SASRI

SOUTH AFRICAN SUGARCANE RESEARCH INSTITUTE

1925 - 2015

Unlocking the potential of sugarcane

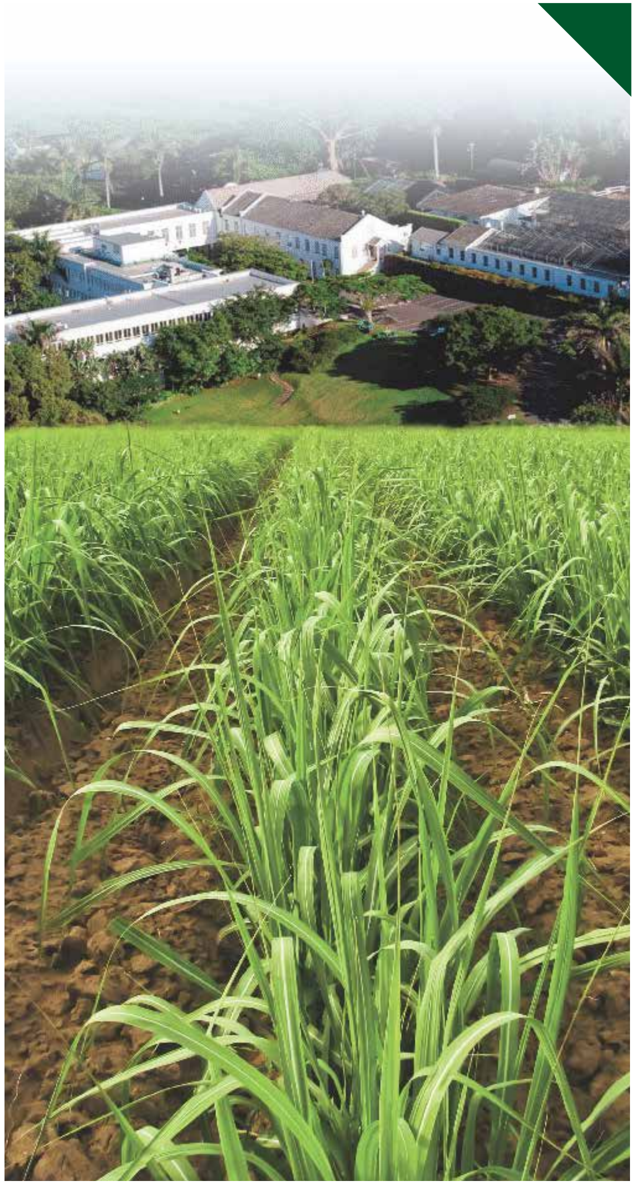
2015/16

South African Sugarcane Research Institute

PROGRESS REPORT

CONTENTS

SRASA* COMMITTEE AND SASRI MANAGEMENT



*Sugarcane Research & Sustainable Agriculture Committee
(at 31 March 2016)

Chairman GD Stainbank
Vice-Chairman PW Russell

GROWERS Representatives

KM Hurly
TJ Murray
F Potgieter
A Russell
S Sharma
R Talmage
TB Funke *(alternate)*
DDP Littley *(alternate)*
S Mashaba *(alternate)*
ST Naidoo *(alternate)*
W Visser *(alternate)*

MILLERS Representatives

EA Brüggemann
N Dlodlo
FM Eggers
AJ Harris
SS Munsamy
DP Rossler
D Singh
D van Rooy
JPM de Robillard *(alternate)*
JDP Erasmus *(alternate)*
RB Lütge *(alternate)*
D Sutherland *(alternate)*
AT Wynne *(alternative)*

SASA Representatives

CM Baker
M Govender
P Mpofu
R Stranack
MK Trikam
DA Watt
AJ van der Nest *(Secretary)*

Sasri Management Team 2015 - 16
(at 31 March 2016)

Executive Committee

Director: CM Baker
Research Manager: DA Watt
Operations Manager: KA Redshaw
Finance and Admin Manager: AJ Van Der Nest
Human Resources Manager: C Botes

Programme Managers

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

Resource Managers

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

CHAIRMAN'S REPORT

Graeme Stainbank

As its name suggests, SASRI's key strategic objectives revolve around research. Foremost, and the one which consumes the majority of the budget, is the development of new varieties. Complimenting new varieties, are the associated specialist services of nutrition, agronomy, engineering and pest and disease practices - all of which add value to the industry stakeholders. High calibre and consistent research also yields innovation. Novelty is critical to survival in our changing world.

New ideas and technology are however worthless if they remain as such. Transferring this knowledge to stakeholders, and ensuring the successful implementation thereof, is critical. Providing the extension service with the appropriate tools to ensure this deliverable, is critical. The constant enhancement of accessibility to resources, optimises this service.

The great challenge facing the institution, is to balance the programme of work between long-term research, and the generation and implementation of new ideas. This is the unenviable task facing firstly the RD&E committees, and then the SRASA committee.

The complexities of the sugarcane plant has meant that long-term research has, to date, not yielded the same step change in yield output, seen in so many other commodity crops. This makes it extremely tempting, in deciding the programme of work, to focus on low risk short-term gains, at the expense of long-term outcome research which has little or no guarantee. We cannot afford to do this if we want to hand on a sustainable industry to the next generation.

Recent developments in the chemical control of eldana have many believing that a panacea may have been found. Results have been extremely promising and, apart from the drastic reduction in losses, could potentially see the ageing of cane in the coastal areas once again.

We however all know that nature evolves constantly, and that there are no "silver bullets" in nature. This pest will be no different. To be complacent now, would be our downfall. We need to encourage the focus on the holistic integrated pest management (IPM) principles, whilst still constantly striving to generate and implement new ideas.

We are on the brink of starting the long road to GM (genetically modified) cane, perhaps our best chance of bringing ground breaking innovation to our research programme. This, together with Sterile Insect Technology, could well reverse the damage caused by eldana and ensure a long-term solution going forward.

However, as the GM business model so effectively illustrates, slow uptake and implementation of new ideas, drastically affects the viability of expensive new ideas. We need to find ways of ensuring better adoption of key outcomes and recommendations, using SUSFARMS® as the base management tool.

The traditional cane breeding programme continues to yield positive results with some exciting new varieties currently being bulked up. Initial studies have shown remarkable returns on investment, where new varieties have been adopted. The NovaCane® programme will play a critical role in the efficient supply and roll out of both traditional and GM modified varieties.

Human capital is what makes SASRI. Attracting, developing and retraining the highest calibre of people, is critical to our success. If we want to make sure that we maintain our status as a world class leader in sugarcane research and technology, we need to look after our most valuable assets. Maintaining a positive environment will create the space for constant and continuous improvement, which is essential to our sustainability going forward.

I believe that SASRI's business has been cost effectively managed and that good governance has prevailed in all aspects of the business. I would like to thank the leadership for their commitment and expertise, which has ensured this, and to all staff for delivering the mandated service to the industry during these testing times. Tough times never last, tough people (and organisations!) do.

Going forward, I believe we need to broaden our horizons and explore the untapped opportunities facing us in other African countries, and use these to increase our customer base and revenue. As leaders we now need to be bold, and to take the next big step to GM.

DIRECTOR'S REPORT

Dr. Carolyn Baker

In a year that was dominated by one of the most severe droughts experienced by the sugar industry, SASRI was under considerable pressure to deliver advice, technology and solutions that would assist in alleviating the impact of the drought on farming operations. Further, the ever-increasing pressure to demonstrate its value meant that SASRI adopted an even more stringent approach towards selecting and approving projects that were aligned with its newly proposed strategic plan. This plan that was devised in conjunction with SRASA Committee representatives, emphasised the significance of delivery of relevant technology to growers, and SASRI's role in facilitating implementation of innovative solutions to sustain the industry. Although not yet approved by SASA Council, the plan served as an overall guide for SASRI's 2015/2016 Programme of Work.

Drought induced focus on biosecurity

Associated with the drought, the spread of eldana became a real threat and considerable effort went into minimising its impact on the industry. New remedial measures for containing eldana were published in the Government Gazette in September 2015 that made provision for the use of an insecticide spray to contain eldana levels and enable carryover. In association with this practice, and to enable carryover, temporary rules that allowed for elevated hazard rules were approved for the Midlands and South Coast. With the registration of a suite of new generation insecticides with varying modes of action, an Insect Resistance Action Committee (IRAC) compliant spray programme to reduce the likelihood of resistance build-up was advocated. This programme was used according to recommendations and served to effectively control eldana numbers and contain spread. Nevertheless the continuing drought has exacerbated the eldana problem in the industry. Early indications are that despite the very successful spray programme, the pest has spread more widely in the Midlands and to those areas that previously had been free of infestation.

In view of the more widespread use of insecticides, special emphasis on the importance of sustaining an IPM approach to pest and disease control was encouraged and considerable interest in developing and deploying Sterile Insect Technology (SIT) was shown. This technology that relies on the release of vast quantities of sterilised insects has been successfully used in the citrus industry to contain their number one pest, false codling moth. SASRI was granted significant funding from the NRF's National Equipment Programme to acquire an irradiator for installation at Mount Edgecombe to enable implementation of a pilot project to test the efficacy of SIT in eldana. However, prevailing austerity measures in the industry, prevented the allocation of the requisite funding for the full project. Discussions are ongoing with potential SIT partners to secure the funding and progress the project in the longer term.

Coincident with the widespread drought in the country, the perception that cane is an easy, fast growing, and hardy crop generated significant interest in cultivating sugarcane for cattle fodder. In view of the potential biosecurity threat that scattered plantings outside the sugar industry may pose, the best way to monitor and manage this matter is under consideration.

The year was marked by the integration of the local pest, disease and variety control functions back into SASRI. Compliance with the provisions in the Sugar Industry Agreement, 2000 requires that SASA be responsible for the pest and disease (P&D) function in the industry, and resulted in considerable expansion in SASRI's complement. Existing P&D employees became SASRI employees, all falling under the umbrella of Extension and Biosecurity, but still based in their respective control areas. Specific value in this integrated service was clearly demonstrated during the course of the year when several P&D survey teams from the northern irrigated areas were deployed further south in the industry to conduct intensive eldana surveys. This level of co-operation and mutual support could only have happened in an integrated industry-wide service.

Investing in new technology

Recognising the specific value of producing NovaCane® plants for the final stages of the plant breeding programme at SASRI, the Committee approved construction of a facility at Mount Edgecombe, capable of producing a maximum of 340 000 tissue cultured plants. Building began in September 2015 and was completed at the end of March 2016. Once fully equipped it is envisaged that the laboratory will begin producing its first batch of plants in late 2016.

During the course of the year further interest in deployment of a GM commercialisation programme at SASRI was shown, culminating in a request for a comprehensive feasibility report. This report will be compiled and presented to the Committee in the course of 2016. In the interim, discussions regarding research into several pre-commercialisation components required for consideration of release of an insect resistant GM sugarcane variety were held with Biosafety SA. This led to the successful award of funds for three key projects that will be conducted in conjunction with collaborating institutions: (a) a socio-economic impact assessment; (b) Bt efficacy studies; and (c) aspects associated with environmental risk.

The need for a user-friendly and simple method to determine juice purities to aid in decision-making regarding application of crop ripeners, resulted in the development of Pur*Est™*. This simple spreadsheet-based tool enables growers to make convenient and more informed ripening and harvesting decisions based on crop maturity and not simply through visual assessment. Plans for developing a mobile application for use on smartphones and tablets is underway and will be released in 2016.

In the Fertiliser Advisory Service (FAS), work to implement a laboratory information system (LIMS) to increase laboratory efficiencies and enhance sample throughput commenced. In addition, further research into nutrition and soil health has contributed to the development of a soil health index that will be incorporated into the FAS analytical package. It is this close relationship between the crop nutrition and soils research group at SASRI and the FAS that enables the requisite valuable input required to support continuous improvement of all recommendations that emerge from the FAS.

Demonstrating value

An investigation into the specific value that SASRI varieties deliver to the industry was conducted in conjunction with CANEGROWERS and in collaboration with two milling companies with comprehensive field records and production data for several of their estates. The value conferred by the SASRI variety development programme was confirmed as the analyses reflected a very favourable return on investment per hectare on a mill area level when newer varieties were adopted.

In 2015, three new varieties were gazetted for release: N60 for the southern irrigated regions and N61 and N62 for the 20-24 month harvest cycle regions in the hinterland.

Progressing partnerships and leveraging funds

In conjunction with our collaboration partners (University of Stellenbosch, Biosafety SA), SASRI was able to leverage funding from the DST's Bioinformatics and Functional Genomics Programme, the DST Technology Innovation Agency and the NRF's THRIP programme. Amounting to support of R12.2 million over a period of three years, it is obvious that maintaining these collaborations is paramount in contributing to the sustainability of SASRI's research programmes.

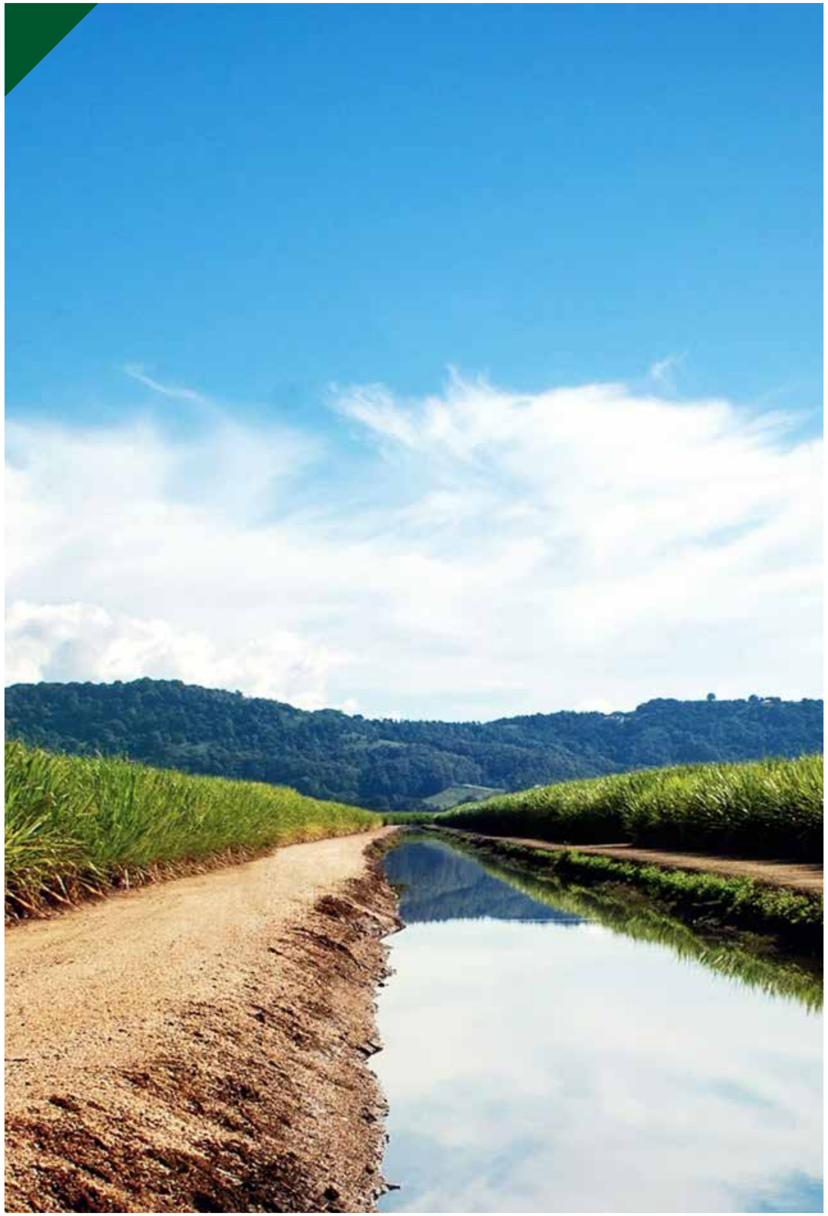
At the University of KwaZulu-Natal (UKZN), progress was made in appointing a new Chair in Crop Science (the SASA Chair). Professor Hussein Shimelis, previously an Associate Professor in the African Centre for Crop Improvement at UKZN, has considerable expertise in Plant Breeding and his appointment will likely lead to valuable collaboration with the university.

Improving efficiencies

In an attempt to streamline committee functions, SASA embarked on a process of consolidating its committees during the course of 2015. Incorporation of the P&D function into SASRI provided an ideal opportunity to integrate the work of the previous Pest, Disease and Variety Control Steering Committee into that of the SASRI Committee. Recognising the need to ensure alignment between the research endeavours at SASRI and the technical work conducted under the watchful eye of the Natural Resources Committee, a new Committee, the Sugarcane Research and Sustainable Agriculture Committee (SRASA) was approved by SASA Council at the beginning of 2016.

Looking ahead

Production of new and improved varieties is just one of the key factors that contribute to the sustainability of the sugar industry. It is also the suite of agronomic recommendations based on rigorous scientific evidence that enable good management of the sugarcane crop, and that are essential for industry productivity. At SASRI the diverse range of specialists and scientists working in inter-disciplinary teams are vital to these achievements, and their focus and dedication throughout the year is fully acknowledged. This annual Progress Report provides ample evidence of their productivity and commitment.



OVERVIEW OF SASRI RESEARCH

Dr. Derek Watt

Research Goals

The research, development and innovation (RDI) programme has four primary objectives: (a) to develop and deliver new sugarcane varieties providing increased economic returns for all sectors of the industry; (b) to undertake research and provide specialist services that advance nutritional, agronomic and engineering practices and pest and disease control measures; (c) to generate new ideas with the potential to enlarge the scope of sugarcane agriculture and sustain the industry into the future; and (d) to transform tacit knowledge and research outcomes into explicit knowledge and technology products.

Research Programmes

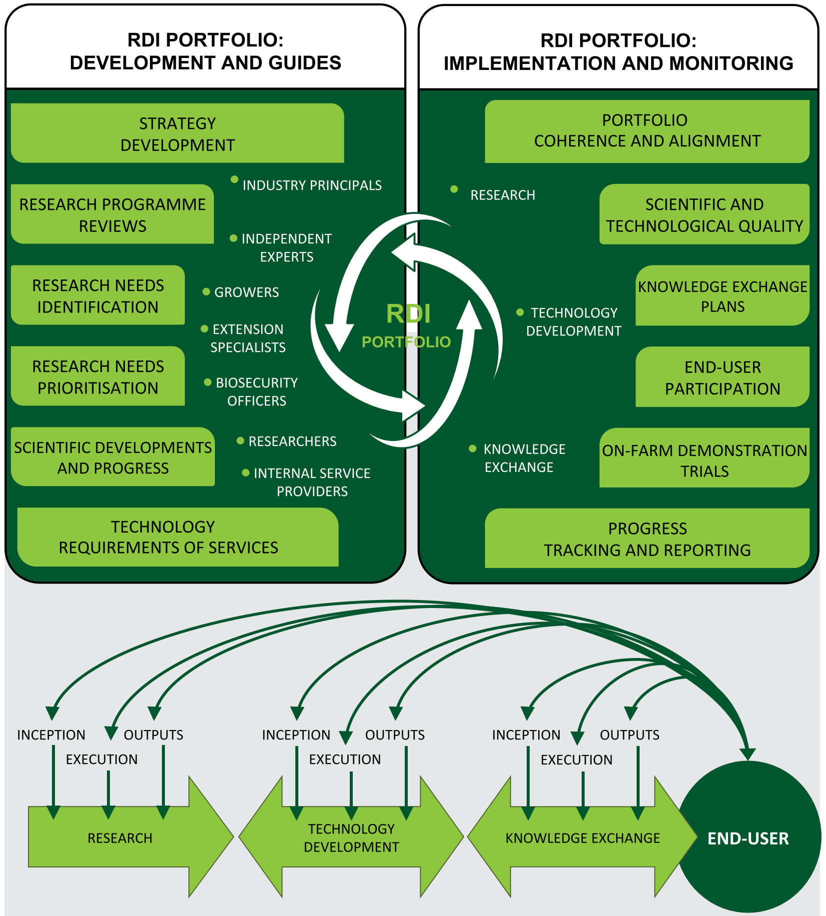
To achieve these objectives, SASRI: (a) maintains a differentiated portfolio of research, technology development and knowledge exchange projects that are managed within four research programmes (Variety Improvement, Systems Design and Optimisation, Crop Protection and Crop Performance and Management) and the Knowledge Management Unit, which is a SASRI unit that functionally bridges the research and extension environments to promote the research-knowledge-extension continuum necessary for effective knowledge exchange with stakeholders; and (b) ensures close alignment amongst research and technology development activities, knowledge management and extension services.

THE RDI PROGRAMME IS CONDUCTED ACROSS FOUR PROGRAMMES

Programme	OBJECTIVE
Variety Improvement	To conduct research and implement strategies for the continual release of new varieties that add value and enhance productivity.
Systems Design and Optimisation	To design and improve farming systems that account for the economic, social and environmental issues that impact on the sustainability of sugarcane production.
Crop Protection	To minimise the effects of disease, weeds, nematodes and insect pests on crop production in a sustainable manner.
Crop Performance and Management	To develop new and fine-tune existing crop management practices to enhance the economic and environmental sustainability of sugarcane production.

Drivers of Innovation

The RDI programme provides agro-technical solutions to growers that are tailored according to key industry features, including challenging growing conditions, pest and disease pressures and biosecurity incursion threats. Layered over this are escalating input costs, which necessitates that SASRI's agro-technical solutions enable growers to improve the bottom line of their farming enterprises. Hence, it is imperative that innovations not only address the bottom line of grower businesses but also the triple bottom line of the industry, in which social and environmental issues are addressed along with the financial.



The research, technology development and knowledge exchange continuum in partnership with end-user

RDI Model

Mechanisms to facilitate the relevance and promote stakeholder ownership of the programme are implemented at two levels, viz. project portfolio composition and individual project planning. The RDI model has been developed to ensure that both the portfolio and the individual projects composing it deliver innovations that: (a) enable growers to enhance the sustainability of their farms; (b) minimise current and potential future threats to industry sustainability; and (c) improve the quality of services provided by the institute to the industry.

RDI Framework

The scaffold for the RDI programme is provided by a five-year strategic plan developed by the SASRI oversight committee (Sugarcane Research and Sustainable Agriculture [SRASA] Committee) comprising grower and miller leaders (Industry Principals) elected by their peers. The plan is developed through an interactive workshopping process, usually facilitated by an independent third party. The plan describes key performance areas and associated strategic objectives and performance indicators against which SASRI performance is benchmarked. Importantly, the plan forms the platform upon which the SASRI annual RDI programme is constructed.

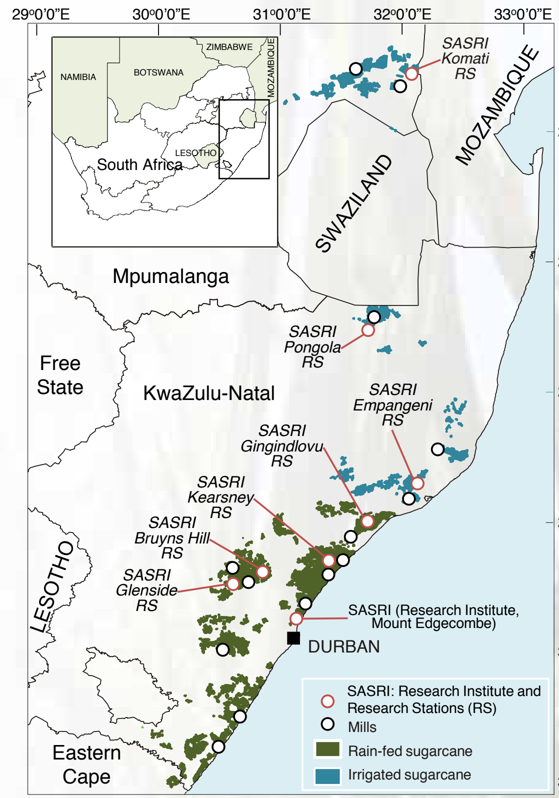
Participative Development

An essential feature of the RDI model is the participation, wherever possible, of the innovation end-user in the planning of the individual projects comprising the portfolio. Where this is not practicable, projects are designed through consultation with end-user representatives, particularly the SASRI Extension Services. Although the end-users are primarily members of the grower community, other innovations are specifically intended to meet the internal needs of SASRI to: (a) improve the quality of services provided to the industry e.g. the SASRI Fertiliser Advisory Service, SASA crop forecasting service; or (b) ensure that the science and technology deployed remains abreast of international sugarcane RDI developments.

The portfolio comprises projects that span the entire RDI value chain, from research to knowledge exchange. To ensure focus on the ultimate end-user, a knowledge exchange plan is mandatory for each project, in which the following are clearly articulated: (a) nature of intended research outputs (e.g. decision-support technologies, best management practices, laboratory procedures or methods); (b) target end-user (e.g. large- or small-scale growers, SASRI Extension Services); and (c) activities to facilitate knowledge exchange amongst the target end-users and SASRI specialists (e.g. on-farm demonstration trials, grower study groups, extension specialist training workshops). Where research is distant from immediate application, a retained focus on the end-user ensures that the research plan is designed to deliver a usable product.

The mechanism to enable participation by industry role-players, particularly growers, in the identification of issues for potential entry into the RDI programme is well-established through the activities of ten regional Research, Development and Extension Committees which operate throughout the sugarcane growing belt. The committee members are drawn from the local grower and miller communities and the regional SASRI Extension and Biosecurity staff.

Representatives gather annually for an intensive workshop with SASRI management and specialists to identify, discuss and prioritise the key regional issues affecting sustainable sugarcane cultivation. The workshop outcome is a list of priority issues on which a deep mutual understanding amongst all stakeholders has been achieved. This list guides the RDI programme, both in the formulation of projects for entry into the annual portfolio and also in crafting the communication strategy for the year.



SUGARCANE GROWING REGIONS

Also shown are the locations of the fourteen mills ( ) and eight research sites operated by SASRI ( ) in relation to the irrigated ( ) and rainfed ( ) sugarcane growing regions

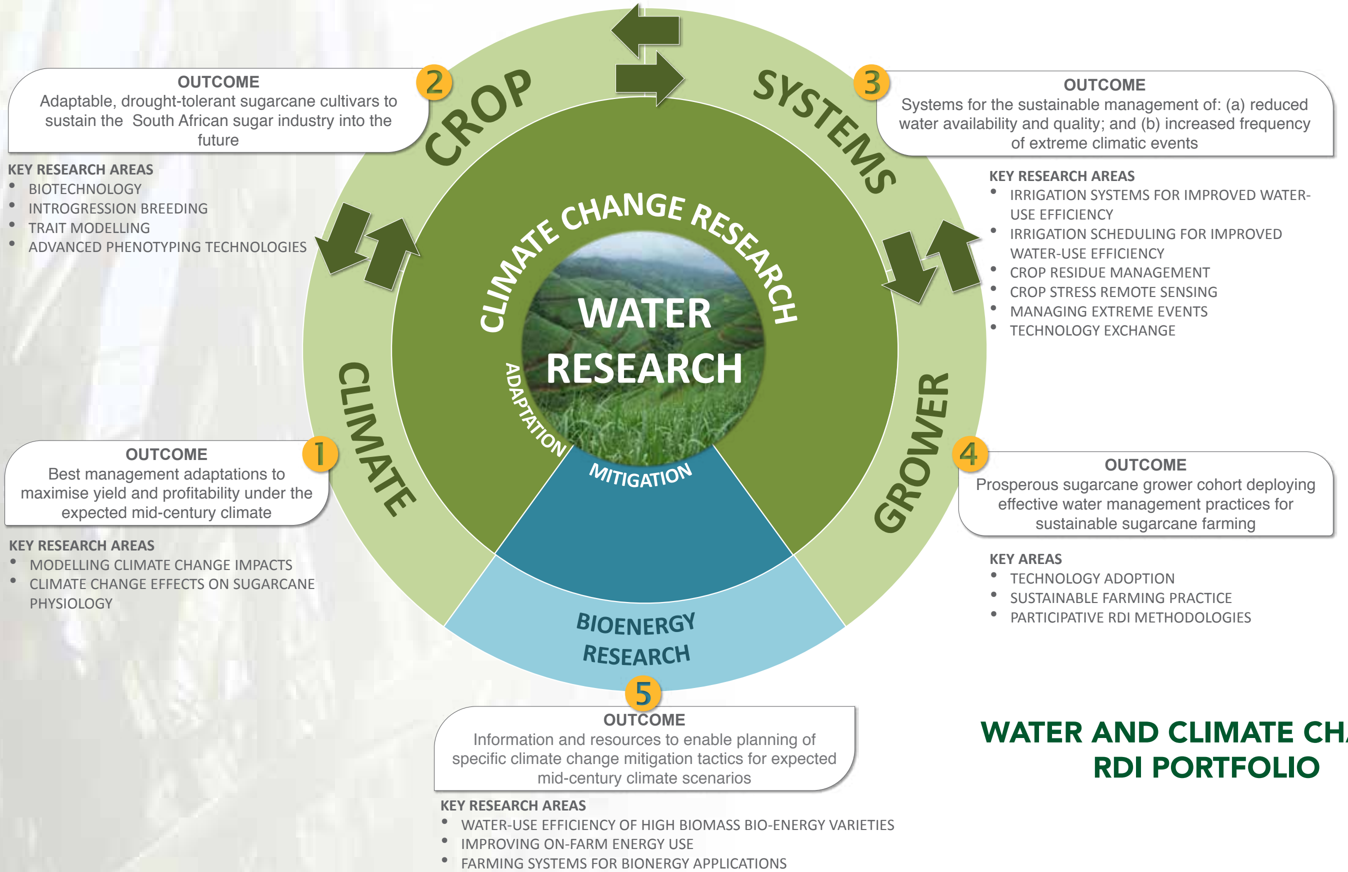
Drought – A Key 2015/2016 Issue

Rainfall well below long-term averages persisted across most regions of the industry during 2015/2016, causing widespread and deep concern amongst all sectors of the industry. Providing growers with resources and tools to increase the resilience of their sugarcane crops under such challenging conditions is a major focus of the RDI programme.

The RDI portfolio addressing water- and drought-related issues integrates with climate change impacts modelling research and is strongly multidisciplinary encompassing sugarcane agricultural engineering, agronomy, breeding, biotechnology, crop physiology crop modelling, extension and knowledge management. The issues are also addressed across hierarchical scales, from modelling climate change impacts and the effects of potential adaptation tactics through to constructing knowledge of the socio-technical drivers underlying grower adoption of sustainable water best management practices.

Progress in 2015/2016

Progress within each of the four research programmes comprising the RDI programme is described in the sections that follow for the period of April 2015 to March 2016. Outcomes are presented for ongoing projects and for those which were finalised on or before 31 March 2016. In addition, the context, objectives and, where appropriate, preliminary progress, are provided for new projects that commenced on 1 April 2015.



WATER AND CLIMATE CHANGE RDI PORTFOLIO

CROP PROTECTION RESEARCH

Dr. Stuart Rutherford

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

To meet the objective of developing integrated management strategies for pests and disease management, research, development and innovation is conducted in five key research areas: (1) Biosecurity; (2) Pathogen and pest biology and ecology; (3) Resistance of sugarcane to pests and diseases; (4) Cultural and environmental practices to limit the negatives effects of pests and diseases; and (5) Agrochemicals to manage pests and diseases.

Biosecurity

Research in this Key Area focuses on: (a) Development of proactive threat-specific counter-measures and biosecurity incursions plans; (b) Generation of knowledge of the biology, pathogenicity and epidemiology of pathogens posing potential incursion threats to the industry, as well as the agro-ecology, behaviour and reproductive biology of new potential pests; and (c) Development of improved procedures and diagnostic technologies to ensure that varieties released or propagated into the industry, or imported via the industry Quarantine Facility, are free of pathogens and pests.

The information and knowledge gained in this Key Research Area are applied towards the development of Integrated Management tactics for potential new pathogen and pest incursions into the industry.

Biology and Ecology

Research in this Key Area focuses on: (a) Investigation of the biology and ecology of the primary pathogens, pests (including nematodes) and weeds of the industry with a view to the development of integrated management tactics and knowledge exchange with the grower community; and (b) Assessment of the impact on crop yield of the primary and emerging pathogens, pests (including nematodes) and weeds in the industry to facilitate grower decision-making with regard to the implementation of management tactics.

The information and knowledge gained in this Key Performance Area are applied to the development of integrated management tactics for the major pathogens, pests (including nematodes) and weeds in the industry.

Resistance

Research in this Key Area seeks to develop knowledge regarding the biological basis of sugarcane resistance to pathogens and pests (including nematodes) in order to develop approaches, resources and technologies to enhance resistance breeding in Commercial Breeding.

Cultural and Environmental Practices

Research in this Key Area seeks to develop cost-effective technologies that permit the establishment of sugarcane agro-ecological environments in which pathogens, pests (including nematodes) are suppressed to low levels by benign biological or ecological means.

Several complementary habitat management technologies are considered, including: (a) Push-pull technology; (b) Biodiversity management, including wetland, riparian zone and vegetation corridor restoration; (c) Crop husbandry, including crop rotation, use of fallow crops and crop residue management; (d) The Sterile Insect Technique; and (e) Parasitoid and entomo-pathogen release.

Agrochemicals

Investigations in this Key Research Area focus on the development of a suite of effective pathogen, pest (including nematodes) and weed control agents that are agriculturally, environmentally, ecologically and economically sustainable.

Research focuses on a series of technologies, including: (a) Development of pheromones to enable monitoring and rational agrochemical application programmes, primarily for eldana; (b) Search for more benign alternative chemistries; and (c) Development of superior application tactics and product formulations.

BIOSECURITY

Research seeks to generate knowledge to guide the development of integrated management tactics for potential new pathogen and pest incursions into the industry. Included is the development of pest and pathogen identity diagnostics and generation of knowledge on the pathogenicity and epidemiology of pathogens and the agro-ecology, behaviour and reproduction of pests. The knowledge gained is deployed in the development of pathogen- and pest-specific threat counter-measures and incursion plans.

Progress in Ongoing Research

Tawny rust: Description, biology and control

The primary objectives of research conducted in 2015/2016 were to: (a) describe and classify the new fungal pathogen causing tawny rust and to use molecular sequence data to place this rust within the Pucciniales in a phylogenetic context; (b) develop species-specific primers for a rapid DNA diagnostic assay to distinguish this rust from brown and orange rust; (c) identify conditions favouring the development of the disease for use as parameters in a rust risk model; (d) assess the susceptibility of released varieties, parental lines and progeny to the disease and quantify any effect on yield; and (e) obtain label extensions for tawny rust for the fungicides Abacus® and AmistarXtra®.

- *Molecular phylogenetics:* A chronogram based on DNA sequence data was developed for the Pucciniales. For the first time, the order has been grouped into distinct clades, which has raised some questions around the naming of the genera that fall within these clades, including *Puccinia fulva sp. nov.* (tawny rust). SASRI pathologists are currently seeking opinion on the results and implications of this study from experts in the field of rust taxonomy and phylogeny.
- *Specificity of diagnostics:* In the initial study, PCR primers were only tested against amplified *P. kuehnii* (orange rust) DNA, as no genomic DNA was available for this rust. Since then, the primers have been tested against new genomic *P. kuehnii* DNA received from Dr Kathy Braithwaite (Sugar Research Australia) and Dr Francisca Perera (Estación Experimental Agroindustrial Obispo Colombres, Argentina). The SASRI-developed primers were found not to amplify any product from those genomic DNA samples, confirming the specificity of the primers for *P. fulva sp. nov.*

Molecular phylogenetic studies revealed uncertainties regarding the classification of tawny rust and phylogenetic relationships amongst the fungi causing rust and a reliable molecular diagnostic test for tawny rust was developed.

Alternative method for RSD diagnosis

Detection of the bacterium that causes RSD (*Leifsonia xyli subsp. xyli* [Lxx]) on a large scale is based on serological assays such as evaporative-binding enzyme-linked immunoassay (EB-EIA), immuno-fluorescence microscopy (IFM) and phase contrast microscopy (PCM). These methods are time consuming and require well-equipped, sophisticated laboratories and hence, are unsuitable for use at remote, near-field sites. This research aims to develop a loop-mediated isothermal amplification (LAMP) assay which allows detection of Lxx in 30 min at 65°C, using xylem sap as the template. A positive reaction is detected using a lateral flow device (LFD). The assay requires minimal laboratory equipment and could be used at near-farm locations, thus saving time and money required to transfer samples from remote areas to the SASRI RSD diagnostic laboratory in Mount Edgecombe.

During 2015/2016, the LAMP-LFD method was shown to accurately differentiate between RSD-containing samples and those that were free of the bacterium. Under the same conditions, the other methods of detection were less accurate, with EB-EIA being the second most accurate, then PC and IFM. The discrepancies noted may be as a result of each methods' limit of detection, where low concentrations of RSD may result in false negatives. The overall results of this investigation revealed the robust nature of the LAMP-LFD method and further supports its potential use as a highly sensitive and accurate RSD detection technique that could be considered as a viable alternative for diagnostic RSD detection by SASRI in the future.

Good progress was made in the development of an alternative RSD diagnostic assay, although further investigation is required to assess suitability for near-to-field applications.

New Research

Mosaic transmission by YSA

Sipha flava (yellow sugarcane aphid [YSA]), a recently arrived insect pest of sugarcane in South Africa, has been reported by sugarcane pathologists in the USA to transmit a serious sugarcane pathogen, sugarcane mosaic virus (SCMV), although the evidence is not unequivocal. Knowledge of whether YSA transmits SCMV is required by South African sugarcane growers for decision-making and planning purposes, particularly in terms of the quantum of financial investment in management of the pest that is warranted. The novel, non-obvious information to be generated by this research will arise from examination of whether the YSA species that has recently invaded the South African sugar industry transmits endemic SCMV strains. The research methodology will comprise a series of highly organised and replicated glasshouse-based bioassays, followed by a structured programme of trials conducted on sugarcane plants grown in large volume pots.

Knowledge regarding the potential of YSA to spread SCMV is fundamental to grower decision-making regarding the extent of resources to commit to YSA control.

PATHOGEN AND PEST BIOLOGY AND ECOLOGY

Research seeks to develop knowledge of the biology and ecology of the primary pathogens and pests of sugarcane towards the development of integrated management systems and providing growers with information regarding their impacts as an aid to decision-making.

Outcomes of Completed Research

Sugarcane and pest chemical ecology

Significant progress was made in identifying plant and fungal volatiles to which eldana is responsive; information which forms the basis of ongoing research to develop an efficient trap for eldana population size monitoring. Evidence was obtained in support of the hypothesis that genotype has an influence on the attractiveness of sugarcane to parasitoids and responses to plant resistance inducers. Within the push-pull habitat management system, the ability of 'push' plants to influence eldana moth behaviour was confirmed.

Good progress was made in understanding the role played by plant volatile compound emissions in influencing biotic interactions within the sugarcane agro-ecosystem.

Research required for the further development of an eldana trap was placed on-hold in 2016/2017 to contain costs due to the low income prevailing in the industry as a consequence of drought conditions.

Research to identify agrochemicals that may alter the degree of sugarcane resistance to pathogens and pests continues as follows:

- Cis-jasmone, which was found to be highly repellent to eldana larvae and detectable by both male and female moths, is under investigation as a potential resistance inducer and eldana repellent.
- The effect of imidacloprid at planting on subsequent eldana infestation is also under investigation, as is the direct effect of this chemical on nematodes.

Eldana trap development was placed on-hold for 2016/2017, however research is ongoing to identify agrochemicals that may alter the degree of sugarcane resistance to pathogens and pests.

RESISTANCE

Research seeks to develop a deep understanding of the basis of sugarcane resistance to pests and diseases as a basis for developing approaches, resources and technologies to enhance commercial breeding and introgression Breeding for resistance.

Progress in Ongoing Research

NIRS prediction of sugarcane pest and disease resistance

Screening for resistance to pests and diseases is currently limited to later selection stages of commercial breeding, largely due to cost and logistical factors. Consequently, susceptible genotypes are progressed to later stages of the selection process before they are discarded.

Application of new pest and disease screening tools at earlier stages will result in cost savings, productivity benefits and increased numbers of resistant clones progressing to later selection stages. Near infra-red spectroscopy (NIRS) is a non-invasive and non-destructive technology that has the potential to be used in the study of the interaction between sugarcane and pathogens or pests. As such, NIRS has great potential for high-throughput pest and disease resistance screening in the early stages of the sugarcane variety selection process.

Previous SASRI research established that sugarcane resistance to smut has two components: (a) a constitutive component that exists in some varieties in an ongoing ('always on') manner by virtue of the stalk and bud presenting a physical/biochemical barrier to smut entry into the plant; and (b) an inducible component in which the physiological response to smut entry of some varieties renders the infecting pathogen harmless.

Research during 2015/2016 revealed that NIRS, when used in conjunction with specific experimental protocols, is capable of detecting and distinguishing between constitutive and inducible resistance to smut. In this regard, an investigation of 39 varieties resulted in the preliminary identification of varieties displaying constitutive resistance and also the identification of varieties in which smut resistance is likely to be based on physiological responses (e.g. N22).

NIRS, when used in conjunction with specific experimental protocols, is capable of detecting and distinguishing between constitutive and inducible resistance to smut.

New Research

Quantifying smut infection of cane

Accurate quantification of the extent of smut infection of sugarcane stalks, which is the focus of this research, is needed to enable the development of a high-throughput cane smut-resistance screening method based on near-infrared spectroscopy (NIRS) that is currently underway. This new research is to explore the use of a highly sensitive DNA diagnostic technology that is based on the quantitative real-time polymerase chain reaction (qPCR).

Research conducted during 2015/2016 has resulted in a highly sensitive and accurate method for quantifying smut infection. This diagnostic technology will be verified in 2016/2017 through application to sugarcane plants with varying known levels of smut infection.

A highly sensitive and accurate method for quantifying smut infection for sugarcane resistance breeding purposes has been developed. Optimisation of the technology is to continue in 2016/2017.

Thrips and YSA impacts on yield

In 2015/2016, dedicated field trials commenced with a view to providing currently unknown estimates of the yield loss caused by two major insect pests; namely sugarcane thrips *(Fulmekiola serrata)* and yellow sugarcane aphid *(Sipha flava)* (YSA), which cause extensive damage and potentially marked reductions in yields throughout the industry.

Concurrent trials are to be conducted in both rainfed and irrigated crops to provide these figures for both agronomic conditions in the sugar belt. Loss estimates are used to assess their pest status, which in turn largely dictates the overall level of management and research effort channelled into combating them. This is an applied research project because the yield loss estimates are then used to calculate cost-benefit ratios of management options, which indicate the economic viability of such tactics. growers use this information to make sure that any measures implemented to reduce pressure from the thrips and/or aphid pest are cost effective. Effective management strategies will lead to increased yields, and hence more revenue for all growers and stakeholders in this sugar industry. Since these are recent pest incursions in this sugar industry, there is no information about this topic for this region, and thus the research will deliver new scientific knowledge. A further outcome of this research will be information about which chemicals to test in future pesticide registration trials.

Yield loss estimates will be used to calculate cost-benefit ratios of management options, which will indicate the economic viability of management tactics. Research is to be ongoing in 2016/2017.

Variety resistance to thrips and YSA

The objective of this research project is to generate new knowledge of the relative susceptibility of South African commercial sugarcane varieties to two of the sugar industry's major pests, sugarcane thrips and yellow sugarcane aphid (YSA). While the methodology used in the research is already established, this will be the first time that relative susceptibility ratings of commercial South African varieties will be developed based on crop damage caused by the pests. Ratings for YSA susceptibility have not been developed for any South African sugarcane varieties and those for thrips are based only on thrips infestation numbers, which is less reliable than crop damage, and in a limited number of varieties.

Relative susceptibility of different varieties to the pests is non-obvious and cannot be systematically predicted or determined from prior knowledge; such information can only be produced by novel, systematic, experimental trials using clearly defined scientific methods that generate quantifiable results. The new ratings could be used by cane growers to choose varieties that are less susceptible to the pests as part of a recommended integrated pest management approach. This will assist in reducing sucrose yield losses incurred by growers when their cane is infested by either or both pests.

Sugarcane resistance ratings to thrips and YSA are to be used by growers to choose varieties that are less susceptible to the pests as part of a recommended integrated pest management approach.

Exploiting quantitative resistance

Near infra-red spectroscopy (NIRS) is typically used to determine components in unknown samples following calibration on samples of known 'wet chemistry' (e.g. for fibre content). Research into the use of NIRS for the prediction of pest and disease resistance ratings of uncharacterised sugarcane lines (where the mechanisms – wet chemistries - are largely unknown), represents a new and improved function for the technology.

Whilst proof of concept has been achieved for resistance prediction in the absence of pest or pathogen challenge, validation of predictions made on previously uncharacterised sugarcane lines requires the planting of replicated field trials for traditional determinations of resistance ratings.

A novel innovation being investigated here is characterisation of the post-challenge plant response to the pest or pathogen using NIRS and also the discovery of DNA markers for quantitative resistance. The new knowledge developed by this research could be deployed within commercial breeding, greatly increasing breeding and selection efficiencies, whilst reducing costs.

CULTURAL AND ENVIRONMENTAL PRACTICES

Research seeks to develop cost-effective technologies to enable the establishment of sugarcane agro-ecological environments in which pathogens and pests (including nematodes and weeds) are suppressed to low levels by benign biological means. Technologies and approaches considered include biodiversity management (riparian zone and wetland rehabilitation), push-pull habitat management systems, sterile insect technique, best practice agronomic management to limit crop exposure to stress and parasitoid and entomo-pathogen release.

Progress in Ongoing Research

Control of eldana based on interactions with Fusarium

Eldana larvae are associated with the fungus *Fusarium* which causes the red discolouration of internode tissue surrounding borings. Most *Fusarium* isolates are found to be beneficial to the survival and development of eldana. However, some are antagonistic, for example isolate PNG40b which was isolated from plant tissue surrounding a small abandoned boring. This research aims to develop a means of controlling eldana based on its interaction with *Fusarium*.

During 2015/2016, the effect of volatiles from two *Fusarium* sugarcane isolates, PNG40b (*F. sacchari* – antagonistic and repellent) and SC17 (*F. pseudonygamai* – beneficial and attractive) on the behaviour of male and mated female eldana moths was investigated. Maize kernels, fermented by these *Fusarium* isolates were tested for volatile attractiveness or repellence in Y-tube olfactometer assays. Mated female moths showed a preference for the SC17 odour treatment and were deterred by the PNG40b treatment - both responses were significant (Chi-square=13.11, df=1, P=0.003). There was a tendency for unmated male moths to select uninoculated kernels over those inoculated with PNG40b but this response was not significant.

When presented with PNG40b, 75% of the mated females and 68% of the males made a choice compared to 62.5% of the females and 55% of the males in the SC17 assays.

These results strengthen the hypotheses that resistance to *Fusarium* stalk rot associated with eldana borings can contribute towards eldana resistance, and that symptomless endophytic colonisation by *Fusarium* isolates antagonistic to eldana could be exploited as a biological control strategy. Alternatively, strategies that limit the colonisation of sugarcane by *Fusarium* isolates beneficial to eldana could be explored.

Sugarcane resistance to *Fusarium* stalk rot associated with eldana borings may contribute towards eldana resistance.

Symptomless endophytic colonisation of sugarcane by *Fusarium* isolates antagonistic to eldana could be exploited as a biological eldana control strategy.

Eldana parasitoids and entomo-pathogens

(a) Recruitment of eldana parasitoids

For many years, SASRI has been striving, with limited success, to establish an eldana biocontrol programme based on the release of insects that parasitise or prey on eldana (parasitoids). A hypothesis for the lack of success currently being tested is that continuous cycles of sugarcane of breeding (narrowing of the genetic base) may have caused the plant to lose the capacity to release specific volatile compounds during eldana infestations; the emission of which are critical to parasitoid recruitment. These volatiles, termed SOS volatiles, are indicators of plant distress during infestations and serve to attract parasitoid insects to prey on the insects feeding on the plant.

In studies conducted during 2015/2016, pupal females of the parasitoid *Xanthopimpla stemmator*: (a) preferred frass from sugarcane genotypes compared to papyrus; (b) among sugarcane genotypes, the *Saccharum officinarum* genotype 51NG146 (a noble cane) is most preferred and N21 is least preferred; and (c) responded to odour from sugarcane leaves when the top of the stalk was damaged more than when the bottom of the stalk was damaged.

These novel observations suggest that: (a) some sugarcane varieties may be more amenable for use in habitat management approaches in eldana IPM; (b) eldana has adapted to escape parasitoids by targeting the lower portions of the stalk; and (c) in the long-term, broadening the genetic base of sugarcane by introgression breeding may have the potential to reinstate SOS volatiles emissions into commercial hybrid sugarcane cultivars.

Broadening the genetic base of sugarcane by introgression breeding may have the potential to reinstate SOS volatiles emissions into commercial hybrid sugarcane cultivars, which will likely result in an agro-ecological environment favouring the recruitment of parasites of eldana (biocontrol agents).

(b) Endophytic entomo-pathogens of eldana

Plants have the capacity to recruit endophytic entomo-pathogens to act in their defence (endophytic entomo-pathogens could be bacteria and fungi that inhabit the internal tissues of plants without causing harm but which are deleterious to any insects that may infest the plant). Previous SASRI research has revealed that certain isolates of the fungi *Beauveria bassiana* and *Fusarium* show high levels of antagonism to eldana.

The purpose of research conducted in 2015/2016 was to: (a) isolate endophytes (particularly *Beauveria and Fusarium*) from different portions of the sugarcane plant; (b) determine the ability of these endophytic entomo-pathogens to colonise different sugarcane varieties; and (c) develop a delivery mechanism for conferring the endophyte-based resistance technology (e.g. sett dips, inoculated NovaCane® plantlets) and establish the degree of persistence into ratoon crops and transmission in seedcane.

During 2015/2016, two groupings of *B. bassiana* sub-species were identified as being particularly effective in colonising sugarcane. In addition, the results indicate that N31, N32 and N41 may favour endophytic colonisation by *B. bassiana.*

Two groupings of the eldana entomo-pathogen, *B. bassiana* sub-species, are particularly effective in colonising sugarcane.

N31, N32 and N41 may favour endophytic colonisation by *B. bassiana.*

Outcomes of Completed Research

Bio-insecticides of white grubs

The research was funded by the European Union Africa, Caribbean and Pacific countries programme (EU-ACP) and involved five collaborating countries: Mauritius, Zimbabwe, Tanzania, South Africa and Malawi.

A large diversity of white grubs species were observed feeding on sugarcane in the SADC region of southern Africa and a wide range of entomo-pathogens (pathogens of insects) with varying virulence against white grubs were discovered from all collaborating countries, which demonstrated the potential to develop indigenous bio-insecticides against these sugarcane pests.

Several strains of *Trichoderma* spp. were isolated from the white grub cadavers received from collaborators.

- *Trichoderma* spp. are known to be beneficial fungi in enhancing soil heath and plant growth and many strains are available commercially.
- The strains isolated during the current project may have the same beneficial effects and may have potential for commercial product development.
- The isolates have been lodged in the South African National Collection of Fungi and are available to interested parties.
- In South Africa, two *Beauveria bassiana* strains have been formulated, and are being tested against targeted white grub species in ongoing trials.
- Isolates of *Metarhizium* recovered from Mauritius, Tanzania and Zimbabwe are being mass produced for trials in Mauritius.

The entomo-pathogens isolated in the study are currently under assessment for commercial production as bio-insecticides against white grubs.

A guide was developed to assist in the identification of white grubs and to promote awareness of the constraints these insects may place on production.

New Research

Commercialisation potential of white grub bio-insecticides

Previous SASRI research has isolated soil-dwelling bacteria and fungi that show potential for use as biocides (biocontrol agents) against white grubs (which feed on sugarcane roots). This research aims to extract value from previous research by: (a) developing technologies for trapping and infecting the adult stage (beetles) of white grubs with the biocontrol agents; (b) testing the efficacy of biocide formulations against white grubs in novel, systematic, experimental trials using clearly defined scientific methods that generate quantifiable results; and (c) examine whether the most efficacious formulations are sufficiently specific to the target pest (white grubs). The scientific and technological information to be generated by the research is novel and non-obvious as the technology to be developed is not currently available to South African sugarcane growers.

Entomo-pathogens isolated in previous studies will be assessed for commercial production as bio-insecticides against white grubs.

Endophytic fungi as pest control agents

An investigation into the ability of endophytic strains of the entomo-pathogenic fungus *Beauveria* to control sugarcane pests is exploratory research since it is not known whether sugarcane naturally contains this fungus as an endophyte, or if it can be sufficiently colonised following inoculation. While *Beauveria* endophytes have been found in other crop species elsewhere in the world, their ability to colonise different sugarcane genotypes, and their effect on different sugarcane pests is non-obvious. The research protocols applied in this project involve several methodical and highly organised laboratory and glasshouse based experiments. The novel knowledge developed by this research could be deployed to control multiple pests in the South African sugar industry and hence, could increase crop yields and grower profitability.

Research will determine whether endophytic strains of the entomo-pathogenic fungus *Beauveria* could be deployed to control multiple pests.

Sterile Insect Technique

F1 insect sterility induced by ^{60}Co irradiation (Sterile Insect Technique) has been shown to be effective under tightly controlled (caged) conditions for the control of eldana. To demonstrate proof-of-concept in the field, further research encompassing trap design, acoustic biology, and volatile attractants based on pheromone, plant and fungal volatiles is required, so that populations can be monitored. Since the communication biology of eldana has proven to be intractable thus far, the outcomes from these aspects of this project are non-obvious. Similarly, in light of eldana's mating biology, the optimal release strategy for irradiated moths is also non obvious. Thus, for pilot release research and development, a series of replicated field trials requires the proximity of an irradiation facility. The new knowledge developed by this research could result in the future commercialisation of this technology, which through improved eldana control could increase crop yields and grower profitability. Further development of eldana SIT via a pilot release project was is to be placed on hold in 2016/2017 as a result of the low income environment prevailing in the industry due to drought conditions.

Results will show the potential for future commercialisation of the Sterile Insect Technique, which through improved eldana control, could increase crop yields and grower profitability.

AGROCHEMICALS

Research seeks to support the registration of a suite of effective pathogen, pest (including nematodes) and weed control agents that are agriculturally, environmentally and economically viable, including pheromones for monitoring purposes, benign alternative chemistries and superior formulations and application tactics.

Progress in Ongoing Research

New chemistries for pest, disease and weed control

(a) Liaison and testing: New products
Chemical and biological pest control products play an important role in both Integrated Pest Management (IPM) and other pest management strategies. To ensure the sustained efficacy of chemicals and biologicals in pest control strategies, new products require evaluation to facilitate their registration, commercialisation and adoption by growers. The introduction of new products not only enables product rotation but also the use of more effective and environmentally benign chemistries and formulations.

Activities undertaken in 2015/2016 continued to focus on liaison with agrochemical companies and the Agricultural Inputs Directorate of the Department of Agriculture, Forestry and Fisheries (DAFF) to facilitate the registration of new chemistries and application methods for the control of pests, diseases, nematodes and weeds in sugarcane.

Liaison with DAFF and agrochemical companies is undertaken to seek registration of agrochemicals deemed advantageous to industry sustainability.

(b) IRAC compliant eldana spray programme
During 2015/2016, three new insecticides for eldana management received registration for emergency use. Unfortunately, the product labels are confusing and unduly restrictive, e.g. a green leaf requirement and a recommendation not to apply during drought conditions. Such recommendations were designed for leaf feeding insects on other crops and are not appropriate for sugarcane. SASRI has obtained very positive trial results on ground based applications targeting the trash and stalk (minimal green leaf application). In future, it will be recommended that labels be written based on a level of damage (as for other crops, and not a time of year).

The anthranilic diamide insecticide group, contained in two of the three new products, has to be used according to very strict IRAC (Insecticide Resistance Action Committee) guidelines. IRAC compliant spray programmes, agreed upon by SASRI specialists and stakeholders from the agrochemical industry, comprise alternating the application according to insecticidal modes of action. The programmes were discussed widely with growers and Extension Specialists.

Three new insecticides for eldana management received registration for emergency applications.

IRAC compliant spray programmes for four eldana chemistries were agreed upon by SASRI Specialists and Farmers' AgriCare.

(c) Managing eldana stool infestations
Significant eldana infestations were observed in the below-ground portions of stools during 2015/2016 and, hence, current research is investigating management options for potential future registration for use under emergency circumstances, such as those that are being experienced as a consequence of the 2015/2016 drought. Under investigation in preliminary trials established at Gingindlovu and Eston is the efficacy of various combinations of active ingredients (carbamates, neonicotinoids, organophosphates, pyrethroids, avermectins), synergists (piperonyl butoxide) and wetting agents to combat deep stool infestations by eldana.

It is anticipated that certain of these combinations will enable more efficient stool penetration and greater efficacy of active ingredients. Promising combinations will be investigated further with a view to potential registration for emergency use, in collaboration with the relevant agrochemical companies and the DAFF.

Efficacy of various combinations of active ingredients, synergists and wetting agents is being investigated to combat deep stool infestations by eldana.

Synergies between nematicides and conazole fungicides

Previous research demonstrated that fungicides with conazole active ingredients increase the efficacy of insecticides through influencing the ability of the insect to detoxify the insecticidal active ingredient.

The current research seeks to establish whether the same synergistic effect exists between conazole fungicides (iprodione, difenoconzole and carbendazim) and three nematicidal compounds, *viz.* oxamyl, abamectin and thiamthoxam. Central to the assessment of potential synergistic effects amongst these compounds has been the development of a reliable, rapid and cost-effective laboratory screening methodology.

During 2015/2016, a Petri-dish bioassay method was tested and found to be suitable for the purposes of the study.

A simple laboratory bioassay was refined to enable testing of interactions between nematicides and conazole fungicides.

Outcomes of Completed Research

Creeping grass management

Arsenal® GEN 2 enabled improved control of three creeping grass species (*Cynodon*, *Cyperus* and *Digitaria*) in sandy and clay soils, with *Digitaria* requiring the highest application rate of 5.22 $L.ha^{-1}$.

Although not enabling *Cynodon* eradication, Arsenal® GEN 2 application (2-5 spots / 42 m^{-2} plot) resulted in less new regrowth than Glyphosate 360 application (84 spots / 42 m^{-2} plot). At both the recommended and twice the recommended application rates, Arsenal® GEN 2 was not phytotoxic to a herbicide-sensitive variety of sugarcane (N31) in clay and sandy soils, provided a waiting period of <u>at least</u> four months was observed <u>AND</u> more than 600 mm rainfall occurred prior to planting.

Arsenal® GEN 2 is a valuable component of an integrated weed management (IWM) approach to sustainable creeping grass control.

Implementation of tactics tailored to the weed control requirements of each field on a farm will offer the most cost-effective approach to managing highly competitive *Cynodon, Cyperus* and *Digitaria* weed species.

An Integrated Weed Management manual describing 20 non-chemical and chemical control tactics has been compiled to assist grower decision-making.

Herbicide residues

Soil bacterial and fungal populations remained the same or increased after imazapyr application to acidic and limed sandy and clay soils; an observation that may help to allay grower concerns in this regard. Imazapyr was observed to leach more in limed sandy and clay soils than in non-limed soils, with higher herbicide leaching in limed sandy soil than in limed clay soil.

Outcomes indicate 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.

Soil management practices may serve to enhance the dissipation of imazapyr residues in soils.

CROP PERFORMANCE & MANAGEMENT RESEARCH

Dr. Riekert van Heerden

The purpose of the Crop Performance and Management Programme is to conduct research to develop models and better management practices to sustain and enhance sugarcane production.

To meet the objective of developing models and better management practices for deployment within the industry, activities are undertaken in seven key areas of research and development: (1) Crop Physiology; (2) Crop Nutrition; (3) Soil Health; (4) Crop Residue Management; (5) Crop Ripening; (6) Water Management; and (7) Climate Change.

Crop Physiology

Research in this Key Area focuses on the gathering of crop physiological data and the use thereof to facilitate modelling, with a view to: (a) assessing the potential resource requirements (water and nitrogen) for high biomass cultivars with potential future bio-energy applications; (b) developing tools to assist Commercial Breeding under current and predicted future climatic conditions; and (c) refining the accuracy of crop yield forecasting.

The resources and technologies developed will ultimately enhance the quest for improved efficiencies in Commercial Breeding.

Crop Nutrition

Research in this Key Area focuses on the development of knowledge, technologies and resources to further enhance the accuracy of fertiliser recommendations to the grower community, including: (a) accurate quantification of soil and leaf nutrient concentrations and the determination of improved leaf nutrient threshold values; (b) assessment of potential differences in variety nutrient requirements; (c) assessment of the efficacy of various sources of nutrients, fertiliser formulations and application rates; and (d) development of soil sampling guidelines and protocols.

Soil Health

Research in this Key Area focuses on the development of knowledge, technologies and resources to enable the maintenance of, and where necessary, the restoration of soil health. In progress are studies to develop: (a) a Soil Health Index that will facilitate grower decision-making regarding the potential requirement for ameliorative measures or alternative practices; (b) guidelines for the amelioration of top and sub-surface soil acidity, which is complemented by a series of trials to demonstrate the efficacy and practicality of recommendations; and (c) an understanding of the factors that may contribute to the low level of root development and soil penetration that has been observed in various areas of the industry.

Crop Residue Management

Research in this Key Performance Area focuses on the development of knowledge, technologies and resources to enable effective and beneficial crop residue management practices in the industry. Particular emphasis is placed on the determination of variety responses to the retention of a crop residue blanket, so that specific recommendations to growers may be formulated.

Crop Ripening

Research in this Key Area focuses on the development of knowledge, technologies and resources to enable and demonstrate effective sugarcane chemical ripening practices in the industry. Under development are technologies and models that will assist the grower community with chemical ripening decision-making.

Water Management

Research in this Key Area focuses on co-ordinated knowledge generation and model development to enable efficient irrigation and the optimal use of available water. In progress is the development of a model (decision support tool) that will facilitate grower decision-making with regard to irrigation scheduling during periods of heightened water scarcity.

The resources and technologies developed in this Key Area strongly complement the research outcomes in the 'Water Management' Key Area of the Systems Design and Optimisation Programme.

Climate Change

Research in this Key Area focuses on the assessment of potential impacts of climate change on the industry and exploration of ways in which field management might be modified to adapt to the projected changed climate.

CROP PHYSIOLOGY

Research seeks to refine and develop mathematical models to facilitate: (a) the estimation of resource requirements of varieties suited to bioenergy applications; (b) the breeding of varieties suited to hot and dry climates; and (c) improved accuracy of crop yield forecasting.

Progress in Ongoing Research

Resource-use efficiency of biomass genotypes

Four nitrogen (N) treatments were applied to well-watered first ratoon crops (two commercial cultivars [N19 and N31]; a high biomass-type sugarcane hybrid [04G0073]; and an *Erianthus* clone [IK76-73]), namely 0%, 50%, 100%

and 150% of FAS recommended N level (140 kg N/ha). Highest biomass yields were achieved by IK76-63 (100 t/ha), followed by N31 (95 t/ha), N19 (84 t/ha) and 04G0073 (83 t/ha). Biomass growth responded to N only in the last four months of the growing season, with the biomass types showing higher response than sugar types. Final biomass yields for the 50 N and 100 N treatments were approximately 50% higher than the 0 N treatments for the biomass types, and about 40% higher for N31. N19 showed much less response (11% at 100 N). Generally, the highest yields were achieved at the 100 N rate.

The information gathered in this study will enable the estimation of N requirements and N uptake by biomass genotypes for potential future bio-energy applications, particularly electricity co-generation and second-generation bioethanol production.

N requirements of selected sugarcane varieties, an unreleased cane genotype and a close relative of sugarcane suited for bioenergy applications were determined.

Genetic trait model parameters of varieties

An important objective of this research is to develop an efficient phenotyping protocol that enables accurate quantification of heritable sugarcane traits during crop development that contribute to sugarcane final yield. Such genetic trait information is to be deployed in: (a) optimising crop management for specific environments (in the short-term); (b) enabling improved performance of model-based studies into sugarcane bio-energy and climate change impacts (in the medium-term); and (c) contributing to the breeding of sugarcane varieties that are better suited to particular environments (in the long-term).

During 2015/2016, a methodology was developed for the measurement of genetic trait parameters that enables considerably improved phenotyping throughput and efficiencies.

The developed methodology enables improved phenotyping through-put and efficiencies.

CROP NUTRITION

Research seeks to develop knowledge, technologies and resources to enable improved recommendations to growers regarding optimising the nutrition of their sugarcane crops.

Progress in Ongoing Research

Leaf nitrogen threshold values

Leaf nitrogen (N) concentration is observed to decline as the sugarcane plant ages due to the dilution effect exerted by biomass accumulation. To compensate for this phenomenon, growers are advised to confine leaf sampling for N determinations to plants of a specific physiological age, *viz.* 3-5 months of age. However, an estimate of plant biomass at the time of leaf sampling would enhance the N fertiliser advice that the SASRI Fertiliser Advisory Service (FAS) provides to growers.

This research seeks to determine whether the model developed by Greenwood and co-workers (1990) and Lemaire (1997), which has been successfully applied to a wide variety of crops, could serve a means to more accurately predict the effects of sugarcane plant age on critical leaf N concentration. Key to the success of the approach will be the availability of a simple and accurate method for growers to measure plant mass at the time of leaf sampling. Results obtained in 2015/2016 have revealed a useful relationship between plant height and standing biomass, indicating that grower determination of plant height at leaf sampling might provide FAS with sufficient information to accurately estimate crop standing biomass.

Grower determination of plant height at leaf sampling might provide FAS with sufficient information to significantly improve the accuracy of N recommendations.

Nutrient fertilisation rates

Measurement of responses to N and other nutrients at six locations in the rainfed regions of the industry continued in 2015/2016. Trials at Doringkop and Umfolozi demonstrated significant responses to N, with 100 kg N/ha being optimum for maximum sucrose yield (t sucrose/ha). Of note is that 100 kg N/ha is the FAS recommendation indicated for both sites.

The lack of response to K fertilisation at the Umfolozi site supports the contention that non-exchangeable K reserves in alluvial soils of this type may be sufficient to adequately meet long-term crop K requirements.

FAS recommended N application rates were confirmed as being optimal.

Non-exchangeable K reserves in alluvial soils at Umfolozi may be sufficient to adequately meet long-term crop K requirements.

Outcomes of Completed Research

Nitrogen dynamics modelling

An N sub-routine was created, included in the DSSAT-Canegro crop model and subjected to validation and testing. Statistical analyses indicate that the model is generally robust and effective at estimating cane yield, sucrose yield and above-ground N mass. Modelled and measured data indicate that: (a) at high concentrations in the soil, inorganic N is rapidly taken up by the crop and accumulated to levels in excess of N requirements; and (b) at low concentrations in the soil, the crop utilises available N (e.g. N contributed from soil organic matter), resulting in a higher nitrogen use efficiency.

The DSSAT-Canegro crop model with the N sub-routine will expand knowledge of N dynamics in sugarcane cropping systems, leading to improved N-management recommendations.

The crop model N sub-routine will expand knowledge of N dynamics and ultimately lead to refined N-management recommendations.

Urea-N volatilisation

The efficacy of urea as an inorganic-N source is highly dependent on conditions at the soil surface, in that, under conditions favouring volatilisation of ammonia, N losses may exceed 40% of the N applied, which affirms the importance of the 'N volatilisation rating' supplied on FAS reports. Soil properties influencing volatilisation losses include soil texture and pH values, with sandy, high pH soils being conducive to volatilisation.

New generation urea-based N-fertilisers, which are coated and/or contain urease inhibitors, have significantly lower volatilisation propensities than conventional urea. The use of new generation urea products or limestone ammonium nitrate (LAN) is warranted where conditions are conducive to high volatilisation rates. LAN is superior to all urea-based products in terms of volatilisation losses.

A detailed cost comparison between N-based products on different soil types and different management practices has been published (Weigel A, Miles N, Nyandeni B, Naidoo G and Wettergreen T [2014]. Ammonia volatilisation losses from nitrogen fertilisers: Laboratory studies. *Proceedings of the South African Sugar Technologists' Association* 87: 353-357).

New generation urea products are advantageous under conditions that are conducive to high N volatilisation.

LAN remains the preferred product in situations where N volatilisation losses are of concern.

Variability in soil sampling

Research conducted in 2015/2016 revealed that variability of soil test results arising from Fertiliser Advisory Service (FAS) laboratory sampling, sample preparation and analytical protocols is low and is statistically insignificant in the overwhelming majority of instances. The major source of variability in soil test results occurs at soil sampling in the field due to an inherent high level of intra-field soil variation, which may be accounted for by intensive grid-based sampling. As intensive grid-based sampling is currently prohibitively expensive: (a) FAS is developing a cost-effective analytical package, based on Mid Infra-Red Spectroscopy (MIRS), which will enable affordable intensive soil testing by growers; and (b) growers are encouraged to manage their fertiliser application regimes according to trends in soil nutrient status over time, for which detailed and accurate record-keeping is essential.

To overcome inherent in-field soil variability and the consequent negative effects on the management of crop nutrition, the adoption of certain pertinent best-management practices by growers is recommended, including: (a) conducting regular soil and leaf sampling on all production field units; (b) maintaining databases of analytical results and recommendations to track field-by-field fertility trends; and (c) applying fertiliser and lime according to long-term trends, rather than upon the results of single analyses.

Planning of fertilisation regimes according to long-term soil analysis is currently the best option for overcoming challenges associated with in-field soil variability.

SOIL HEALTH

Research seeks to develop knowledge, technologies and resources to enable growers to maintain and, where necessary, restore the health of the soils on their farms.

Outcomes of Completed Research

Poor rooting phenomenon

During 2015/2016, no single factor was found to be unequivocally associated with poor root development across the study area, rather the quality of rooting was associated with combinations of factors in the top- and sub-soil. In top-soils, good root systems were most commonly associated with: (a) high clay and organic matter contents; (b) high concentrations of Mg, Ca, K and Si; (c) a high concentration of total cations; and (d) large populations of the fungi *Fusarium* and *Trichoderma* (these fungi may serve as either beneficial or pathogenic microbes, depending on the strains and growth conditions). In contrast, poor root systems were generally associated with top-soils characterised by: (a) large populations of root damaging nematodes (Criconematid nematodes[plant-parasitic nematodes], *Helicotylenchus* [spiral nematodes]; and *Paratrichodorus* [stubby-root nematodes]); (b) high total bacteria populations; (c) high Fe levels; and (d) low concentrations of Na and Mg. In the subsoil, a high total cation concentration and high concentrations of Mg, Ca and Cu were associated with good root systems, while high levels of exchangeable acidity, high acid saturation, high Fe concentrations and low levels of Na and Mg were associated with poor root systems.

Of further note was the association of good root systems with the extent of soil disturbance, with soil disturbance apparently favouring root development, although this observation remains to be confirmed in 2016/2017.

Root systems of acceptable quality were generally associated with indicators of good soil health. Implementation of best management practices and recommendations to improve soil health and crop nutrition are likely to promote root development.

New Research

Soil health index

This research aims to develop a laboratory-based soil health index for the industry. To this end, the objectives of the project include: (a) the bench-marking of the health-status of production fields in the sugarcane industry; and (b) the identification of in-field practices which serve to improve the health of sugarcane-producing soils. With soils of the sugarcane industry being markedly heterogeneous, this research involves the collection of soil samples from fields with representative soil types, and the evaluation of a range of existing and novel laboratory tests to characterise soil health status. To facilitate the bench-marking protocol, samples from grazed pastures (deemed 'optimum' in terms of soil biology, chemistry and physical status) are included in the study. With soil scientists throughout the world grappling with the problem of developing a soil-health test for use in routine soil testing services, this research will deliver novel scientific knowledge which is expected to contribute greatly to the sustainability of crop production in southern Africa.

Potential exists for the development and roll-out to the industry of a cost-effective, high-throughput Soil Health Index. Research towards this objective will be ongoing in 2016/2017.

CROP RESIDUE MANAGEMENT

Research seeks to develop knowledge, technologies and resources to demonstrate and enable effective and beneficial crop residue management practices.

Outcomes of Completed Research

Variety interactions with crop residue blankets

When cultivated under similar growing conditions, varieties generally exhibit similar yield responses to mulching and any minor varietal differences in canopy development rates associated with the practice are not likely to impose major productivity penalties.

Under coastal rainfed conditions, most varieties show positive yield responses to mulching. Under irrigated conditions, some varieties may show delayed canopy development, although this does not negatively influence final ERC yields. Under irrigated conditions, any potential yield loss imposed by mulching is sufficiently small to be off-set by cost savings in water, electricity, herbicide and associated application costs. Under the cool conditions of the midlands, most varieties are likely to show reduced cane and ERC yields due to mulching. Growers operating in the midlands should consider a partial residue blanket, comprising tops only, to promote moisture conservation, together with the added benefit of improved weed control.

Mulching is encouraged for all varieties cultivated in the rainfed regions.

Mulching recommendations for the midland regions are to be adjusted to promote the use of partial residue blankets, comprising tops only.

CROP RIPENING

Research seeks to develop knowledge, technologies and resources to demonstrate and enable effective sugarcane ripening practices.

Progress in Ongoing Research

Chemical ripener evaluation

During 2015/2016, results from numerous field trials clearly demonstrated that chemical ripening with Fusilade® Forte (and generics), according to product label instructions, does not cause any negative residual effects in the subsequent ratoon crops. Research will continue to confirm that this is the case for all newly released rainfed and irrigated varieties.

Ripening with Fusilade® Forte (and generics) according to product label instructions does not cause any negative residual effects in subsequent ratoon crops.

Modeling of chemical ripener responses

One of the goals of this research is to develop a "Ripener Effectiveness Index" inside SASRI WeatherWeb. The index will serve to alert Extension Specialists and growers of periods of high chemical ripening potential in different parts of the sugar industry, based on past and current climatic conditions. Testing during 2015/2016 of a new model developed in the project has revealed that the model is very robust and stable in simulating the effects of ripeners on cane quality. Although model development was completed during 2015/2016, further refinements are currently underway to ensure predictive accuracy.

Testing has revealed the new ripener model to be very robust and stable in simulating the effects of ripeners on cane quality.

Outcomes of Completed Research

PurEst™ a tool to guide ripener decision-making

The existence of a strong positive correlation (R^2 = 0.69) was confirmed between stalk Brix% values determined in-field with a hand-held refractometer and laboratory-determined juice purity values. The regression method used to analyse the data revealed a significant ($p<0.01$) correlation between the two variables regardless of variety, cutting cycle or whether the samples were from irrigated or rainfed fields. Additionally, significant ($p<0.01$) correlations were demonstrated amongst the field-measured Brix% values and laboratory-determined RV% (R^2 = 0.76) and stalk moisture% (R^2 = 0.67).

The mathematical models form the basis of a novel whole-stalk juice purity, RV% and stalk moisture calculator that has been trade-marked as Pur*Est*™. Pur*Est*™ is available as a Microsoft® Excel tool and will be soon be made available as a smartphone app.

Pur*Est*™ enables growers and extension specialists to rapidly estimate crop maturity in the field for purposes of ripening, drying-off and harvest decision-making. The whole-stalk juice purity output may be used to decide if chemical ripening is warranted and identify the most suitable registered chemical for use. The stalk moisture% output may be used to guide drying-off of crops by enabling drying-off to be monitored until the desired target moisture content is attained. The RV% output may be used for harvest scheduling, ensuring that mature fields are harvested before those that require more time to reach desired maturity levels.

Pur*Est*™ enables growers to rapidly estimate crop maturity in the field for purposes of ripening, drying-off and harvest decision-making.

CLIMATE CHANGE

Research seeks to assess the potential impacts of climate change and explores ways in which field management might be modified to adapt to the projected climate changes.

Progress in Ongoing Research

Modelling climate change impacts

This research aims to calculate the likely impacts of various climate change scenarios on the South African sugar industry. Several improvements to the algorithms within the DSSAT-Canegro sugarcane simulation model have been accomplished as a result of work conducted during 2015/2016. Investigations have also included refinement of simulations for high biomass varieties (and environments), as well as climate change responses (high temperatures and elevated atmospheric CO_2 content).

Updates to the model during 2015/2016 have resulted in improvements to the simulation of above-ground dry biomass, which is fundamental to accurate mechanistic simulation of stalk and sucrose yields. Of note is that the validation set does not include very high biomass yields, nor experiments that were conducted at very different atmospheric CO_2 content. If higher-biomass or high-CO_2 experiments were included, even better performance figures would likely be noted.

Model updates have improved the simulation of above-ground dry biomass, which is fundamental to accurate mechanistic simulation of stalk and sucrose yields.

SYSTEMS DESIGN AND OPTIMISATION RESEARCH

Dr. Rianto van Antwerpen

The purpose of the Systems Design and Optimisation Programme is to investigate, develop and transfer innovative systems that optimise industry agricultural performance.

To meet the objective of providing innovative systems for the industry, research, development and innovation is conducted in three key research areas: (1) Production Sustainability; (2) Water Management; and (3) Technology Development.

Production Sustainability

Research in this Key Area focuses on topical issues pertaining to production sustainability, including: (a) assessment of the impacts of agronomic and mechanisation issues on production efficiencies and sustainability; (b) determination of opportunities for on-farm energy savings and reduction of carbon dioxide emissions; (c) deployment of novel technologies to improve operational efficiencies and services to the industry; and (d) development of new and improvement of existing technologies and approaches to further promote alignment between research and development and industry requirements.

Water Management

Research in this Key Area focuses on the: (a) development of recommendations and advice to promote effective water management and deployment of associated technologies, both in terms of irrigation practices and surface water management; and (b) analysis of the socio-technical drivers of adoption of technology, recommendations and best practice advice, with specific reference to irrigation scheduling.

Technology Development

This Key Area encompasses the adaptation, development and deployment of technologies that focus on enhancing SASRI internal efficiencies and the quality of service provision by the institute to the industry.

PRODUCTION SUSTAINABILITY

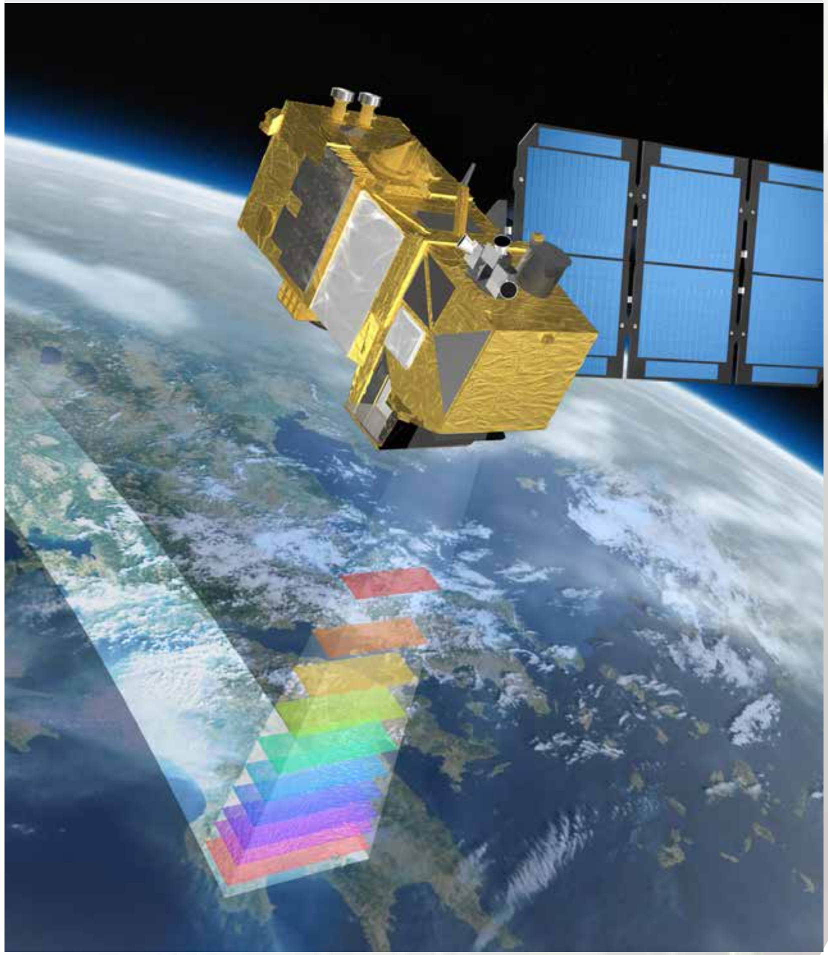
Research is undertaken to develop and refine systems that promote sustainable sugarcane production, including the industry crop yield forecasting system and promote controlled in-field traffic.

New Research

Incorporating remote sensing into operational crop forecasts

The aim of this research is to adapt an existing sugarcane crop forecasting system (a model-based system) to utilise real-time estimates of canopy cover derived from remotely sensed data. It is believed that this will improve the quality of crop forecasts, enabling improved efficiency of cane supply and value chains. Although the concept has been proven before and is used for other crops, the application of the approach to operational sugarcane crop forecasting is unique internationally.

The use of remotely-sensed data will improve the accuracy of operational sugarcane crop forecasting. Research will be ongoing in 2016/2017.



In-field traffic impacts

The research that commenced in 2015/2016 involves the comparison and analysis of commercial harvesting and loading operations typically found in the South African sugarcane industry. The objectives are to: (a) categorise systems according to their potential to cause traffic-induced yield losses; and (b) determine the cost of this previously unknown impact on operational economics.

Detailed, methodical and organised time-and-motion studies are to be conducted and analysed to define the position, intensity and extent of in-field traffic associated with harvesting and extraction operations for a range of systems typically found in the industry. Detailed meta-analysis of the international literature will be required to quantify strategic harvesting methods that are currently not typically used in the local industry but which are available and commonly used in sugarcane industries elsewhere.

The outcome of this research is non-obvious as no such research has been previously conducted. The availability of cost effective technology such as GNSS surveying and GIS software has enabled the application of this research approach. Modelling of in-field traffic and in-field traffic optimisation are potential enhancements that are being investigated in this research phase. Modelling of the economic impact of infield traffic over the entire cropping cycle is an envisaged outcome. The research will deliver new knowledge that may be used by growers and extension specialists to make practical on-farm management changes and advise on the cost: benefit of changing to alternative systems.

Research will provide resources to guide the designing, planning and optimisation of in-field extraction systems. Research will be ongoing in 2016/2017.

WATER MANAGEMENT

Research seeks to develop recommendations and advice to promote effective water management and technology deployment, both in terms of irrigation practices and surface water management.

Progress in Ongoing Research

Guidelines for low-flow sub-surface drip irrigation systems

Several factors, including water application efficiency compared with other irrigation systems, increased interest in mechanisation and escalating labour costs, have led to sub-surface drip irrigation (SDI) systems gaining popularity for irrigation and fertigation. However, constraints on the performance of SDI systems have been reported, including poor crop growth (germination and ratoon establishment) and general system performance (e.g. emitter clogging). During 2015/2016, direct measurement of soil water content on farms using SDI systems and the results of a survey of growers using these systems revealed the prevalence of significant over-irrigation of young cane. Despite investment in SDI systems and the prevalence of soil water content monitoring probes, 85% of growers surveyed follow a fixed Summer / Winter irrigation cycle, highlighting the need for knowledge exchange regarding irrigation scheduling.

The survey undertaken in 2015/2016 also aimed to assess the performance of existing low-flow (SDIs) systems under local field conditions, with a view to developing 'rules of thumb' regarding the correct design (installation depth, emitter discharge rate and spacing within the lateral) and management strategy (frequency and duration of irrigation) for a given soil type. SDIs are most often deployed by larger-scale growers and miller-cum-planter companies, primarily due high initial capital cost (R36 000 to R 43 000/ha) of such systems. Savings of between 30 to 40% are reported in the amount of water applied which, in many instances, has made expansion in the area under SDI possible.

Germination problems in the plant crop are reported by many growers, which may be overcome through the use of a thicker walled surface drip line that is only ripped into the soil in the first ratoon crop. In many instances the installation and commissioning of the system is undertaken by the users themselves as a cost-containment measure. Although users acknowledge that SDIs have higher management inputs (e.g. scheduling, flushing, fertigation), these are not sufficiently high to discourage deployment of the systems. Minimum flow rates and peak delivery rates are the main considerations that need to be accounted for during system design, as is the consideration of specific soil properties. It appears that what users generally perceive as being low flow (1.0 to 1.2 $L.h^{-1}$) is not formally classified as low flow (0.4 to 0.8 $L.h^{-1}$).

Consequently, based on the current survey results, very little low flow sub surface drip appears to be currently practised, as much of SDI falls in the 1.0 to 1.6 l/h category which are considered medium flow.

A survey revealed that very little low-flow sub-surface drip irrigation occurs in the industry, as much of SDI currently practised delivers water at rates between 1.0 to 1.6 $L.h^{-1}$. Research will be ongoing in 2016/2017

Socio-technical drivers of adoption: A case study

In this research, Systems Dynamics modelling is used as a tool to understand the drivers of technology adoption by sugarcane growers, using irrigation scheduling as a case study. Investigations conducted in 2015/2016 included a focus on the mathematical modelling of technology 'dis-adoption' by growers. In mathematical terms, the rate at which growers dis-adopt a technology is described as being dependent on the number of growers who have adopted the technology and the residual level of uncertainty regarding the technology. A higher flow of uncertainty is associated with low number of adopters. In this regard, it is conceivable that, in the initial stages of roll-out of a new technology, growers who adopt early do not have a peer cohort with whom they can share and discuss early teething problems and hence, do not have support structures to offer reassurance and comfort with the technology. Conversely, in the early implementation phase, it is also assumed that the developers, suppliers and supporting agents of the technology will work quickly to resolve initial teething problems. During 2015/2016, the dis-adoption function was incorporated into the broader model which has enhanced accuracy and the representation of reality.

The model was further refined in 2015/2016 to more accurately depict the role that grower uncertainty surrounding a technology plays in adoption (uncertainty in this instance comprises both technical matters and economic benefit). On-farm testing of the technology with relevant specialist support was identified as an important means to address uncertainty. However, initial engagement with growers is required to allay uncertainty to a level that triggers a commitment to on-farm testing. These refinements and those that are to be undertaken in 2016/2017 are increasing the model's representation of reality and are paving the way for the development of an extremely useful tool for guiding the conception and planning of technology development projects at SASRI.

The tool under development will ensure that consideration of critical drivers of adoption remain paramount during the conception, planning and execution of research and technology development projects and knowledge exchange interventions. Research will be ongoing in 2016/2017.

New Research

Validation of industry dry-off recommendations

Research commenced in 2015/2016 to refine resources that have been previously developed to assist growers in determining the correct number of dry-off days before harvest. To-date, the tools developed include: (a) an internet-based decision-support programme; (b) look-up tables; and (c) a dry-off wheel. These tools cater for both chemically-ripened and non-chemically ripened (water-stress induced ripening) sugarcane. The goal of the research that commenced in 2015/2016 is to further refine and validate these recommendations before distribution to growers.

During 2015/2016, two databases were updated:

- Non-chemically ripened cane: A new database of dry-off recommendations has been developed for: (a) eight locations (Amatikulu, Beaumont, Powerscourt, Empangeni, Pongola, Mtubatuba, Malelane and Komatipoort); (b) five total available water (TAW) categories (60, 80, 100,120 and 140mm); and (c) the months from March to December.
- Chemically ripened cane: A new database of dry off recommendations has been developed for the same eight locations (as above), as well as for soils containing five different proportions of clay (8, 15, 25, 35 and 45% clay).

Research in 2016/2017 will focus on the validation of the databases during two workshops that are to be convened for industry experts.

Refinement and validation of industry dry-off recommendations will be ongoing in 2016/2017.

TECHNOLOGY DEVELOPMENT

Activities encompass the adaptation, refinement, development and deployment of technologies that focus on enhancing internal efficiencies and the quality of reporting and service provision to the industry.

Progress in Ongoing Research

WeatherWeb real-time weather data

During 2015/2016, two additional Automatic Weather Stations (AWSs) in Mpumalanga were added to the network, bringing the total number of AWSs for which real-time data are accessible via the SASRI WeatherWeb to 18. Of particular note is that the on-line WeatherWeb user-interface was adapted during 2015/2016 for use on smart phones and tablets.

The SASRI WeatherWeb is accessible via the url: *www.sugar.org.za/sasri*

SASRI WeatherWeb is now accessible via smart phones and tablets.

Tablet-based data capture

During 2015/2016, progress was made in evaluating the potential for tablet-based data capture during important SASRI research operations. Several minor issues are currently being resolved, including reduction of screen glare in full sunlight, battery charging at remote locations and the consistent loading of data capture templates.

Tablet-based data capture during important SASRI research operations remains under investigation.

Revamping MyCanesim®

MyCanesim® is a web-based sugarcane crop simulation system designed by SASRI to assist sugarcane researchers, Extension Specialists and growers that do not have access to expensive commercial cane management software systems. MyCanesim® may be deployed operationally for yield benchmarking and irrigation scheduling, as well as in sugarcane agriculture research. The crop model component of MyCanesim® is written in PL/SQL, while the supporting algorithms (e.g. for irrigation scheduling advice) are written in C# and Java™. MyCanesim® input and output data are stored in Oracle® with a user-interface that was developed in Oracle® Portal (which will soon be phased out by Oracle®).

The goal of this research is to revamp MyCanesim® to reflect the latest scientific and technological advances and to make the system more accessible and useful to researchers, extension, consultants and practitioners. As a result of the updates undertaken during 2015/2016, MyCanesim® now: (a) includes a sophisticated multi-layered soil water balance with improved water stress simulation; (b) accounts for atmospheric CO_2 impacts on crop water use; (c) contains revised algorithms for biomass accumulation and crop lodging; (d) has functionality to utilise climate forecasts in future simulations; and (e) accounts for water restrictions when scheduling irrigation.

MyCanesim® functionality expanded to include additional useful features, including: (a) a multi-layered soil water balance with improved water stress simulation (Aquacrop approach); and (b) a feature that accounts for water restrictions when scheduling irrigation.

Outcomes of Completed Research

Communicating economics of recommendations

An MS Excel tool was developed to assist researchers in reporting the economics of best management practices and recommendations, with a view to encouraging grower adoption.

The tool:
- enables SASRI scientists to calculate the production costs associated with cane and RV% yields obtained in research trials for knowledge exchange interactions with growers;
- accounts for additional costs associated with higher yields due to a particular experimental treatment;
- provides sufficient flexibility to enable researchers to use costs relevant to the growers with whom they are interacting;
- is appropriate for knowledge exchange regarding ripeners, nematicides, fungicides, insecticides, varieties, fertilisers, age-at-harvest and residue mulch research outcomes;
- calculates gross margins which are correlated with RV yields; and
- provides compelling insights into the RV yield benefits required to justify certain agronomic treatments.

The tool will greatly enhance the ability of SASRI scientists to use economic arguments while promoting recommendations and best management practices. It is envisaged that the tool will ultimately contribute to the increased profitability of growers that will emanate from technology adoption.

The tool facilitates the use of economic arguments during the promotion of recommendations and best management practices.

Performance-based vehicles in sugarcane transport

Through consultation with stakeholders from the miller and haulier sectors, two essential resources were developed to assist decision-making regarding the potential deployment of Performance Based Standards (PBS) vehicles (Smart Trucks) for sugarcane delivery to 13 mills operating in the industry, namely: (a) a list of important measurable parameters; and (b) a mind-map of issues that require consideration to accommodate PBS vehicle entry into the cane receiving environments.

The resources developed are designed to assist stakeholder decision-making regarding the suitability of cane receiving environments for PBS vehicle deployment at 13 South African sugar mills. Furthermore, recommendations have been formulated on the potential changes that might be required to accommodate PBS vehicles in cane receiving environments. The findings are to be made available to the Road Transport Management System Committee that is responsible for transport-related matters at an industry level.

Resources developed to assist decision-making regarding the deployment of PBS vehicles in cane-receiving environments at mills.

New Research

SUSFARMS® Progress Tracker central database

During 2015/2016, research commenced to develop a system for the seamless, rapid and efficient extraction of data from a number of SUSFARMS® Progress Tracker Excel spreadsheets. It is envisaged that the extraction tool will enable the simultaneous extraction of data into a single repository. Such a repository would enable the verification and validation of data per submission by extension specialists. In addition, the repository should accommodate the use of visualisation software for reporting on results or trends at the farm, ecozone or mill level.

It is envisaged that the tool to be developed will enable reporting on individual sustainability indicators and be invaluable to extension specialists reporting on progress towards implementation of best practices in each ecozone.

The tool to be developed will facilitate reporting on progress towards implementation of best practices and attainment of sustainability targets. Refinement of the tool will be ongoing, as necessary.

VARIETY IMPROVEMENT RESEARCH

Dr. Sandy Snyman

The purpose of the Variety Improvement Programme is to conduct research and implement strategies for the continual release of high sugar yielding (biomass and sugar content), adaptable, pest and disease resistant varieties that add value and enhance industry productivity.

To meet the objective of releasing superior varieties to the industry, research is undertaken in five key research areas: (1) Commercial Breeding; (2) Introgression Breeding; (3) Genomics; (4) Variety Characterisation; and (5) Trait Development.

Commercial Breeding

Commercial Breeding lies at the core of the Variety Improvement Programme. This major component of SASRI activities consists of five primary areas of research and operations, viz. crossing, selection, genotype testing, bulking and variety release. Together, this highly co-ordinated series of activities results in the release to the industry of varieties with high sugar yield (both sucrose and cane yield), pest and disease resistance, adaptability, ratooning ability and agronomic and milling characteristics that are desirable to both millers and growers.

Introgression Breeding

Introgression Breeding seeks to expand the genetic base of parental germplasm used in Commercial Breeding by performing successive crosses between elite commercial varieties and either plant species closely related to sugarcane or ancestral species that gave rise to modern commercial hybrid varieties. Of particular relevance is that Introgression Breeding provides access to genes from other species that have the potential to contribute improved vigour, resilience and pest and disease resistance to commercial varieties bred through Commercial Breeding.

Research in this area also focuses on the development of methods and technologies to enable the crossing of sugarcane varieties with closely-related and progenitor cane species, which includes synchronisation of flowering, pollen storage and genetic diversity analysis.

Genomics

Genomics entails the analysis of the sugarcane genome to identify genes and determine their arrangement on chromosomes, which is undertaken with a view to discovering DNA markers linked to commercially-relevant traits for ultimate use in marker-assisted commercial breeding. As the highly complex sugarcane genome is not fully sequenced, a comparative mapping approach is used in which the sequenced genomes of closely-related plant species, including sorghum, are used as a genome assembly scaffold. This data- and computing-intensive undertaking requires the development of customised bioinformatics software applications.

Variety Characterisation

Articulating strongly with Commercial Breeding, Variety Characterisation research and development aims to provide comprehensive information on the performance of new varieties under different management practices and agro-climatic conditions upon, or soon after, their release to the industry.

As for Commercial Breeding, Variety Characterisation is complemented by a series of research projects that are instituted to address specific issues, for example variety ratoon longevity and the performance of varieties derived from the NovaCane® technology.

Trait Development

Research and development underlying Trait Development are strongly focused on the development of innovations of strategic importance to the future delivery and sustainable cultivation of varieties with novel traits (characteristics) within the industry. Traits currently under development include enhanced nitrogen-use efficiency and herbicide and drought tolerance. Research in this area also includes the development of technologies and resources required for genetic engineering, mutagenic breeding and the preservation of valuable germplasm, as well as the demonstration of proof-of-concept regarding the performance of the novel lines produced.

COMMERCIAL BREEDING

Commercial breeding seeks to develop new varieties with higher sucrose yield and increased resistance to pests and diseases, compared with existing varieties, and which are adapted to specific agro-climatic conditions prevailing within the sugar industry.

Progress in Ongoing Research

New varieties

A particular highlight in 2015/2016 was the release of three new superior varieties with good RV yields and disease resistance: N60, N61 and N62.

- N60 is recommended for mid- to late-season harvesting on a twelve month harvesting cycle in the southern irrigated regions. This variety has good general disease resistance and high cane and RV yields in the late season.
- N61 is recommended for planting in sandy soils on a 20 to 24 month harvesting cycle in the southern high altitude rainfed regions. This variety has good general disease resistance (resistant to mosaic and eldana) and high cane and RV yields in sandy soils.
- N62 is adapted to both humic and sandy soils and is recommended for a 20 to 24 month harvesting cycle in the rainfed midlands regions. This variety has good general disease resistance, intermediate eldana resistance and high cane and RV yields in humic and sandy soils.

Varieties N60, N61 and N62 released – contributing high RV yield potential and improved disease resistance.

Selection process refinements

The 2015/2016 season also saw good progress in the implementation of tactical revisions to promote efficiencies in breeding for improved pest and disease resistance and ratoon performance. Primary amongst these were approaches to enable pest and disease resistance screening in the very early stages of the breeding process, particularly in the first stage of selection during which families of plantlets from specific parental crosses are evaluated. Data obtained during the course of 2015/2016 demonstrated significant family effects and high predicted selection gains, indicating that the new tactical approach has the potential to deliver significant improvements in eldana resistance over time.

Good progress made in implementing pest and disease resistance screening earlier in the breeding process.

Genetic gains

Data regarding the progression of sugarcane genotypes from the single line stage of selection programmes to the observation trial stage revealed significant improvement in key traits relative to the controls (a set of released varieties most commonly cultivated in the region that the selection programme services).

- In the selection programme for the irrigated regions, data indicated the potential for good genetic gains in cane yield, RV% and sugar yield. In addition, data from the observation trials indicated potential gains for eldana resistance, which is promising.
- For the long- and short-cycle coastal programmes, analysis of selection data indicated significant improvement (relative to control varieties) in cane yield, ERC% and total sugar yield, which indicates that genetic gains are being made in these traits. Unfortunately, the observed gain in eldana resistance for this programme was disappointing and research is ongoing to improve eldana resistance amongst the parents used in this programme. Of note is that N58 is proving to be a good parent for the coastal programme, with progenies displaying high cane, sucrose and total sugar yields.

Good potential demonstrated for genetic gains in cane yield, RV% and sugar yield for the irrigated regions

Good potential demonstrated for genetic gains in cane yield, ERC% and total sugar yield for the long- and short-cycle coastal programmes.

INTROGRESSION BREEDING

Introgression Breeding seeks to expand the genetic base of parental germplasm used in Commercial Breeding by performing successive crosses between elite commercial varieties and either plant species closely related to sugarcane or the ancestral species that gave rise to modern commercial hybrid varieties.

Progress in Ongoing Research

Research in 2015/2016 focused on developing technologies to:
(a) synchronise flowering amongst commercial varieties and their ancestral and related species; (b) store pollen so that it remains viable for as long as possible, particularly for planned crosses in which synchronisation of flowering of parents is problematic; and (c) determine the genetic diversity of current parental germplasm to enable rational planning of introgression crosses.

Synchronisation of flowering

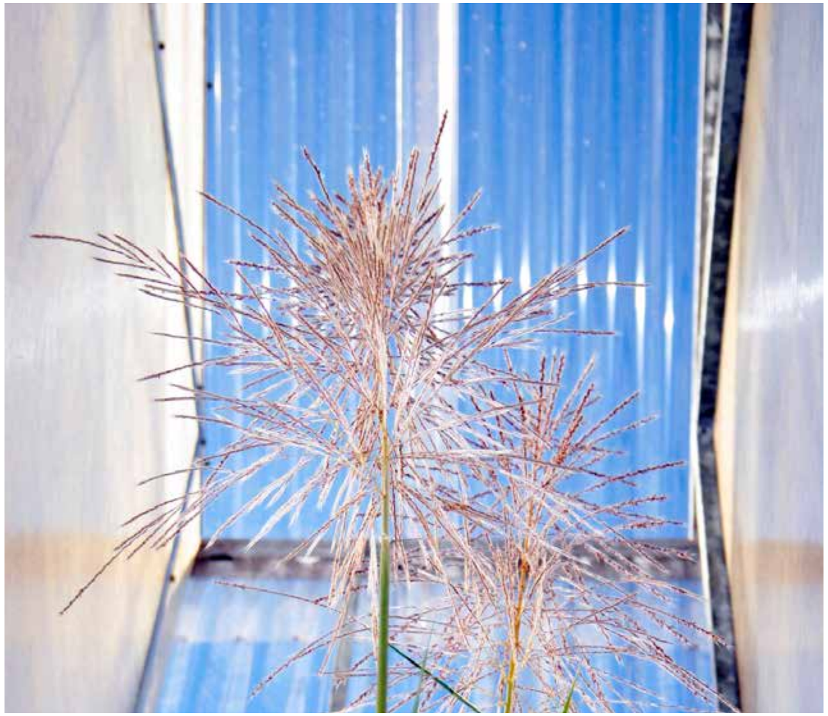
Recent data indicate that manipulation of day length through photoperiod treatments together with pollen viability testing will play an important role in achieving the desired introgression crosses. For example, introgression crosses between commercial *Saccharum* spp hybrids and wild species (*e.g. S. spontaneum*) or F_1 hybrids will be possible using natural date to flowering and pollen viability assessments. Protocols to synchronise the flowering of the commercial hybrids and the wild sugarcane relatives and ancestral species remain under investigation and development.

Protocols to synchronise the flowering amongst sugarcane varieties and ancestral and related species show promise.

Pollen storage

A particular challenge faced in sugarcane breeding is that sugarcane genotypes and varieties flower at different times and considerable effort is required to synchronise flowering through photoperiod treatments so that specific crosses may be made. As a result, research is underway to develop ways to store the pollen of different varieties and genotypes so that targeted crossing becomes possible. Promising preliminary results indicate that sugarcane pollen might potentially be stored for at least ten days at 9°C following a dehydration treatment for 1h. Should this storage period be increased further, far greater flexibility and increased efficiencies would result for the SASRI commercial and introgression breeding programmes.

Pollen storage for at least ten days at 9°C under specific conditions may be feasible.



Pollen viability testing

Traditionally, a simple starch-iodine staining test is deployed to assess if sugarcane pollen is viable before it is used in crossing. The iodine test is known not to be completely reliable and, hence, research is underway to develop an alternative more reliable test that is as equally convenient and cost-effective. Recent results have identified a test that potentially meets these criteria. The test under investigation is based on the stain, 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide (MTT).

A promising alternative method for reliable pollen viability testing is being investigated.

Genetic diversity analysis

A study has been undertaken to evaluate the extent of the genetic diversity that exists within SASRI breeding populations using DNA markers. The experimental population analysed comprised a set of 557 sugarcane genotypes with subsets of 470 genotypes selected from the different SASRI regional breeding programmes (including released varieties) and 87 wild and related species (37 *Saccharum spontaneum*, 13 *Erianthus* spp., 9 *S. robustum*, 29 *S. officinarum* and 1 *Miscanthus* spp). The genetic diversity was assessed both within and amongst the regional programme breeding populations.

The results obtained during 2015/2016 revealed a general trend over the past 50 years towards the narrowing of the genetic diversity of the SASRI breeding germplasm both within and amongst the regional programmeme breeding populations. These results emphasise the importance of Introgression Breeding, which aims to increase the genetic diversity of germplasm used in breeding.

A general trend over the past 50 years indicates a narrowing of the genetic diversity of the SASRI breeding germplasm.

Introgression breeding aims to expand the genetic base of parental germplasm used in Commercial Breeding.

GENOMICS

Genomics entails the analysis of the sugarcane genome to identify genes and determine their arrangement on chromosomes with a view to discovering DNA markers for ultimate use in marker-assisted Commercial Breeding. As the complex sugarcane genome is not fully sequenced, a comparative mapping approach is used in which the sequenced genomes of closely-related plant species are used as an assembly scaffold. This data- and computing-intensive undertaking requires the development of customised bioinformatics software applications.

Progress in Ongoing Research

Bioinformatics pipeline development

In a first for international sugarcane genomics research, a unique bioinformatics pipeline has been developed that allows for the assembly of the DNA sequences of all expressed genes (the 'exome'). Using this pipeline, 40 genes associated with stress tolerance have been identified. These genes have been characterised in sorghum and maize and the pipeline has revealed their presence and expression in sugarcane. In addition, a gene identified in *Miscanthus* (elephant grass), a relative of sugarcane, associated with flowering (*apo1*) has been identified in sugarcane. This bioinformatics pipeline will permit the identification of further genes associated with important sugarcane traits which will ultimately be deployed in marker-assisted Commercial Breeding.

A unique bioinformatics pipeline has been developed to facilitate the assembly of the DNA sequences of the sugarcane exome.

New Research

Molecular biology of sugarcane responses to eldana

Research commenced in 2015/2016 to identify genes that are expressed differently between eldana resistant and susceptible sugarcane varieties when subject to infestation by the insect. This approach will permit the identification of genes involved in eldana resistance mechanisms. The genes identified will be subjected to intense analysis to determine their suitability for use as molecular markers of resistance. These markers will be deployed in marker-assisted breeding to identify the presence of specific resistance genes in both parents and progenies. If successful, this approach will result an effective eldana resistance breeding strategy through enabling targeted crossing and early-stage selection.

During 2015/2016, a randomised, replicated trial was conducted under controlled conditions during which N11 (eldana susceptible) and N33 (eldana resistant) were subjected to boring by eldana larvae over a two day period. Stalk tissue surrounding each boring was collected, snap frozen to an ultra-low temperature and processed for the sequencing of genes expressed.

Identification of genes associated with eldana resistance will permit the development of genetic markers for use in eldana resistance breeding.

VARIETY CHARACTERISATION

The performance of newly released and established varieties is subjected to ongoing assessment under a range of agro-climatic conditions, providing information which is used in the development of variety recommendations for growers.

Progress in Ongoing Research

Variety ratooning dynamics

Plant crop RV yield data were obtained during 2015/2016 from variety evaluation trials conducted under irrigation on co-operating grower farms in Pongola (high and low potential conditions) and Komatipoort (average potential conditions). Varieties N49 and N53 performed consistently well across the trials. Relative to N25 and N36, the RV yield of N41 and N57 did not meet initial high expectations, although, based on preliminary data from other sources, these two new varieties are expected to significantly outperform the older cultivars in the ratoon crops.

N49 and N53 perform consistently well under northern irrigated conditions

Resistance to Yellow Sugarcane Aphid

A variety evaluation trial located in the Upper Tongaat area on the farm of a collaborating grower, confirmed that N12 shows generally good resistance to yellow sugarcane aphid and thrips infestations, as well as brown rust infections.

N12 shows generally good resistance to yellow sugarcane aphids and thrips.

TRAIT DEVELOPMENT

Modern biotechnological tools are used to either confer novel traits to sugarcane or to enhance existing traits. During 2015/2016, research was ongoing to improve nitrogen-use efficiency by genetic engineering and to confer drought tolerance and tolerance to the herbicide, imazapyr, by mutagenic breeding. Current research also seeks to refine genetic engineering technologies to ensure optimum efficiencies, should the industry elect to commercialise a genetically-modified variety in the future.

Progress in Ongoing Research

Improved nitrogen-use efficiency by means of GM technology

In a trial conducted on potted sugarcane plants grown under N-limiting conditions, genetically-modified NCo376 plants expressing a barley alanine aminotransferase gene were observed to have significantly higher biomass, particularly evident as increased stalk height, than genetically unmodified plants. The nitrogen-use efficiency (NUE) of two of the GM lines was significantly higher than the untransformed NCo376 controls. The GM technology enabled NCo376 to be transformed from a low NUE variety into a high NUE variety, with a NUE similar to that of N19.

In a proof-of-concept study, GM technology enabled the transformation of NCo376 from a low NUE variety into a high NUE variety.

Methodology for NUE determinations

A method to rapidly and reliably determine the nitrogen-use efficiency (NUE) of genetically-modified sugarcane lines expressing a barley alanine aminotransferase gene is under development. The outcomes of NUE assessments conducted on plants grown in tissue culture and in 20 litre pots have been compared to those from field trials. Results indicate that a rating system conducted on potted plants yields similar NUE data to those obtained under field conditions. With further development, refinement and validations, the system could potentially be used to rate the NUE of conventional varieties.

A refined method could potentially enable the determination of variety NUE without the need for lengthy and costly field trials.

Herbicide-tolerant sugarcane by mutagenic breeding

Three lines of N12 produced by mutagenic breeding at SASRI that have increased tolerance to imazapyr underwent field assessments in 2015/2016 to determine whether they have similar agronomic features and perform as well as conventional N12. The stalks of conventional N12 were found to have a greater diameter than those of the herbicide tolerant lines, although there is evidence suggesting that this might be a common tissue culture effect that will dissipate over successive ratoons. In addition, the fibre content of conventional N12 was observed to be greater than that of the herbicide tolerant lines.

Generally, no significant differences in yield between the herbicide tolerant lines and conventional N12 were observed, although one of the herbicide tolerant lines outperformed the conventional N12. In terms of pest and disease resistance, the herbicide tolerant lines did not differ significantly from the conventional N12, although one line was observed to have a significant increase in the number of internodes bored by eldana.

Molecular analyses revealed that two of the herbicide tolerant lines have a point mutation in the gene of the enzyme acetohydroxyacid synthase (AHAS), which confers tolerance to imazapyr. Interestingly, the herbicide tolerant line that outperformed conventional N12 in terms of yield did not display the same point mutation. The mechanism underlying the imazapyr tolerance of this this line will be investigated further in 2016/2017.

The agronomic performance of imazapyr-tolerant sugarcane produced by mutagenic breeding are undergoing agronomic assessment.

Optimisation of protocols for producing GM sugarcane

An important consideration for the commercialisation of GM crops is the number of copies of the new gene present in the plant, with regulatory authorities favouring GM crops that have a single copy. Consequently, SASRI is conducting research to develop a protocol that produces GM sugarcane containing a single copy of the introduced gene. Results obtained during 2015/2016 revealed that the new protocol produced GM lines as follows: single copy (19%); two-to-three copies (10%); no copies (24%); and multiple copies (47%). These results are promising and investigations will continue in 2016/2017 to refine the methodology to further increase the proportion of GM lines containing a single copy of the new gene.

New Research

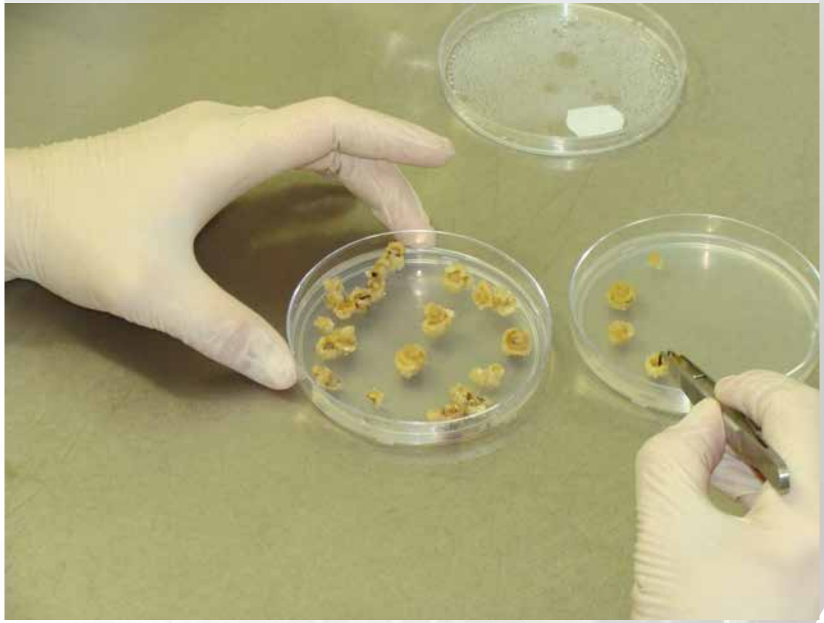
Mutation breeding for eldana resistance and drought tolerance

During 2015/2016, the refinement and application of technologies to enable mutagenic breeding for eldana resistance and drought tolerance commenced. The research comprises two components: (a) the refinement of two *in vitro* chemical mutagenic methods developed previously; and (b) the development of *in vitro* selection protocols to identify sugarcane mutants displaying the increased eldana resistance and drought tolerance.

Mutagenesis is to be conducted using a combination of two chemical mutagenic agents to increase the likelihood of obtaining mutants with both increased allelic variation (genetic sequence changes) and expression variation (due to epigenetic tag changes and retrotransposon activity). For *in vitro* selection, mutagenised regenerable sugarcane callus will be exposed to heat stress and a selection of xenobiotics that are produced in plants during stress. These selection methods will be based on the ability of the mutant sugarcane plants to tolerate or detoxify these cytotoxic compounds.

During 2015/2016, embryogenic callus of N41 and NCo376 were exposed to the two chemical mutagens and selection was conducted for mutants tolerant of oxidative stress, lipid peroxidation and a metabolic by-product of stress. Analysis of the mutants produced will be ongoing in 2016/2017.

Analysis of mutants for eldana resistance and drought tolerance will be ongoing in 2016/2017.



RESEARCH EXCELLENCE

International and National Benchmarking

- Eleven peer-reviewed articles were published in internationally-accredited scientific journals.
- Twenty-three articles were published in peer-reviewed scientific journals and conference proceedings.
- Two chapters were published in books with wide international recognition and distribution.
- Thirteen Honorary University appointments were sustained by staff members.
- National Research Foundation (NRF) rating was maintained by nine scientists.
- Several international collaborations sustained (SRA, CIRAD, CSIRO, ICIPE, ICSB, ICSM, IRD, MSIRI).
- Fourteen post-graduate students and two post-doctoral researchers were based full-time at SASRI.
- Degrees were conferred on one PhD and six MSc post-graduate students.
- Research of seven SASRI staff undertaken towards a post-graduate qualification (4 PhD, 4 MSc).
- Two staff obtained MSc or MSc (Engineering) degrees.

Quality assurance and benchmarking research excellence against best in the world thereby ensuring innovative and advanced technology development.

Increased research capacity provided through collaborations and post-graduate research programme thereby providing more value to our stakeholders.

Strategic RDI Partnerships

SASRI maintained formal R&D partnerships or collaborations as follows:

- School of Engineering (University of KwaZulu-Natal) – Research project.
- Institute for Plant Biotechnology (Stellenbosch University) – Two research projects.
- Department of Logistics (Stellenbosch University) – Research project.
- School of Biological Sciences [Botany Division] (North West University) – Research project.
- International Consortium for Sugarcane Biotechnology - Research project.
- International Consortium for Sugarcane Modelling - Research project.
- Water Research Commission – Research project.
- Agricultural Model Intercomparison and Improvement Project (AgMIP): Regional climate change impacts assessment and sugarcane model improvement projects.
- Wildlife and Environment Society of South Africa - Research project.

SASRI seeks out new and fosters established partnerships to enhance research and development capacity to the benefit of the industry.

Funding Awards

SASRI Researchers were awarded grants as follows:

- Department of Science and Technology Bioinformatics and Functional Genomics Programme (in conjunction with the Institute for Plant Biotechnology at Stellenbosch University) – R597 578 over two years.
- Biosafety SA (DST Technology Innovation Agency) – R4 462 800 over three years.
- Department of Science and Technology National Equipment Programme – R6 300 000.
- Department of Agriculture, Forestry and Fisheries Research and Technology Fund – R900 000 over three years.
- International Atomic Energy Agency – €6 000 over two years.
- Research excellence of SASRI was recognised by the award of NRF Incentive funding to eight SASRI scientists.
- Co-funding of projects was awarded by the Water Research Commission, World Wildlife Fund and the National Research Foundation.
- Ongoing funding for investigating bio-pesticides for white grub control was received from the European Union Africa, Caribbean and Pacific (EU-ACP) Programme.

Increased leveraging of funds achieved, contributing to research efforts.

ACHIEVEMENTS AND AWARDS

William Gillespie (Small-scale extension specialist: Midlands) won the Most Popular Paper for his paper titled "Measuring the effectiveness of Extension for small-scale sugarcane growers: A case study" at the 49th SA Society for Agricultural Extension Conference. He co-authored the paper with FJ Mitchell (Scientific Manager Natural Resources, DARD).

Sifiso Hlela (Small-scale Extension Specialist: Pongola) and **Patrick Ngcobo** (NFG Extension Specialist) won the Best Delivered Poster for 2015 for their co-authored poster titled "The use of sugarcane ripeners within the small-scale grower sector in Pongola" at the 49th SA Society for Agricultural Extension Conference. Other contributors to this poster were Sivuyile Ngxaliwe (SASRI Assistant Research Officer), Nosipho Qwabe (SA Canegrowers), B Motsa (TSB) and M Mahafha.

The South African Society of Crop Production (SASCP) is a science-based organisation renowned for providing leadership in crop science. In 2015, **Dr Alana Patton**, Crop Agronomist, was elected onto the Council of the SASCP for the 2015/2016 period.

Dr Sanesh Ramburan, Variety Scientist, was elected as Vice-President of the SASCP for 2015/2016 at the same event. In early 2016, Dr Ramburan was also awarded the Best Paper at Congress (for a member older than 30 years) by the SASCP for his paper "Agronomic and economic comparisons of harvest age effects on rainfed sugarcane in South Africa" at the 2016 Combined Congress.

Dr Ramburan was also awarded with the Kynoch Prize for his paper "Optimum harvest age in rainfed regions: interactions between variety, age and *Eldana saccharina* (Lepidoptera: Pyralidae) damage" at the 88th SA Sugarcane Technologists Association Congress (SASTA). This prize is given for the best paper in the Agricultural section of Congress. This is the second time Sanesh has received this prize as he was first awarded with this honour at the 86th SASTA Congress in 2013.

Further to this, he won the Agricultural Jubilee Award which is a trip to the 2016 International Society of Sugar Cane Technologists Congress (ISSCT) in Thailand. This award is given to an exceptional author's paper/poster contribution at the SASTA Congress in the year preceding each ISSCT Congress.


William Gillespie


Philemon Sithole


Sifiso Hlela


Aresti Paraskevopoulos


Patrick Ngcobo


Rianto van Antwerpen


Alana Patton


Neil Miles


Sanesh Ramburan


Marvellous Zhou

Philemon Sithole (Assistant Research Officer: Agronomy) and **Aresti Paraskevopoulos** (Scientific Programmemer) won the Agriculture Poster Prize for their poster "A web-based real-time weather data tool for the South African sugar industry" at the 88th SASTA Congress.

Dr Rianto van Antwerpen, SASRI Senior Soil Soil Science Society of South Africa (SSSSA) 2015/2016 period. In addition, he won the Best Paper at Congress (for a member older than 30 years) for his research paper entitled "Effect of 75 years of fertilisation and mulching on soil acidification in sugarcane" at the 2016 Combined Congress. The paper was co-authored with **Dr Neil Miles** (SASRI Senior Soil Scientist) and Dr Pascal Podwojewski (IRD).

Dr van Antwerpen was also awarded the Fertiliser Association of SA Silver Medal for Research in 2015.

Dr Marvellous Zhou was elected as the Vice President of the executive council of the South African Plant Breeders' Association in 2015.

ADVISORY AND SUPPORT SERVICES

Kerry Redshaw

SPECIALIST ADVISORY SERVICES

SASRI researchers and specialists provide essential sugarcane agriculture services and support to the local sugarcane industry as well as to a number of external customers (local and international). 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 these SARs 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; pest and disease identification; control and management; crop forecasting; ripener advice and decision-making; soils management; and crop performance and management.

SASRI received 71 Specialist Advisory Requests (SARs) during 2015/2016. After evaluating capacity and relevance to SASRI, 53 of these requests were addressed by the end of March 2016.

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 36 Extension Requests for Advice (ERA) during 2015/2016. Of the total, 31 of these ERAs were for Land Use Plans (LUPs) and farm maps. 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. This advice is 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 2015/2016, the FAS focused on expanding their services provided to crops other than sugarcane eg. bananas and macadamia.

Soil sample submission numbers during 2015/2016 were lower than 2014/2015 however, the other samples (leaf, fertiliser and water) were similar to the previous season. A breakdown in sample numbers for 2015/2016 are captured in the following table:

	2015/2016				2014/2015
	SA Growers	SASRI Research	Outside SA	Total	Total
Soil	16061	3630	4776	24467	27651
Leaf	1008	4790	4111	9909	9861
Fertiliser	2972	26	508	3506	3545
Water	56	3	86	145	105

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 (RSD) and Yellow Leaf Virus (YLS). During 2015/2016, a total of 10 134 RSD samples were analysed with 7 771 of these samples coming from SA growers and 2007 from other countries. The remaining number of samples (356) were from SASRI research trials. SASRI also conducted training on a user pays basis, in Mozambique and Malawi 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 is 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 2015/2016, 19 different disease-free varieties were exported to 9 countries, namely Burundi, Gabon, Ghana, Mozambique, Nigeria, Sierra Leone, Tanzania, USA and Zambia. Sugarcane fuzz was exported to Zimbabwe and Pakistan. A total of 23 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 2015/2016, SASRI mass reared and distributed 182 068 biological agents for the Department of Environmental Affairs. The biological agents produced by SASRI 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 2015/2016, a total of 1 938 DNA sequences and 3 249 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 available on the SASA Website).

Many stakeholders make use of these mechanisation reports. Growers use them for annual budget preparation. 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 DSPs.

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 giving comment on the development and implementation of the national government's water policy on behalf of the sugar industry.
- Monitoring and giving 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.
- 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. All installations are conducted according to established standards and include programmeming 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 AND EXTENSION

Rowan Stranack

BIOSECURITY

The incorporation of the pest, disease and variety control inspectorate into SASRI resulted in the integration of Extension and Biosecurity staff into a single unit to effect more streamlined and economical management. At the end of the report period there were 24 inspection teams servicing 12 Local Pest Disease and Variety Control Committee (LPD&VCC) areas across the industry. This now represents a full complement of field staff who are managed by a team of nine Biosecurity Technicians and Officers supported in all but one instance by local SASRI Extension Specialists.

Programmes of work and reporting systems were implemented and regular feedback was provided to the industry through the Sugarcane Research and Sustainable Agriculture Committee (SRASAC). This committee, absorbed the functions of the Local Pest Disease & Variety Control Steering Committee during the course of 2015.

During 2015, a new LPD&VCC area was established to service the Mkhuze and Makhatini region in northern KwaZulu-Natal. An office was established at Jozini and a new team for the area was recruited. These were active by the end of March 2016.

Two additional inspection teams were employed in the Midlands South and Umzimkulu areas as current resources were inadequate to cope with the additional inspection demands, particularly with respect to eldana and seedcane surveys.

The LPD&VCC Rules were approved by SASA Council in March 2015. These rules set minimum standards for both Committee governance as well as pest, disease and variety control. Particular emphasis was placed on the provision of adequate supplies of Certified and Approved Seedcane. Committees have been given an eight-year window period within which to ensure that all replanting of commercial fields is carried out using either Certified or Approved seedcane.

Strategic biosecurity

The SADC regional biosecurity is an expert group facilitating communication and the exchange of knowledge on biosecurity issues affecting the region. This will enable early warnings of any new incursions into the region and the possibility of a co-ordinated approach to dealing with them. Regular contact is maintained with Swaziland, in particular, due to the close proximity of the two industries.

Crop Watch Africa was engaged to establish a network of pheromone traps along the borders of South Africa and Mozambique in order to provide early warning of an incursion by the spotted sugarcane borer, *Chilo sacchariphagus*. This organisation provides a scouting service to a number of other crops in the region. Through them, valuable contact has been established with the relevant government departments as well as the US Department of Agriculture who provide assistance to developing countries in matters of biosecurity.

Eldana

The prolonged drought which began in 2014, resulted in an alarming increase in eldana levels along the KwaZulu-Natal coastal belt and adjacent Midlands areas.

In response to this problem, an amendment to clauses 77 and 78 of the Sugar industry Agreement 2000 was published in the Government Gazette. This enabled the inclusion of the spraying of eldana insecticides as a remedial measure in addition to harvesting of infested cane. Two new products obtained temporary registration and another full registration. The arrival of these insecticides was fortuitous given the magnitude of the threat and necessitated a large-scale awareness programme amongst growers. In addition, the introduction of certain requirements by the Insect Resistance Action Committee (IRAC) added to the complexity of the required spray programmes and frequent meetings were held with the agrochemical trade to establish understanding of both these requirements as well as the correct and effective use of the products.

In 2015, approximately 105 000 hectares were surveyed for eldana across the industry. Surveys were mainly focused on cane for the following season, as this cane was the most susceptible and required protection due to the continued drought and rising eldana levels. Additional survey teams had to be deployed in areas where eldana posed the most serious threat, namely the North Coast and Zululand. This exercise was successfully completed and enabled strategic decisions on control measures to be taken with confidence.

LPD&VCCs were forced to adopt a more strict approach in order to protect the crop in areas where eldana was not previously regarded as a serious threat. The Midlands North and South, and Umzimkulu LPD&VCCs all applied for changes to be made to their local rules to enforce spraying of cane which was found to be approaching hazard levels. These rules also required evidence of a reduction in eldana levels before permitting carryover to the following season.

Overall the treatment of carryover cane with insecticides proved successful. The Midlands South area took the decision to levy their growers to fund spraying and in other areas spray programmes were co-ordinated to ensure effective and optimum use of resources. Generally, in areas where eldana was a problem and growers did not spray, levels in the off season rose dramatically resulting in very poor quality and yields. Some premature harvesting of fields had to be ordered at the beginning of the 2016 season to clear the most severely infested fields.

Other pests

During the year a number of other minor pest incursions were recorded. There was an outbreak of scale insects with associated sooty mould in Mpumalanga. Sooty mould associated with infestations of the sugarcane aphid *Melanaphis sacchari* was also recorded in Pongola and the Midlands. Leaf folder moth was found in cane in the South Coast, Umzimkulu and Midlands South regions and minor outbreaks of grasshoppers were also noted in some regions.

More damaging were occurrences of white grubs (*Heteronychus* spp.) in the Gingindlovu area. These caused localised stool mortality and further monitoring of these outbreaks will be necessary in the future. The most serious new pest incursion to the industry was identified in the Entumeni area in October 2015, when damage caused by the larval stage of the Cerambycid family was noticed. This pest causes extensive damage to the lower regions of the cane stalk and often leads to mortality. Close monitoring of this pest incursion continued throughout the year.

Disease inspections

The LPD&VC teams inspected 7 451 commercial fields and 3 214 intended seedcane sources for smut, mosaic and off-types during the 2015/2016 season. Inspections covered over 46 300 ha representing approximately 12% of the total area under cane. In addition, a total of 9 695 samples were received from commercial and intended seedcane fields for RSD testing.

Smut

There was a slight increase in smut incidence (percent stools infected) in the 2015/16 season compared to the previous two seasons, with notable increases in Pongola and Gledhow. The increase in Gledhow was largely due to extremely high levels in two fields (one NCo376 and the other mixed) on one farm. The increase in Pongola was more widespread with the disease increasing in prevalence (percent fields infected) than in previous seasons. Smut was observed in most varieties being grown in the area but was particularly common and severe in N19, N25 and N41. Smut prevalence has decreased rapidly in Amatikulu over the past three seasons as NCo376 has been replaced with more resistant varieties. A slight increase in smut incidence was noted in the Midlands North area with N48 and N54 being most commonly infected.

Mosaic

Mosaic incidence and prevalence were below the five year mean in most areas. Mosaic was more widespread in Maidstone than in previous seasons but levels within the infected fields were lower. High levels of mosaic in N12 fields on one farm in Umzimkulu resulted in a marked increase in mosaic incidence in the area and plough out was required. A number of seedcane fields of N57 were condemned in the Lowveld due to an outbreak of mosaic in early 2016. Of the 78 fields of N57 inspected, 27 (35%) were found to be infected, with levels ranging from a trace to 2.5% stools infected.

Ratoon stunt (RSD)

A total of 9 695 samples were received for RSD testing in 2015. Of the 6 116 samples from commercial fields, 413 (6.8%) tested positive for the disease. This is lower than the five year average of 9.3%. RSD was detected in 1.9% of the samples submitted from intended seedcane sources, similar to the five year average of 2.2%. However, there was a marked year-on-year increase in Umfolozi since 2012 and RSD levels in the Darnall/Gledhow, Sezela and Umzimkulu areas exceeded the five year average in 2015. No RSD was detected in 153 samples collected from commercial fields in the Felixton area but five seedcane sources tested positive.

Rust

Brown rust was observed through much of 2015 in the high lying areas, particularly in varieties N37, N39 and N42 but infections tended to be less severe than previous seasons. Fewer reports of tawny rust was received but N57 was degazetted in the Midlands due to the severe infections observed in new plantings grown under irrigation in 2015.

Seedcane

The ongoing drought has placed extreme pressure on seedcane sources in many areas. Generally however, the area replanted during 2015 was less than normal due to the unfavourable conditions in spring 2015. Emergency seedcane had to be sourced in most areas and only in areas where compulsory seedcane schemes are in place was this easily sourced. The shortage of seedcane was likely to become more serious in the coming seasons as growers find it necessary to replant more in order to keep their fields in cycle.

New varieties

A total of 61 bulking plots of new varieties were established in LPD&VCC areas across the industry in 2014. Most of these were either released directly to growers or bulked up further in seedcane schemes. Of the latest SASRI varieties, the coastal long cycle varieties N58 and N59 formed the bulk of the releases in 2015. Other varieties released were N52, N53, N54 and N57, all in the southern rainfed regions. Fortunately, only a small number of the plots were affected by the drought and releases were delayed as a result.

In spring 2015, new SASRI varieties N60, N621 and N62 went into bulking as transplants on co-operators farms in the Midlands and coastal rainfed regions. These will be released in spring 2016.

EXTENSION

Mpumalanga (Komati, Malelane)

Good rains from October through to December 2014, raised expectations for the 2015/16 crop. However, erratic rainfall resulted in January, March and April 2015 being well below LTM. Unfortunately below average rain continued from spring and summer 2015 to February 2016 and restrictions were imposed on all systems; the Crocodile Komati and Lomati. By January 2016 only 50% of allocation was available and this dropped to 30% in February 2016. The lack of water in these critical growth months had a significant impact on the outlook for the 2016/17 crop.

At the extreme, some fields were eventually abandoned as water supplies diminished. Dam levels dropped significantly and the water supply for 2016/2107 was under severe pressure. The lack of rain and restricted water availability through the season resulted in the final crop declining by 5% on the first estimate. The season provided an ideal environment for natural ripening and the Lowveld mills, together with Pongola ended up with the highest RV% of the mills across the industry. Dry conditions and higher purities during the early part of the season resulted in less Ethephon being applied than in the previous year.

Although smut levels were not significantly different to past seasons, one field of 35 hectares received an immediate plough-out order. Some concern was raised over the detection of mosaic in the newly released variety, N57. An extensive survey was undertaken and 30% of fields surveyed of this variety were found to have mosaic. A warning was circulated to growers cautioning them to ensure all seedcane sources were mosaic-free. Although not worse than previous years smut in some instances was recorded at levels which required plough-out orders. The most significant of these was a field of 35 hectares which required eradication.

Pongola

For the entire 2015/2016 season conditions were extremely dry. Rainfall was above LTM in only one month. The level of the Bivane dam at the start of the season was only 53% and irrigation was restricted to 50%. The level of the dam started to drop steadily through the year to 12% in March. The Pongola River rose periodically as a result of rains in the catchment and growers on the river system were able to apply water for a period.

In the early part of the season, yields and quality were very good and only at the end of the season had yields begun to decline due to the lack of irrigation and rainfall. Cane quality remained good throughout the season. By the end of the season, the ratooning crops were under severe stress slowing growth during the critical summer months.

Planting was restricted due to the poor conditions. Prospects for the 2016/17 crop were pessimistic as a result. Extension efforts were aimed at minimising the impact of reduced water availability. Grower days and newsletters were used to emphasize the message. The superior water use efficiency of drip irrigation systems compared to overhead was highlighted during the season. With the stress to the crop, eldana emerged as a threat and efforts were made to caution growers regarding carryover. A grower day was held to highlight eldana management strategies, especially with the advent of chemical control options. Smut levels also increased particularly in varieties N25 and N41. At the end of the season the final crop was only slightly down on the first estimate but prospects for the following season were not promising due to the persisting drought.

Umfolozi

The 2015/16 season was like many other areas characterised by very low rainfall. The drought was already entrenched in 2014 but despite this, the crop harvested during the early part of the season performed reasonably and estimates were even exceeded in some instances. The normally high water table on the Umfolozi Flats can affect both yield and quality negatively in some seasons. In the absence of good rains however, the water table was lowered and this could have resulted in improved yields and quality. Apart from good rain in July 2015, rainfall remained below LTM for the 2015/16 season. There were instances of stool mortality but the region was spared widespread ratoon failure.

Eldana remained a threat due to the dry conditions and surveys were targeted accordingly. The final crop for the 2015/16 season was only slightly down on the first estimate for the season, but prospects for the following crop were bleak due to the on-going drought.

Extension efforts during the year were aimed at drought-related issues. Grower days on managing droughted cane and eldana control featured but attention was also given to variety management and particularly the new varieties N58 and N59. A ripener workshop was also held. A campaign was started to focus grower's attention on delivering clean cane. Ash tests had been introduced and growers were given regular reports on performance on this important issue. A soil identification workshop was held for land reform growers.

Felixton

Rainfall in the Felixton area followed a similar pattern to other parts of Zululand. The drought began in 2014, continued through 2015/16 and with the exception of July, rainfall was below LTM every month. The July rain was significant and saved the crop from extensive ratoon failure. However, growth was not influenced to improve the crop. Growers in the Mposa area resorted to mowing their crops instead of carrying over the cane.

By early 2016 the drought had resulted in severe water stress and the prospects for the 2016/17 season were not good. Cane quality throughout the season was problematic with low purities and high non-sucrose levels. The moisture content of the cane was also relatively low due to the dry conditions. The threat of eldana increased as the drought persisted and some growers undertook chemical control measures, which yielded positive results.

With little inflow into the Goedetrouw Dam, levels dropped significantly during the season. By early 2016, the level in the dam was only 20%. Water restrictions had been in place for some time before this and very little irrigation was possible. There was a widespread shortage of seedcane but planting was generally curtailed due to the drought. This shortage and reduced planting would have a negative effect in the following seasons when an increased area would need to be replanted placing demands on seedcane supplies. Due to the long-established seedcane scheme in the area however, there was a ready supply of emergency seedcane available.

Extension efforts were aimed primarily at managing the drought and related issues. Grower days on managing drought affected cane and spraying insecticides to control eldana were held during the year. A presentation was also given on the benefits of green cane harvesting, following a trial examining the effects of a mulch on a range of varieties that was conducted in the area. Variety field days were also held at SASRI variety trials where growers could observe the performance of released varieties under highly adverse conditions. The new varieties N58 and N59 were released during the season. Efforts were made to encourage SUSFARMS® amongst growers in the area.

Amatikulu

At the beginning of the 2015/16 season, the Amatikulu area had already experienced 18 consecutive months of below average rainfall. This obviously placed the crop under severe stress and the trend continued through most of the season with the exception of one above average rainfall event in July, and December when long-term mean rainfall was recorded. For the remainder of the report period the crop remained under severe stress, placing some growers under financial pressure. The unfavorable conditions resulted in the lowest crop since the severe drought of the 2010/11 season. The July rains did however, prevent widespread ratoon failure which reduced the need for replanting. On the better soils in the hinterland, conditions were not as severe however crop growth and cane quality were very disappointing. The final crop was down 43% from the previous season.

Poor rainfall resulted in increased eldana levels and there was great concern that cane would have to be carried over due to being un-millable; exposing the crop to even more eldana pressure. Extensive surveys were undertaken by the LPD&VCC teams, with the assistance of additional teams from outside the area. Fortunately this enabled high risk fields to be identified early enough for action to be taken. The season also saw the start of an extensive insecticide spray programme to control eldana in carryover cane being implemented by many growers. Extension efforts were aimed particularly at assisting growers plan their spray programmes since the release of the three new chemicals for eldana. This was done with the input of SASRI specialists who guided the complex technicalities of applying insecticides without the build-up of resistance.

By the end of the season and into 2016, the drought had not broken and the area braced itself for another difficult year. Towards the end of 2015, a new pest was identified on a farm in the Entumeni area. The larval stage of a longhorn beetle of the Cerambycid family, caused extensive borings in sugarcane stalks, eventually causing stalk mortality. Further surveys and investigations were ordered and the outbreak was closely monitored into the new season.

North Coast (Darnall, Gledhow, Maidstone)

Like Zululand, the North Coast began the season with the cane already under water stress from an extended period of below average rainfall. As with other parts of the coastal belt there were welcome rains in July but these did not contribute significantly to crop size but did prevent widespread ratoon failure. Dry conditions continued into 2016 and as a result the crop was significantly affected being the lowest since the 2010 drought year. Cane quality was also poor with short cane being harvested with low RV% and high fibre levels. This was due to tops being included in order to load the cane.

As with the other coastal areas, eldana was a major problem. Growers embarked upon spray programmes to protect the crop going into the following year. In many instances good results were achieved through spraying and it will likely become standard practice in the future. Sporadic outbreaks of yellow sugarcane aphid occurred although not as widespread as in previous years. There was a serious incidence of white grub (*Heteronychus licas*) damage on a farm in the Tugela Mouth area. This pest is not widely recorded on the North Coast and will require monitoring in the future. Extension efforts were aimed primarily at assisting growers with drought related issues and in particular eldana management and spraying strategies.

Good use of grower study groups is being made in order to facilitate the exchange of new technology. A significant achievement this year was the award to a North Coast grower of the Young Farmer of The Year Award, a national competition organised by agricultural writers. This prestigious achievement served to highlight the effectiveness of Better Management Practices as promoted by SASRI through extension. As part of the Crop Performance & Management Research programme review, a very successful visit was held to this particular farm.

There was a focus on the provision of adequate seedcane supplies into the future. Certified nurseries at Maidstone and Gledhow assured some stability of supply but wider use of these facilities will need to be encouraged in order to ensure all fields are planted with either Certified or Approved Seedcane sources. The new varieties N58 and N59 were released to growers from bulking in Spring 2015.

Midlands (Eston, Noodsberg, UCL)

Like other areas in the industry, the start of the 2015 season was made on the basis of a very poor growing season in 2014 characterised by generally below average rainfall. Rainfall during the 2015 was generally below average, apart from an unseasonal single but significant rainfall event in July, and December when good rains were recorded. Two significant hailstorms occurred in the Midlands early in 2015, one in New Hanover and the other in the Powerscourt area, both causing extensive damage to cane. Although frost did occur the events were not as severe as previous years. Some traditionally frosted areas remained free of frost for the season, resulting in growers withdrawing these fields from their estimates. The end result of the crop for the 2015/16 season was that it was significantly down on the previous season by almost 20% and the lowest in 10 years.

Eldana was a major problem particularly in the Eston and Midlands North (Noodsberg/UCL) area, due to the drought. As a result the LPD&VCC rules had to be changed to accommodate insecticide spraying to ensure safe carryover. Measured on this, spray programmes were generally successful. However, in the Eston area, in certain unsprayed fields, levels of eldana levels increased over the off-crop to the extent that emergency harvesting was necessary.

In both the Midlands North and South regions, there were launches held to introduce SUSFARMS® Version 3. These events were well attended and were addressed by the co-ordinator of the Midlands 2018 Collaboration. A delegation from SASRI, Illovo Sugar and the Midlands Collaboration attended a workshop with Solidaridad in Sao Paulo, Brazil to investigate the Rural Horizons system as a means of collating and analysing SUSFARMS® data. The Midlands North area hosted a field visit of delegates to the ISSCT Agronomy Agricultural Engineering and Extension Workshop in August 2015. This opportunity showcased both small-scale grower extension activities as well as soil conservation and health issues related to the production of sugarcane in the region.

South Coast (Sezela, Umzimkulu)

Similar to other areas further north, the area came into the season with the crop under some stress following a succession of below average rainfall months during the summer of 2014/2015. However good rain in April and July along the coast helped sustain the crop for a while. Following that, conditions dried off considerably through spring but fortunately by the summer of 2015/2016 rainfall had returned to levels around long-term average for the coast and hinterland areas. Further inland, the prospects for the following season remained uncertain due to lower rainfall.

The variable growth conditions in 2014 and early 2015 with the crop periodically under stress, led to a significant outbreak of eldana, particularly in the coastal hinterland regions. In the Umzimkulu area, eldana levels were well above carryover hazard levels and application was made to change the local rules in order to accomadate insecticide spraying. This was approved and a large-scale spray programme was implemented. In the Sezela area, harvesting of heavily infested fields remained the remedial measure that was enforced. However, the successes of spraying in the neighbouring areas encouraged a few growers to consider late applications of insecticide.

Cane quality at both mills was overall below industry average with Sezela faring worse than Umzimkulu. Moisture levels in deliveries of cane gave indications of the general drought conditions that prevailed for much of the season. As a region, the slightly better rainfall experienced compared with areas further north resulted in a crop lower than the previous season, but not as low as that generated by the 2010 drought. Extension efforts across the region were focused largely around crop management under drought conditions and eldana control.

Unfortunately planting was generally curtailed and orders for transplants from the Sezela nursery were drastically reduced. This placed the facility under some pressure to survive and strategic interventions from the respective stakeholders in the nursery were required. These will hopefully guarantee the survival of this important facility into future seasons. The new varieties N58 and N59 were bulked up in the regions and for the most part grew well with N58 showing some drought tolerance, for which it is known. There was an occurrence of high levels of mosaic in the Harding area which required attention and plough-out orders. Sporadic outbreaks of yellow sugarcane aphid also occurred.

SMALL-SCALE GROWER EXTENSION (EVA)

The Extension Venture Agreement (EVA), first signed in 1996, is a service allowing SASRI Extension Specialists to support and train Department of Agriculture and Rural Development agricultural Extension Officers (AEO's), working with small-scale sugarcane growers in KwaZulu-Natal.

The objective of EVA is to provide appropriate sugarcane technology and updated information to small-scale growers. EVA aims to promote sound agricultural practices, adding value to the industry through increased productivity and profitability. The agreement also helps establish and maintain contact with communities and promotes appropriate agricultural Extension techniques amongst these groups.

In 2015/16, the area under cane on small-scale farms was 39 156 hectares. A total of 576 761 tons cane was delivered. This tonnage was lower than previous years due to the on-going drought. Extension activities within the EVA programme of work mainly involves farm visits, various training days and grower days. All of these were particularly effective this year with 231 farm visits, 84 training days with 2 185 attendees, and 108 grower days with a total number of 2 643 attendees.

Some of the topics covered in the training and grower days were soil potential, weed control, management of droughted cane, irrigation and environmental awareness. Also covered were crop estimating, programme planning of operations, soil sampling and CTS cane quality reports.

In 2015/16, there were also 8 refresher courses for DARD Extension staff, with 216 attendees. Modular courses were also held in 11 mill areas with a total of 584 attendees. There was also a radio broadcast outreach and 8 broadcasts were made during the year covering topics such as fire control in sugarcane, weed control and general farm planning.

There were a number challenges during the year with the persistent drought, weed control, demo plot funding, runaway fires, lack of seedcane and irrigation infrastructure.

Despite these challenges however there were numerous successes and achievements. There was improved cane quality and production in some areas with continual structured skills transfer and knowledge to growers. There was an improvement in the AEOs' performance in undertaking regular farm visits. Upliftment and grower development through training and practical skills transfer was also a highlight. Demonstration plots were established in all regions and from 2001 to 2015 the number of demo plots planted was 55, covering 75 hectares in total. This has improved the availability of seedcane and enhanced the relationship between growers and Extension as well as improved sustainable farming practices and environmental awareness. Household sustainability has been improved through the income derived from sugarcane and there had been good teamwork between DARD and SASRI with strong DARD commitment to the EVA programmes.

These records show the significant and comprehensive impact that the EVA has had on the small-scale community in KwaZulu-Natal. Despite severe challenges, the partnership has remained strong. Skills knowledge and learning in all aspects of sugarcane growing has been transferred to growers at farm level due to the close contact that EVA facilitates. Annual work programmes and regular reporting enables efficient monitoring and reviews to be carried out. This has kept work focused on the most pressing needs of the growers.

KNOWLEDGE EXCHANGE AND TECHNOLOGY TRANSFER

Michelle Binedell

With 2015 being the year that SASRI turned 90, the emphasis was on celebrating the depth of knowledge that exists within SASRI and on sharing this knowledge with our stakeholders. Through increased attention to grower days, the various teams within SASRI learned much from close engagement with growers in the field.

POPULAR ARTICLES

The Link

In the 2015/16 reporting period three editions of The Link magazine were published. The 41 articles that were published focussed 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. This publication is aimed at our English and Afrikaans speaking growers.

Regular features

- Topical Tips
- Weather
- Messages from the Director

Stewardship and sustainability

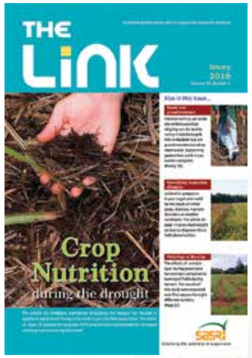
- Latest edition of SUSFARMS® released
- Sustainable practices of a North Coast grower

Pest and disease control

- New insecticides for eldana control
- Pest, disease and variety control/ Plaag, siekte en variëteitbeheer
- Monitoring grasshoppers/locusts on the North Coast
- Scouting for eldana / Eldana verkenningsopnames
- It wasn't me! (Insect damage symptoms)
- Rotating chemicals for eldana control
- Impact of green manures on nematode control
- Training your pest and disease scouts
- What is wrong with my field?

Cane quality

- Farming for sugar: Agronomic factors influencing cane quality/ Boer vir suiker: Agronomiese faktore wat riet kwaliteit beïnvloed
- What is pithing and how is it caused? / Wat is pitvormig?
- How to manage hail damaged sugarcane / Hoe om haelbeskadigde suikerriet te bestuur
- Essential steps for quality seedcane



Mechanisation

- Sustainable sugarcane transport

Ripening

- Do chemical ripeners have any residual effects on ratoon regrowth?

Weed control

- A practical approach to the integrated control of Pereskia aculatea
- Weed management under dry conditions

Soil sustainability

- Soil Health: Fertilisers and 'green' agriculture
- Soil Health: Re-visiting the use of lime and gypsum in the industry
- The case for green cane harvesting/ Die saak vir die oes van groenriet
- Advice from FAS: Dealing with soil sample variability/ Advies beskikbaar FAS: Hoe gemaak met die wisselvalligheid in grondmonsters?
- Crop nutrition in the current drought - for rainfed areas/ Gewas voeding vir die huidige droogte – toestande in droëland areas

Varieties

- New varieties (N58 and N59)
- Yield responses of varieties to mulching in the coastal region

General

- Out and about with SASRI staff
- New information sheets
- Meet SASRI's new Extension and Biosecurity Manager
- A sweet reward for a young farmer
- Is it a bird? Is it a plane? (Use of UAV's in the industry)

The Ingede

Three editions of the isiZulu newsletter, Ingede, containing 15 articles in total, focussed on issues related to the small-scale grower sector. 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.

May 2015

- Choose a career you are passionate about!
- Cane quality
- Winter does not mean there are no weeds in the field!
- Let's talk growers (Celebrating 90 years of excellence competition)
- Using chemical ripeners

September 2015

- Matching your soils to varieties
- Modular courses: We will succeed when working together!
- Planting after a drought
- The success of Extension Specialists at the SASAE conference
- Topical tips

January 2016

- How to use the SASRI Programme Planner
- From the grower's point of view: Mr Gwala and Mr Zuma
- The importance of budgets
- Topical Tips
- The importance of doing sugarcane estimates

eNewsletters

Monthly electronic newsletters are regular outputs from many Extension offices. These newsletters contain information and advice specific to the region and are an important communication tool for Extension Specialists.

A monthly electronic newsletter for the Lowveld region "Die Laeveld Insig" was launched in January 2015 to Mpumalanga growers with 6 newsletters being published in both English and Afrikaans.

SASRI also made use of other publication platforms such as the South African Sugar Journal, Coastal News and popular agriculture magazines. Over the year, SASRI published thirteen articles in the South African Sugar Journal and ten articles to Coastal News, once again show-casing SASRI's achievements and promoting best practice.

Articles published in the South African Sugar Journal - 2015 / 16

- Insect resistance action committee
- The new era of nematicides
- Enabling efficient agrochemical programmes
- Growing growers
- Working together to improve small-scale grower productivity
- Irrigation management
- Irrigation scheduling toolbox
- Sustainable sugarcane transport
- Estimating mechanisation costs
- Specialist, Analytical and Advisory Services
- SASRI scientists raise the bar for research
- Technological excellence in the sugar industry
- Highlights of the 2015 SASTA Congress programme

TECHNICAL PUBLICATIONS

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

During the 2015/16 period, the Irrigation Working Group at SASRI finalised a new series of Information Sheets that will replace the existing sheets pertaining to water use. This Irrigation series will be specifically relevant to areas under full or supplementary irrigation. Some of the topics include available irrigation systems, effective scheduling of irrigation, electricity usage, soil salinity and sodicity, and chemigation. These Information Sheets aim at informing growers on how to effectively irrigate while still ensuring both cost savings and water conservation.

Annual updates of the Herbicide Guide, Mechanisation Reports and Rates for SASRI Services were completed providing recommendations, new products and prices relevant for the new year.

The technical booklet on Seedcane Production was updated in 2015 to reflect the latest information on the production of good quality seedcane.

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

New and updated Information Sheets

2.1......Ratoon Stunt (RSD)
2.10 ...Sugarcane rusts
4.5 .....Management of cane affected by drought
4.11 ...Hail damaged sugarcane
5.1 .....Irrigation Fundamentals
5.4 .....Irrigation Scheduling Toolbox
5.5 .....Chemigation - basic principles
5.5 .....Chemigation – choosing chemicals
5.7 .....Introduction to irrigation systems
5.10 ...Energy inputs and electricity saving in irrigation
7.18 ...Condensed Molasses Solids (CMS)
11.9 ...NovaCane® planting guide
13.43 . Variety N58
13.44 . Variety N59

RADIO

During 2015, over 80 radio programmes were broadcast over 10 radio stations within KwaZulu-Natal. The radio broadcasts which take place every month have become an effective medium used successfully to transfer agronomic advice to isiZulu speaking growers. The radio programme is co-ordinated through a Radio forum which is formed by different sectors that meet quarterly to discuss topics that are relevant to the audience, and aims at providing a platform to educate and inform the community. The partnership SASRI has with the Department of Agriculture and Rural Development (DARD) via the Extension Venture Agreement (EVA) has proved to be very fruitful over the years with more sugarcane growers showing an interest in these broadcasts.

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

STAKEHOLDER INTERACTION

Significant face-to-face interaction with industry stakeholders served to effectively transfer best practice, research outcomes and technical know-how, thereby informing the industry of new advancements. Extension Specialists and researchers conducted over 1 600 visits to growers, hosted 156 grower days and exhibitions and were involved in 265 conference presentations, workshops, refresher courses, seminars and demonstrations. SASRI also hosted 1 166 visitors in 2015/16 on site.

Significant face-to-face interaction with industry stakeholders served to effectively transfer best practice, research outcomes and technical know-how, thereby informing the industry of new advancements.

CERTIFICATE COURSES

SASRI has been involved in Certificate training for the past 53 years. Since the first Senior Certificate Course in 1963, over 3 600 people have attended the five-week Senior course while over 2 500 (since 1975) have attended the three-week Junior course. These Certificate Courses have been instrumental in developing the capacity of the South African sugar industry while also serving as an important training resource for the southern African region.

In 2015/16 a total of 229 students from 8 different countries attended two Senior and two Junior Certificate Courses.

Certificate Courses have 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.

INFOPACK DVD

One of the most valuable resources produced by SASRI is the newly updated 2016 InfoPack DVD which contains a historical collection of nearly all SASRI publication resources. This resource can be used to rapidly locate previously published articles, information sheets, books, manuals or posters.

The 2016 version of the InfoPack had a number of new additions which included the updated Seedcane Production manual and thirteen new information sheets. A booklet, Feedback to RD&E Committees: 2015 Stakeholder Issues contained SASRI's response to a number of industry issues raised at the RD&E AGM of 2015 and is a valuable reference of informative and helpful communiqués from SASRI specialists.

KNOWLEDGE EXCHANGE PROJECTS

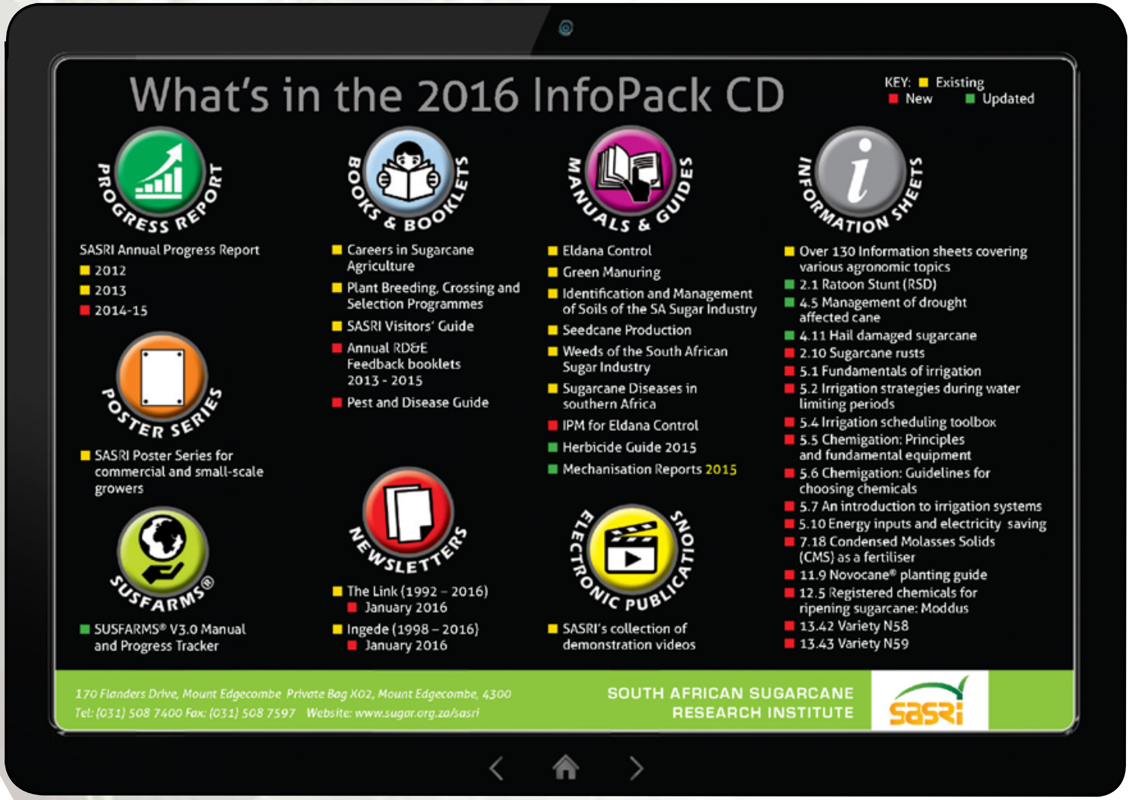
Two knowledge exchange projects closed-out this year and produced the following results:

Field and Pot Trial Guidelines were produced that consolidated the numerous procedures and protocols that SASRI researchers and Technical Teams follow during the conducting of trials. The guideline document serves as a useful training tool for new staff members.

After an evaluation of mill yards, a report was prepared to establish the potential for PBS vehicles within the industry. This report included a list of basic parameters critical for quickly establishing the potential for PBS vehicles at each mill yard. The findings from the project will be made available to the RTMS committee dealing with transport related matters at an industry level.

Two completed knowledge exchange projects have resulted in the consolidation of research trial protocols and recommendations for the introduction of PBS vehicles into the industry.

The wealth of knowledge and information that lies within SASRI is enormous but it can only be effective if it is both accessible and applicable. These two principles are at the core of SASRI's knowledge management activities and much attention is placed on facilitating the transfer and exchange of knowledge to all industry stakeholders.



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