incursion of fall armyworm (*Spodoptera frugiperda*) hit southern Africa during the reporting period. This pest was particularly devastating on maize, as well as other crops and vegetables. However, despite the pest having been reported on sugarcane in other countries, it was clear that it did not favour sugarcane as a host. This was evident by instances where maize and sugarcane were growing adjacent to one another, and the sugarcane remained unaffected whilst severe damage was observed on the maize. As a precaution should the crop be attacked, chemistries have been registered for control of fall armyworm on sugarcane. Biosecurity inspection teams were trained in the identification of the pest, and reported numerous incursions on other crops during their surveys.

Yellow sugarcane aphid (*Sipha flava*) once again proved particularly troublesome and persistent in some areas. Despite growers spraying these infestations with registered insecticides, often repeatedly, the pest proved difficult to control and caused serious yield losses in some instances.

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. Frequent contact was maintained with sugarcane estates in the SADC region on a number of biosecurity related issues. Training and research form a part of this contact but the informal exchange of information on a range of threats common to the region such as fall armyworm and yellow sugarcane aphid also contributes to an effective regional communication network. This network was formalised in the form of an agreement by all parties to contribute to a database of all known threats, their relative severity, the possibility of spread as well as common control methods being employed.

Extension

Extension is currently delivered to growers under three models:

SASRI delivers a regionally based Extension service to large–scale growers in 12 of the 14 mill areas in the industry. Growers are levied for this service which 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 which 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 are often used as a platform for SASRI Specialists to present the results of their latest research enabling growers to better understand and implement these technologies. Regular newsletters and updates are also provided electronically to growers. Valuable technical support is given to the many local grower structures operating in the industry, for example Local Pest Disease and Variety Control Committees, Environment Committees, local farmer associations and mill group boards.

A private Extension service is delivered to growers by the local milling companies in the UCL and Malelane cane supply areas.

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, the SASRI sugarcane Extension Specialists ensure that the problem is addressed either by themselves or together with a SASRI research specialist. 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 performed by Extension Specialists is to identify and gather specific research needs in their respective areas. This is enabled through locally elected RD&E Committees (RD&E) 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. In May 2016, an RD&E workshop was held in Mpumalanga to gather specific needs from the irrigated regions. This led to the inclusion of a number of new research projects which will benefit these regions specifically, for example, the risk of spreading disease through mechanical harvesting and the benefits of the integration of other crops in the cropping cycle for improved soil health, disease control and improved farm sustainability. The trial planting of cotton in the Pongola region is an example of how the sugarcane cropping cycle could be better utilised to sustain farm viability.

In March 2017, it was the turn of the rainfed regions to hold their RD&E workshop, alternating annually with the irrigated regions. High on the list of needs at this meeting was the need for research into the longhorn beetle incursion. This was duly addressed through a fast-tracked research proposal comprised of both short-term containment research needs as well as a longer term basic research programme.

MITIGATING THE EFFECTS OF DROUGHT

The prolonged drought of the preceding two seasons eased somewhat this year in the KZN region. However in the irrigated northern regions, low river and dam levels resulted in water supplies being under extreme pressure. With very little rain to ease the situation, growers had to resort to extreme measures. Water was prioritised and often other crops were favoured over sugarcane. There was also some crop mortality. Aggravating the situation was the lack of seedcane necessitating the use of emergency planting material where this could be found.

In the Pongola region where SASRI Extension was present, grower days and other communications helped growers develop an effective strategy to cope with the effects of the lack of irrigation water. Extension was involved in irrigation scheduling trials to demonstrate the benefits of careful water management. Irrigation systems such as drip, where water can be applied accurately and with minimum losses, showed the yield benefits which could be attained by investing in these systems. This could well spark a move to more water-efficient systems by growers in the future.

A carry-over effect of the drought in all areas was an increase in the levels of eldana. Extension was called upon to guide

LPD&VCCs in strategies to contain this threat. For the first time in many years, eldana was an important factor in cane growing in the irrigated north. Every effort was made to ensure that no infested cane was left over at the end of the season and generally no spraying was required.

In the KZN coastal and midlands regions however, careful management of carryover cane had to be implemented. Extension was instrumental in ensuring the guidelines around spraying of cane were followed and, to this end, the Umzimkulu, midlands south and midlands north, all had their temporary eldana rules extended for a further year.

Fortunately, widespread ratoon failure was not the norm during the recent droughts and whilst certain fields did suffer stool mortality, enough rain fell at critical times to prevent widespread damage. The droughts did however prove once again the resilience of certain varieties, particularly N12 in coping with dry conditions. The recently released varieties N52, N54, N57, N58 and N59 also showed signs of tolerance of dry conditions and these could prove popular going forward.

CANE QUALITY

Although there was some relief from the drought in the southern rainfed regions, the rainfall patterns generally were erratic. Following a dry start to the season in April, many areas had well above average rainfall in May and then again in July. These unseasonal conditions affected cane quality by lowering sucrose and purity levels whereas other negative factors such as ash levels increased due to the wet conditions. A wet spring was then followed by a relatively dry early summer. Extension was often called on to give advice on cane quality issues to growers under these variable conditions. To this end, the Pur*Est*™ app was put to good use in assessing the relative maturity of cane and to provide advice on the need for ripening. A number of grower days were held across the industry to introduce this app and all Extension Specialists were equipped with refractometers to enable testing of sugarcane.

VARIETIES AND SEEDCANE

The promotion of new SASRI varieties remained a high priority with Extension. Being one of the most common questions from growers, variety choice is becoming increasingly complex with a wider range of varieties available. This year N60 and N61 were released to growers in rainfed areas. These added to the recently released N57 (irrigated), N58 and N59. These varieties are enjoying some success, particularly N57 in the irrigated areas, where it has come through the recent dry spell still performing well.

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 have been established in most Extension areas and from them Extension is able 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. Eight such grower days were held this year. They also served to answer long-standing questions such the ratoonability of new varieties and the performance of varieties under green cane harvesting.

Ensuring adequate seedcane supplies was 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 such as in recent seasons. Extension and Biosecurity staff have made considerable contributions to the establishment of seedcane schemes in areas where before there were none such as Pongola, north coast and midlands north. In addition to established schemes in the Felixton, Amatikulu and Sezela areas, these new schemes will soon bolster seedcane supplies in these areas and provide an effective means of introducing new varieties.

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 practicals on irrigation, land use planning, weed control and management. A new development this year was a modularised Senior Course which was presented to growers on the north coast. The success of this course held on one day per month over 10 months could provide an effective model for instances where growers cannot leave their farms for extended periods of time.

SUSFARMS® 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. Annual completion of a Progress Tracker is compulsory for all participating growers. The Collaboration has employed a full-time co-ordinator, supported by a farm planning technician and, together with Extension Specialists, work with growers to implement a process of continuous improvement on their farms. There has been some interest in SUSFARMS® from outside the midlands region and visits were made to other mill areas in order to promote the concept. Efforts were also made to integrate SUSFARMS® into the small-scale grower sector and a number of grower days were held to explore this possibility.

Extension Specialists are often called on to assist with the implementation of land use plans. This will involve the siting of key roads and waterways, as well as contour structures. Land use

plans are generated by the midlands Collaboration and SASRI has also produced a small number of plans during the year. Effective use is made of interns to do this work who, in so doing, gain new skills and work experience.

SOIL HEALTH AND CROP NUTRITION

Key success stories in the implementation of green cane harvesting on certain farms on the north coast, with subsequent favourable yield responses resulted in a resurgence of interest in this practice. Growers from other areas visited farms where green cane harvesting is practised with the aim of promoting wider adoption.

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 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.

PEST AND DISEASE CONTROL

In their support to LPP&VCCs, Extension Specialists help in guiding general pest and disease strategies in their areas. The threat of smut to the variety N41, for example, necessitated a campaign to raise awareness of the threat to this popular variety in the irrigated areas.

A large proportion of time however was spent on the management of eldana. This pest emerged as a particular threat to the midlands north region where it was barely found previously, except in a few eco-zones. In previous seasons, the midlands south region had faced similar increases in the spread and levels of the pest and reacted proactively by the introduction and promotion of targeted spraying programmes, guided by survey results and on-farm scouting. This proved very successful in that eldana levels generally remained under control during 2016 in this area. The midlands north LPD&VCC instituted a similar general awareness programme, accompanied by certain changes to their rules to incorporate spraying as a remedial operation. This generally was successful in that by the end of the season only few fields were found unsuitable for carry over to the following season. The role of Extension as technical advisors to LPD&VCCs has proved vital in all areas where eldana was a problem. Even in areas such as Pongola where eldana problems are largely unknown, Extension had to assist individual growers identify specific problems, and the LPD&VCC with strategy in dealing with infested fields.

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.

Extension also responded to calls to identify outbreaks of African armyworm, and to confirm the presence of fall armyworm where it occurred on crops such as maize.

Conditions were favourable at times for the development and spread of both brown and tawny rust. Extension was called upon to advise on the need for spraying.

THE EXTENSION VENTURE AGREEMENT

SASRI and the Department of Agriculture and Rural Development have an Extension Venture Agreement (EVA) which has been in place since 1996. The most recent renewal of the agreement was in 2015, for a five-year period. 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, effective Extension is achieved.

Under the EVA, SASRI employs five sugarcane Extension Specialists, jointly funded by SASRI and DARD, to provide support to DARD Extension staff working with small-scale and land reform sugarcane growers farming in KwaZulu-Natal. This support provides for assistance 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.

The 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 sector, regional levy-paid Extension also provides support and advice and under the SASRI umbrella, Extension is managed and deployed regionally as a unified team. In so doing, the EVA has access to an even wider range of advice and support. An excellent example this year 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.

Another highly successful programme within EVA has been the establishment of demonstration plots. Having been in place for a number of years in the Noodsberg area, these plots not only create a farming classroom for growers, but have also enabled seedcane of new SASRI varieties to be distributed and propagated in these areas. These 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.

During the course of 2016, there was some recovery from the recent crippling droughts and this created a natural focus for Extension work, assisting growers to get back into full production. In this regard, funds have been approved to enable the planting of some 80 demonstration plots across KZN during 2017 and 2018. These will contribute significantly to the availability of good quality seedcane in the coming years.

SUSFARMS® was promoted amongst small-scale growers during the year. There has been some work in this direction to adapt SUSFARMS® to the small-scale farming environment, there being merit to its use as a guide to better management practices (BMPs) as well as its use as a monitoring tool.

In April 2016/17, the area under cane for small-scale growers was 36 418 hectares, a reduction of 2 899 hectares from the previous year, continuing a concerning long-term trend of land going out of production in the small-scale grower sector. In this regard, there was an urgent need to halt the reduction in area under cane and to ensure the sustainability of small-scale growers. Key areas where growers needed assistance in order to remain viable were identified and Extension activities tailored to address these. Drought mitigation and recovery from drought were obvious areas of attention but in addition planting, varieties, seedcane, soil sampling, crop nutrition and weed control were also common subjects addressed during grower days, modular courses and individual farm visits.

Where small-scale grower development projects were undertaken, the EVA staff were able to contribute significantly to the technical input required. Attendance at local grower structure and co-operative meetings also formed an important part of the EVA programme of work. Through the platforms these structures provide, 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 the one of the primary goals of the EVA programme. The DARD staff involved in the EVA programme have on the whole adopted sugarcane Extension as an important component of their work programmes. Close co-operation and effective communication between the EVA partners has resulted in a highly effective Extension service being maintained.

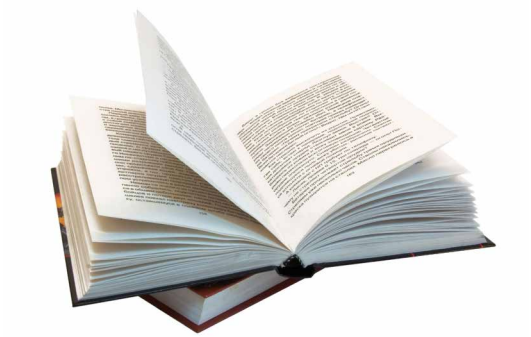
TECHNOLOGY DEVELOPMENT & KNOWLEDGE EXCHANGE

Michelle Binedell
(Knowledge Manager)

Publications effectively communicated existing and new best practice to industry stakeholders in an effort to support their uptake!

Technology development and knowledge exchange aims to move innovative research results into the marketplace so that adoption of technologies and best practice may 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.

PUBLICATIONS



During the 2016/17 year, three editions of *The Link* and *Ingede* magazines, aimed at our English/Afrikaans and isiZulu speaking growers, were published. These 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.

The Link

Soil sustainability remained one of the main subjects that were addressed. Articles covered lime and gypsum application, managing salt problems, a new 'potassium reserve' test offered by the FAS Agricultural Laboratory as well as advice on managing compaction and crusting of soils.

2017 saw the release of three new varieties N63, N64 and N65 which hold much promise for the industry. In an article on pest and disease resistance, growers were reminded that varieties are only released if they demonstrate improved yields, with superior pest and disease resistance profiles under the prevailing conditions.

Articles on eldana control continued to raise attention of this persistent pest and, newly registered products, guidelines and recommendations were provided for its control. An equalling threatening pest, the stalk borer Chilo, remained a potential threat to the industry. An in-depth article on SASRI's biosecurity early-warning monitoring strategy featured in the January 2017 edition.

Readers were also alerted to the risks associated with a potentially damaging disease that has yet to reach our industry – Orange Rust. Spores were detected on a spore trap located on the SASRI Research Station at Komatipoort. While the disease has yet to be found on sugarcane in South Africa, the rust identification chart provided a pictorial method to distinguish the differences between orange rust and the two other rusts found in our industry – brown and tawny rust.

For the first time ever, an article in the January 2017 edition of *The Link* publicised the significant damage brought about by the longhorn beetle in Entumeni. In this article, recommendations for the eradication of cane stools were provided and assistance was sought from growers to be on the lookout for damage symptoms.

On the technology front, SASRI's first ever smartphone app, Pur*Est*™, was launched in 2016. Aptly titled "App-ropriate ripening", the article explained how the mobile app can assist with ripener decision-making based on measurements of Brix% in sugarcane stalks.

The Ingede

The *Ingede* focussed 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 once again given to the management and control of weeds, in particular, Parthenium. This weed has had a devastating impact on arable land and is difficult to control.

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 and the choice of the most appropriate varieties.

The Longhorn Beetle damage in the Entumeni area was also highlighted in the January 2017 edition of the *Ingede* and growers were urged to be on the lookout for symptoms on their farms.

Other newsletters and articles

Over the year, SASRI published five articles in the *South African Sugar Journal* and eleven articles in *Coastal News,* once again showcasing SASRI's achievements and promoting best practice.

Annual updates of the Herbicide Guide and Mechanisation Reports were completed and one video was updated.

Seven new Marketing Flyers were produced to promote SASRI products and services.

An edition of the electronic newsletter "*Die Laeveld Insig*" was produced in both English and Afrikaans.

A new electronic newsletter for the Fertiliser Advisory Service was launched in 2016/17 to highlight the latest FAS services available to growers.

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 twenty-nine information sheets were published containing new and updated information on varieties, pests, diseases and good production practices.

RADIO

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

During 2016/17, 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.

GROWER INTERACTION

Significant face-to-face interaction with industry stakeholders in 2016/17 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 1700 visits to growers, hosted 115 grower days and exhibitions and were involved in 370 conferences, workshops, refresher courses, seminars and demonstrations. SASRI also hosted 1135 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 2016/17. SASRI responded to this demand again by delivering two three-week Junior Certificate Courses in Sugarcane Agriculture in April and October 2016. A total of 98 students attended the Junior Courses, 79% from South Africa and the balance from Zambia, Malawi, Swaziland, Tanzania and Sudan.

Two Senior Certificate Courses, which are aimed at tertiary-level students, were held in June 2016 and February 2017 with 124 students attending. Over 76% of students were South African applicants, while the balance of students were from Malawi, Swaziland, Zambia, Mozambique, Tanzania, Nigeria, Zimbabwe and China.

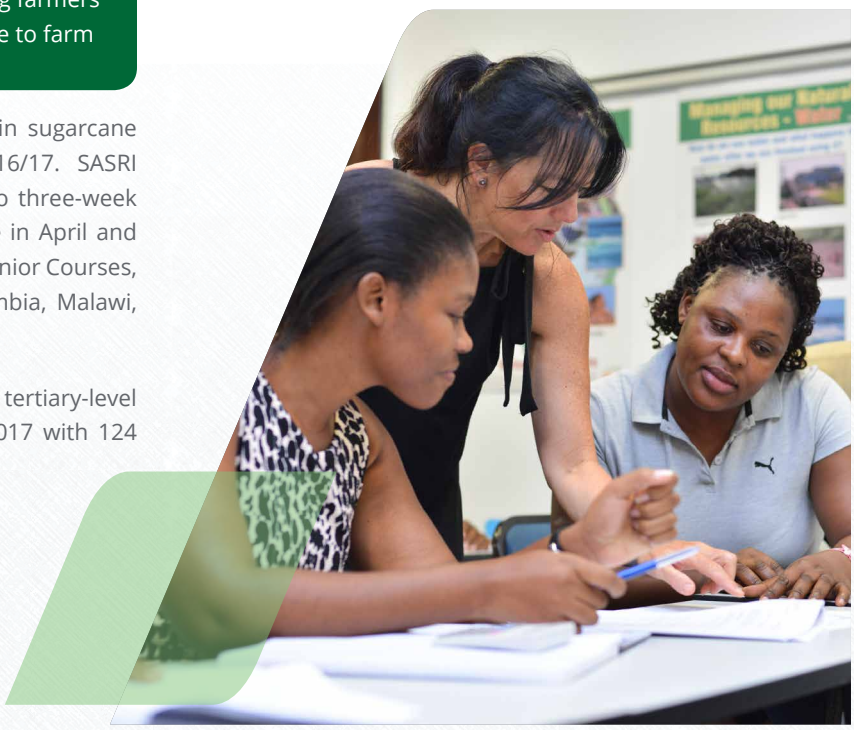
INFOPACK CD

One of the most valuable resources produced by SASRI is the InfoPack CD which contains a 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 2017 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: 2016 Stakeholder Issues.* This contained SASRI's response to 41 industry issues raised at the RD&E AGM of 2016.
- The newly updated isiZulu video: *Tin and String Application of Fertiliser.*
- All new and updated *Information Sheets* published over the past year.

Throughout 2016/17, staff at SASRI have been committed to transferring both new research outcomes as well as established, "back-to-basics" practices that have been shown to benefit the industry. Relevant and appropriate technology transfer mechanisms have been chosen to achieve this, including now the use of smartphone applications. Throughout the coming year, SASRI will continue to explore new tools and new communication technologies that will be effective in addressing a diversity of stakeholders and their needs.



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