South African Sugarcane Research Institute

Progress Report 2013

Unlocking the potential of sugarcane

Contents

SASRI Committee and Management

COMMITTEE 2013
(as at 1 January 2013)

Chairman S Rau

Vice-Chairman ST Naidoo

Growers Representatives

EJO Grantham

KM Hurly

TJ Murray

F Potgieter

S Sharma

GD Stainbank

R Talmage

Millers Representatives

G Brown

EA Bruggemann (alternative)

J Dewar

JPM de Robillard

B Govender (alternative)

DM Meadows (alternative)

TB Ngeleza (alternative)

S Rau

D van Rooy

DP Rossler

PW Russell

PM Schorn

SASA Representative

MK Trikam

Co-opted from SASRI

CM Baker

AJ van der Nest

DA Watt

MANAGEMENT TEAM: 2013
(as at 1 January 2013)

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: GW Maher

Knowledge Management: ML Binedell

Biorisk Management: RA Stranack

Chairman's Report

One of the key functions of the leadership of the South African Sugarcane Research Institute is the need to ensure that the programme of work is relevant and focussed on the needs of the sugar industry.

Stan Rau

Opportunity to benchmark SASRI's research outputs against the best in the world presented itself at the XXVIII International Society of Sugar Cane Technologists (ISSCT) congress held in São Paulo, Brazil in June 2013. SASRI staff presented no less than 13 technical papers at the congress and Dr Abraham Singels, a principal scientist at SASRI, was awarded the best paper at the conference. It was evident from the high standard of the presentations by SASRI delegates that our scientists are indeed among the best in the world.

A further measure of the value of SASRI comes from the recognition by the Department of Science and Technology (DST), which has offered an opportunity to SASRI to acquire government funding for scientific research. Furthermore, the national and international recognition of SASRI's scientists, by the appointment of nine scientists to honorary university positions and the achievement of National Research Foundation (NRF) rating by six of our scientists, bears testament to the excellence of our institution.

A notable development in this past year has been the increasing attention being given to sustainable farming practices by leading sugar customers. As examples, Unilever and Coca-Cola (through SABMiller) have announced that by 2020 all raw materials for their range of products will be sourced from sustainable agriculture. Through SUSFARMS®, the South African sugar industry is well prepared for this requirement. SASRI continues to develop the effectiveness of SUSFARMS® to meet stringent customer requirements.

The cane breeding programme continues to produce successful varieties and this year saw the release of N54, N55, N56 and N57, maintaining the trend of releasing new varieties regularly. Perhaps the most critical area of focus for the variety breeding programme will be the decision to develop a strategic plan that will lead to the commercialisation of genetically modified (GM) sugar cane. While it is recognised that worldwide acceptance of GM sugar may be a long way off, this does not preclude the successful development of an eldana resistant sugar cane variety. This will make a significant contribution to the existing suite of control measures against this pest within our Integrated Pest Management programme. Even an accelerated approach to the commercialisation of GM sugar cane will not see the release of a GM variety within a ten year framework. It is critical, therefore, that the industry approves SASRI's research programme leading to the successful release of such a variety. Since this will require significant investment, a strategic view of this research is needed by the leaders of our industry. Ultimately, it is the task of the SASRI Committee to broker this process through the leadership of the sugar industry.

The funding of a research programme is always a delicate balance between apportioning costs to the pursuit of research that will deliver long-term outcomes and those that offer short-term gains. It is indeed in the longer term research focus that value lies, but the outcome of such long-term research cannot always be guaranteed. The risk and reward profile associated with such research may therefore not always be palatable to the leaders of the industry.

SASRI, through its peer review process, and Research, Development and Extension (RD&E) committee structure, strives to ensure that its research efforts yield the highest possible return to the industry. A challenge of the committee is to manage the research budget through the programme of work to

deliver the balance between short- and long-term outcomes. This is particularly challenging in an industry where production (and therefore funding) is in decline and there is a temptation to sacrifice the long-term research to the financial constraints of the industry. Again, the committee's role in brokering this balance with leaders of the industry is critical.

I would like to thank the SASRI committee for their open and committed support in my term of office over the last two years. I am honoured to have been part of the leadership of this fine institution and wish the Director, her staff and the committee every success in the years to come.

Director's Report

In a year that posed significant challenges for the industry and also the research institute, SASRI maintained its focus and continued to deliver research outcomes that are directed towards securing the sustainability of sugarcane farming. Collectively, SASRI's scientists and specialists applied their considerable expertise to achieve a number of meaningful goals, largely by engaging with industry representatives to ascertain their needs and understand their challenges as well as through the implementation of a balanced portfolio of innovative research projects.

Dr Carolyn Baker

Varieties for the Future

In recognition of the fundamental role that improved varieties bring to the industry, progress in adoption of the new approach in the plant breeding programme was sustained. Optimising the value from each cross by recognising familial diversity was particularly evident when the variety release committee visited research stations to view the most promising pre-release varieties. Further, refinements to the process associated with the assessment and decision-making aspects of variety release at SASRI, to provide SASA Council with the requisite information for industry approvals were made. Of the four new varieties that were released, N54, N55 and N56 showed high cane and sugar yields in the midlands and hinterland in particular, while N57 demonstrated good disease resistance in the irrigated north, serving to complement N25 in that region.

The importance of introducing resistance in new varieties remains one of the key drivers of the plant breeding programme. Progress in accelerating resistance in new varieties through a mutagenic approach has been good with two somaclonal variants of N12 demonstrating increased tolerance to an imazapyr herbicide. Achieving herbicide resistance in this manner has obvious benefits, and further work in evaluating the performance of these herbicide resistant clones will continue in the forthcoming year.

Sustainability Through Innovation

Considerable progress associated with the industry's approach to genetic modification (GM) was achieved at a workshop held in October 2013. Attended by 32 people including members of the SASRI Committee, delegates from the Chairmen's Indaba, SASA Executives and SASRI staff, the workshop aimed to enhance an understanding of the development of GM sugarcane varieties and the implications of their introduction into the South African sugar industry. In view of the mounting urgency to address industry sustainability, and the need to consider strategies that would provide significant step-change improvements in the medium to long-term, SASRI presented the opportunities that GM could offer. The workshop demonstrated considerable alignment and overwhelming support amongst all stakeholders regarding GM commercialisation and established quite definitively that the major agricultural problem that could benefit from a GM approach would relate to eldana control. The decision to develop a strategic plan associated with GM commercialisation was welcomed.

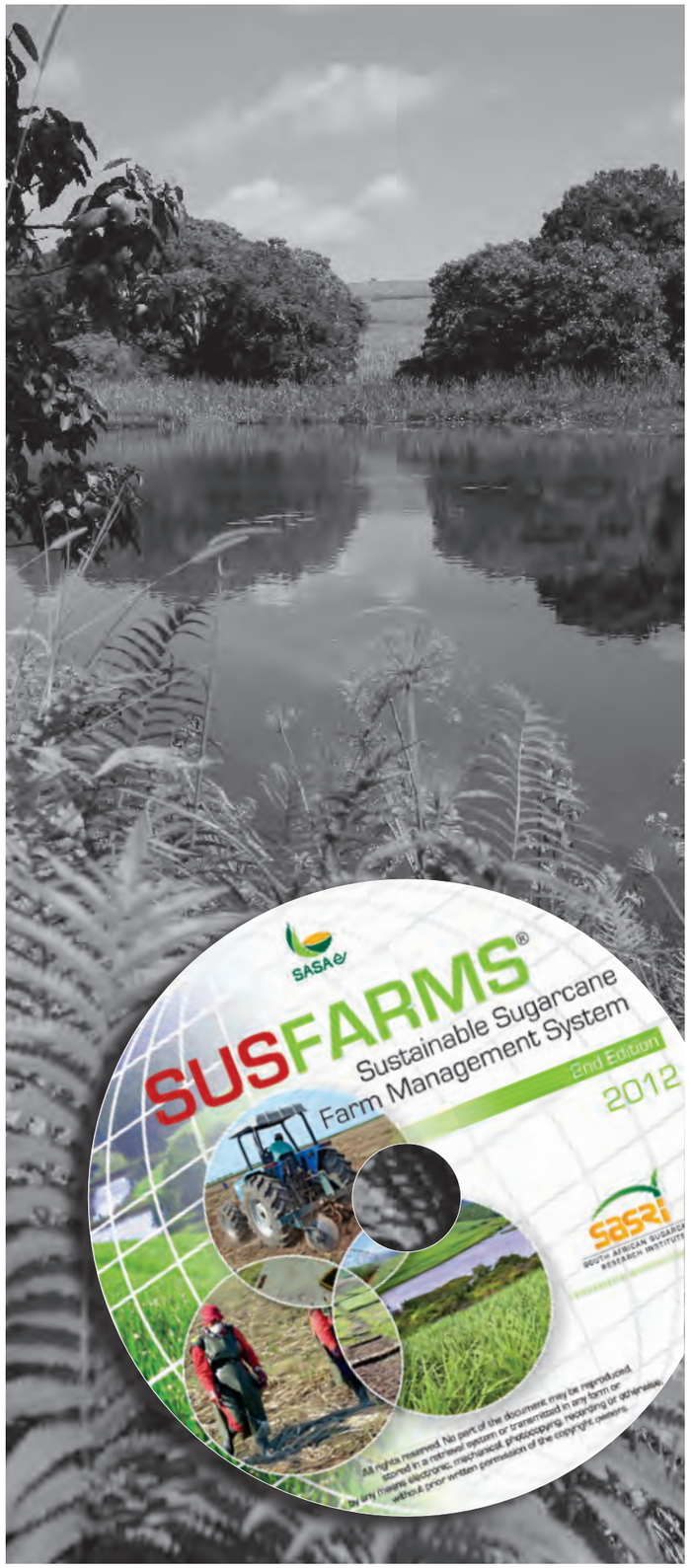
Industry emphasis on pursuing innovation to secure long-term sustainability was evident in the support, not only of progressing a GM approach, but also in the deployment of NovaCane® technology in the plant breeding programme.Extensive discussions regarding the pros and cons of building

an in-house SASRI facility to service the direct requirements of the plant breeding programme were held, and realisation that the fundamental responsibility of the industry is to develop and disseminate new varieties that are true-to-type and free of all known diseases, led to agreement to retain this strategic function at SASRI. It was acknowledged that this requirement stood apart from the commercial requirements of the greater industry, whose supply of NovaCane® emanates from the Dube AgriLab.

Increasingly, global pressures to source sustainable products have placed the spotlight firmly on SUSFARMS®. This farm management system that was developed in 2008 and revised in 2012 was adopted by SASRI's Extension services as their primary tool to guide deployment of better management practices on all growers' farms. Using current legislation as the basis for the system, SUSFARMS® has become acknowledged as one of the world's best at providing guidance on all farm management practices. During the year SASRI specialists toured the industry to introduce the system to growers and to launch the Progress Tracker – a simple but valuable tick-box system that enables all growers to assess their level of compliance with all relevant legislation and also their progress in implementing sustainable practices. It is this system that has attracted the attention of several significant international businesses that require their goods to be sourced from sustainable products. Encouraging adoption of a SUSFARMS® approach will remain one of the key functions of Extension in the coming year.

Minimising Biosecurity Threats

In a year that once again saw the industry being affected by a new biosecurity threat, namely the sugarcane yellow aphid, the value of in-house pathology expertise in conjunction with alert and widely dispersed field and extension staff was apparent. Their role in identifying the insect and then ascertaining its spread and potential impact on sugarcane growth was done in concert



with local and international pathologists. Being able to predict the nature of pest or disease incursions is not always possible, and yet the importance of monitoring and managing outbreaks remains obvious and provides clear evidence of the importance of stringent biosecurity surveillance. In preparation for assuming the responsibility of the pest and disease function in the industry in the future, SASRI became increasingly involved in understanding the manner in which each of the Local Pest and Disease Offices operated.

Eldana remains the number-one sugarcane enemy affecting sugar yields, certainly in the coastal areas, even though research into its control and development of several 'tools' to reduce its impact have been ongoing for many years. SASRI has recognised the importance of using a suite of innovative approaches to control the pest and the need to ensure that growers adopt an integrated area-wide pest management approach. As part of this initiative, investigations into Sterile Insect Technology (SIT) commenced with a view to consider its deployment in the industry should pilot releases of sterile male moths be successful. This work, being conducted in conjunction with the University of Stellenbosch, promises to provide definitive evidence regarding its efficacy in our industry.

In recognition of the importance of conducting high quality research to address the sugar industry's pest and diseases threats, SASRI's Crop Protection research programme underwent an external expert review during the year. These annual research reviews are part of SASRI's ongoing commitment to excellence in science and service delivery to the industry. Conducted by three international experts, the overall commentary was favourable particularly regarding the levels of discipline integration evident in crop protection research projects and also the key role that SASRI plays for the industry in mitigating risks of incursions.

Enhancing Quality

While yield enhancement is also an important driver in our plant breeding programme, correct applications of ripeners is an important way of improving cane quality. During the year, variety-specific ripener recommendations were demonstrated to good effect in a series of strip trials in the irrigated north, midlands south and Zululand. The trials aimed at demonstrating the economic benefits associated with ripening under commercial conditions, showed consistently improved cane quality when conditions were favourable, and also that their application had no deleterious impact on subsequent ratoon crops.

Recognition of Excellence

Retaining SASRI's position and role as a valuable research service provider for the industry is important, and several events during the year provided pleasing evidence of the esteem in which the institute is held.

It was not insignificant when a government gazette from the Department of Science and Technology (DST) in February 2013 recognised the particular value and role of our research institute when they included SASRI in the list of government declared scientific institutions that would be eligible for government support for research. This support from the DST in providing eligibility for bursaries, fellowships, research equipment and research grants for travel and capacity development was welcomed.

The XXVIII International Society of Sugar Cane Technologists (ISSCT) congress held in São Paulo, Brazil in June 2013 that was attended by a delegation of SASRI senior scientists provided an opportunity to showcase findings from the research programmes. This conference, recognised as being the forum for exchange and discussion amongst the world's leading sugarcane technologists provided a fabulous opportunity for SASRI to showcase its wealth of expertise and innovation, and it was notable that the presentation by one of SASRI's Principal Scientists, Abraham Singels, was awarded the Best Paper at congress amongst the 180 papers that were delivered.

National and international recognition of SASRI scientists was sustained during the year as evidenced by the number of honorary university appointments (nine) that are held by various specialists in a range of disciplines, as well as the six National Research Foundation (NRF) ratings that were maintained. These ratings serve as a valuable benchmark for research performance in South Africa.

All of the many and varied achievements over the past year that are amply showcased in this annual progress report reflect the extent of commitment of SASRI's staff to the productivity of the sugarcane industry, and we look forward to the forthcoming season where challenges of demonstrating value and relevance will remain at the forefront of our endeavours.

Overview of SASRI Research

Strategic objectives

- To develop and deliver new sugarcane varieties which provide increased economic returns for all sectors of the industry.
- To undertake research and provide specialist services that advance nutritional, agronomic and engineering practices and pest and disease control measures.
- To generate and implement new ideas for enlarging the scope of sugarcane agriculture, including alternative uses and the delivery of alternative high-value products, with a view to sustaining the industry into the future.
- To ensure the transformation of tacit knowledge and research outcomes into explicit knowledge and technology products.

2013 Research Portfolio

Consultative development

SASRI is highly responsive to the needs of stakeholders and, as such, adaptive[1] research formed a significant component of the 2013 research programme. Of the 81 projects in the 2013 portfolio, 33 (41%) were implemented as a direct consequence to needs communicated by stakeholders through industry Research, Development and Extension (RD&E) structures and processes. Such needs-driven research spanned the investigation of solutions for issues pertaining to ratoon performance, pest and disease management, soil health, crop nutrition, crop husbandry and farming systems.

Relevant technologies

Within the 2013 portfolio, 14 projects (18%) focused on the development and delivery of technologies to enhance service delivery and support improved stakeholder performance. The development of such technologies is a core area of competence of SASRI research.

The technologies delivered are both tangible (e.g. models, operating manuals, decision support tools) and intangible (e.g. consultancy, problem-solving, training) and span the spectrum of solutions from low- to high-technology.

Innovative solutions

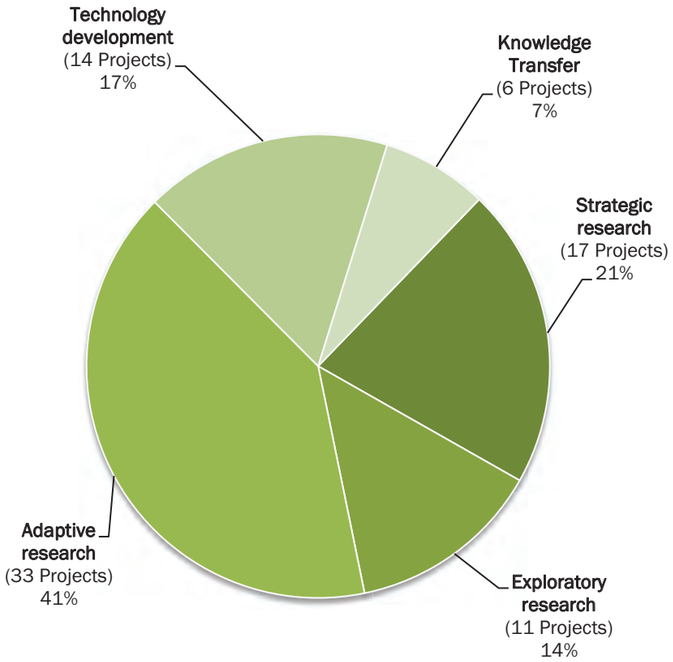
The quest for innovative solutions to broader industry issues also lies at the heart of the SASRI research programme. Consequently, strategic[2] and exploratory[3] research comprised 21% and 14%, respectively, of the 2013 research project portfolio. Within this innovation space, projects explored the exploitation of untapped potential in the sugarcane genome for enhancing pest and disease resistance, genetic and mutagenic breeding to deliver novel traits to South African sugarcane germplasm, innovative technologies to enhance the repertoire of tools available for the integrated management of the African sugarcane stalk borer, crop modelling strategies to enhance sugarcane breeding efficiencies in a changing climate and strategies to facilitate irrigation decision-making during periods of heightened water scarcity.

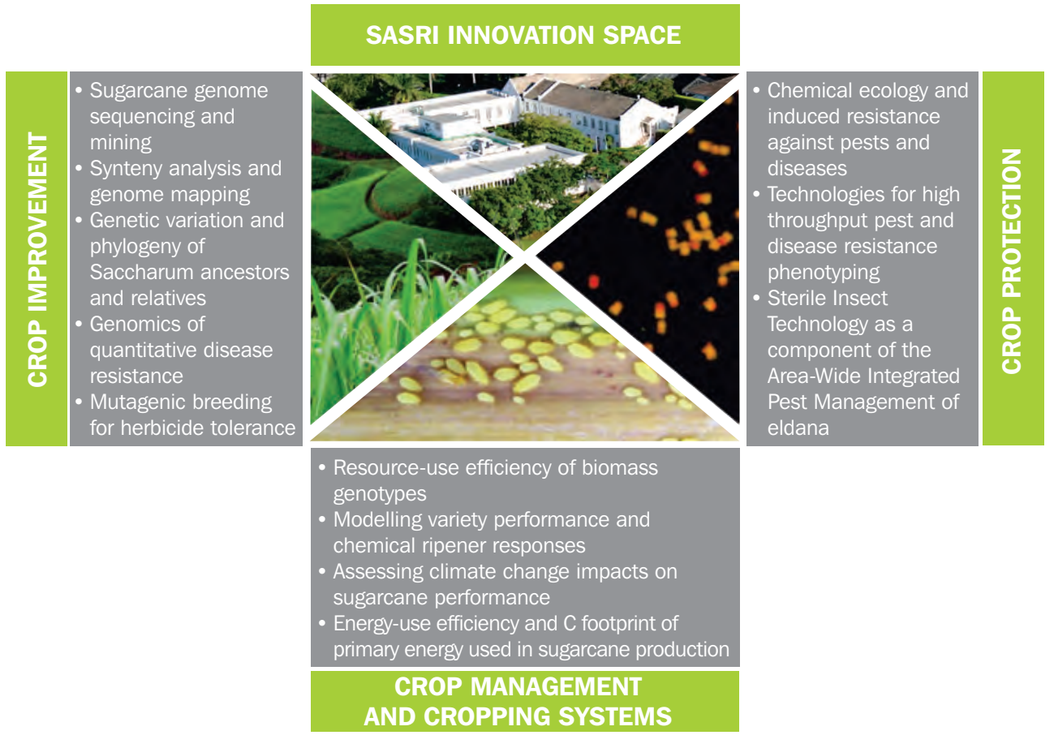
Dr Derek Watt

1. Adaptive research is needs-driven and provides solutions to problems of immediate consequence to the South African grower community.
2. Strategic research is directed towards meeting perceived medium- to long-term development needs, which are strongly informed by international scientific progress and potential local industry innovations
3. Exploratory research serves to establish the boundaries within which innovation is possible.
4. Pannell DJ (1990). On the balance between basic and applied agricultural research. J Agric Res Econ 43:91-113.
5. Stirling CM, Harris D and Witcombe JR (2006). Managing an agricultural research programme for poverty alleviation in developing countries: An institute without walls. Expl Agric 42: 127-146.

Portfolio balance

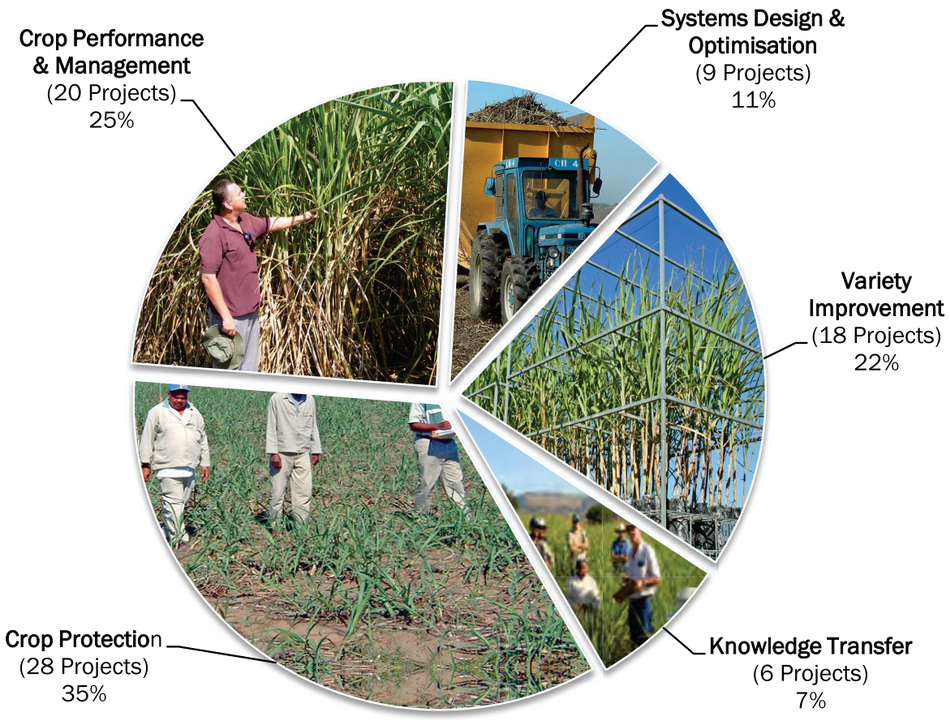
It is widely recognised that diversified project portfolios in agricultural research ultimately deliver greater value than those that are solely reactive[4;5]. Given this, SASRI strives to maintain a 70% to 30% ratio between needs-driven, reactive research and proactive, innovation-focused research; a ratio that is deemed most appropriate for successful agricultural R&D programmes[4]. In 2013, 47 projects (58%) within the portfolio were implemented as a direct consequence of either issues raised by stakeholders (33 adaptive research projects) or the need for technology enhancements to improve service delivery (14 technology development projects). Projects of a more strategic or exploratory nature comprised the remaining 35% (28 projects). In addition, the portfolio contains seven knowledge transfer projects (7% of the portfolio), which are specifically designed to transform tacit knowledge and research outcomes into explicit knowledge to enable effective communication with growers on technical matters.





Research programmes

The SASRI research project portfolio is managed within four clusters of cognate research: Crop Protection, Crop Performance and Management, Systems Design and Optimisation and Variety Improvement. Integral to delivery of value from the research programmes are knowledge transfer projects that are managed within the SASRI Knowledge Management Unit but which articulate closely with the research environment.

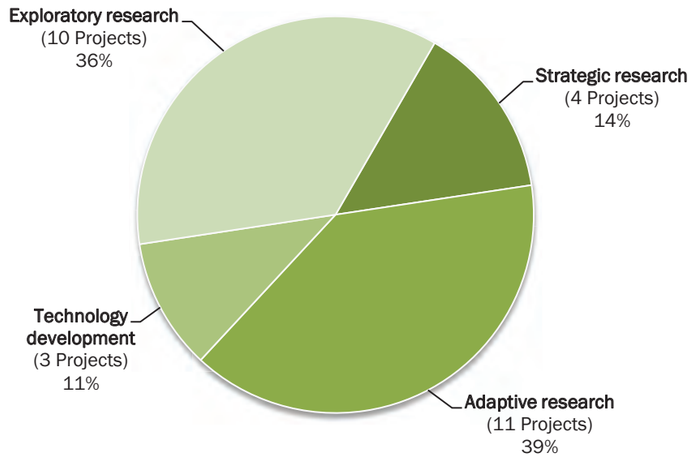


Programme	Goal
Crop Protection	To minimise the effects of disease, weeds, nematodes and insect pests on crop production in a sustainable manner.
Crop Performance and Management	To develop new and fine-tune existing crop management practices to enhance the economic and environmental sustainability of sugarcane production.
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.
Variety Improvement	To conduct research and implement strategies for the continual release of new varieties which add value and enhance productivity.
Knowledge Management Unit	To ensure the transformation of tacit knowledge and research outcomes into explicit knowledge and technology products.

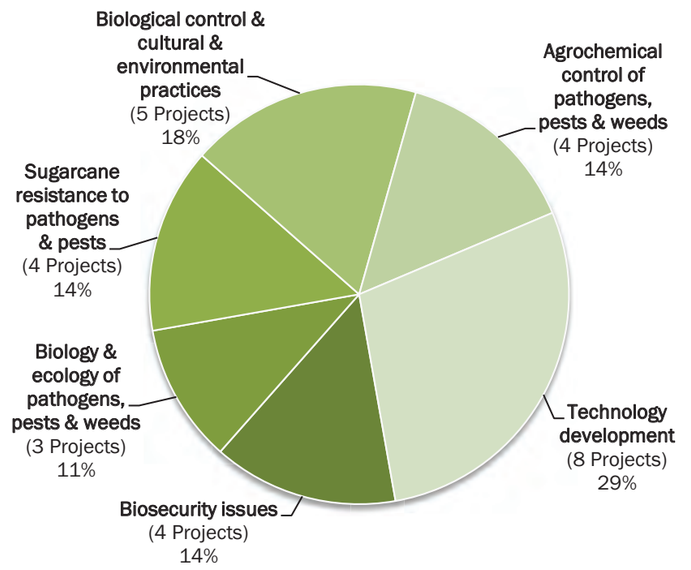
Crop Protection Research

Strategic objectives

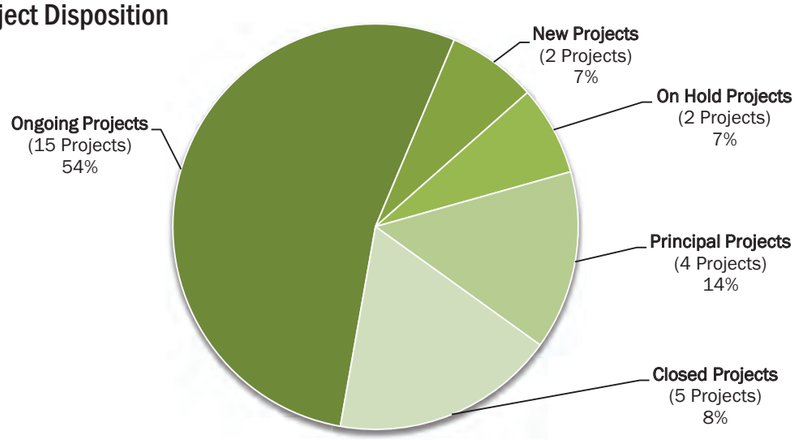
- To promote biosecurity by conducting research that results in improved procedures for ensuring that varieties released, propagated into the industry or imported through quarantine are free of disease.
- To conduct research to develop proactive threat-specific counter-measures and incursion plans.
- To generate knowledge on the biology and ecology of pests, diseases, nematodes and weeds.
- To gain understanding of the biological basis of resistance to pests, diseases and nematodes.
- To develop improved pest and pathogen resistance screening techniques for variety improvement.
- To develop effective integrated pest and pathogen management strategies combining varieties, agrochemicals, biological control agents and nutrition with beneficial cultural and environmental management practices.



Dr Stuart Rutherford



2013 Project Disposition



New Research Projects

New Rust Disease: Description, biology and control	ADAPTIVE RESEARCH
Need Statement	▪ A new rust disease has been observed on a number of South African sugarcane varieties, including N12, N25, N41, N46 and N49, infecting plant and ratoon cane of up to an age of ten months. ▪ The rust was first observed on sugarcane in Swaziland in 2009, and was subsequently found in Pongola, Umfolozi and the Midlands North and South regions. ▪ Symptoms appear as brown lesions on the cane leaf, with orange spores developing in pustules on the upper and lower leaf surfaces. ▪ Molecular diagnostic assays have confirmed that it is a previously unknown rust species.
Project Objectives	The objectives of the research are to: ▪ describe and classify the new rust pathogen; ▪ develop a rapid and reliable molecular diagnostic assay to distinguish the new rust from brown and orange rust; ▪ determine the conditions favouring the development of the disease for inclusion in a rust risk decision support tool; ▪ assess the effect of the disease on yield; ▪ assess the susceptibility of released varieties, parental lines and progeny to the new disease; and ▪ conduct efficacy trials with the Abacus® fungicide to support a label extension to encompass the new sugarcane rust.
Approach to be Adopted	▪ Methods for spore storage are to be developed to enable ongoing laboratory studies. ▪ Effect of selected climatic conditions on spore germination and pathogenicity is to be determined in laboratory and field-based studies. ▪ Observation trials are to be established adjacent to automatic weather stations on SASRI Research Stations in Pongola and Komati to monitor rust incidence in relation to prevailing climatic conditions. ▪ Data from laboratory and field studies are to be used in the development of a rust risk model to assist growers with the timing of fungicide applications. ▪ Effect of the new pathogen on yield is to be assessed. ▪ Yield information is to be used to support the manufacturer of Abacus® in pursuit of registration of the fungicide against the pathogen. ▪ Surveys are to be conducted to identify potential alternate host plants of the pathogen, which if controlled could enable interruption of the pathogen life cycle. ▪ Released varieties, plant breeding parental lines and progeny at the SASRI Pongola Research Station are to be screened for resistance to the new pathogen to enable resistance breeding.
Anticipated Outcomes	▪ An improved understanding of the biology of the new rust pathogen and its effect on yield. ▪ A preliminary fungicide treatment strategy to enable growers to manage the disease. ▪ Towards long-term control, evaluation of the resistance of released varieties and parental lines to the new pathogen to ultimately enable resistance breeding.
Technology and/or Knowledge Transfer Plan	Information emanating from the study of the new rust pathogen will be disseminated in various publications appropriate to the target audience: SASRI Pathology Laboratory Methods Manual, *The Link*, *Proceedings of the South African Sugar Technologists' Association* and science journals.
Anticipated Value to Industry	▪ Orange rust generally infects fairly mature cane (older than six months-of-age) and is reported to reduce stalk population, stalk biomass and sucrose concentration, resulting in losses in cane yield of between 30 and 43% in susceptible varieties. ▪ Brown rust infects cane of between three and six months-of-age and causes similar losses in stalk population and biomass, but does not affect juice quality. ▪ Losses from both diseases are related to the duration of the epidemic. ▪ Greater yield losses might be expected from the new sugarcane rust as the disease has been observed on three to ten month-old cane and has the potential to infect cane at different growth stages when conditions favour its development. ▪ The value to the industry of this research resides in the improved management recommendations that will be forthcoming.

Improvement of methods for identifying and quantifying nematodes	TECHNOLOGY DEVELOPMENT
Need Statement	The SASRI Crop Biology Resource Centre provides a nematode analytical service to enable customers to manage these serious sugarcane pests effectively. As soil nematodes occur in complex communities, nematodes require identification to genus-level. Nematode identification and enumeration are time-consuming activities, requiring skills which are becoming increasingly scarce. Recent progress in pattern recognition software suggests that semi-automation of nematode identification and enumeration is potentially possible.
Project Objectives	In striving to increase efficiencies within the nematode analytical service to customers, the objectives of this research are to: ▪ identify commercial image analysis software suitable for application to nematode identification and enumeration applications; and ▪ critically evaluate the performance of identified software in improving efficiencies in the SASRI nematode analytical service.
Approach to be Adopted	▪ The ability of commercial software, obtained on a trial basis from the manufacturer, to accurately discriminate amongst images of different nematode species is to be assessed. ▪ The capacity of the most suitable of the image analysis software packages to improve time and accuracy efficiencies on sample processing within the SASRI nematode analytical service is to be assessed. ▪ In parallel to the conventional manual methodology, assessments are to be conducted on two primary sample sets: (1) routine commercial samples; and (2) samples in which the nematode communities have been manipulated to represent both low and high diversity and low and high frequencies of individual species. ▪ If the proposed new system proves to be reliable, rapid and cost-effective, the relevant process changes to the SASRI nematode analytical service are to be effected.
Anticipated Outcomes	An accurate, cost-effective and sustainable technology for application to the SASRI nematode analytical facility to improve service delivery.
Technology and/or Knowledge Transfer Plan	The new technology is to be documented in the SASRI Nematology Methods Manual and through publications in relevant science journals.
Anticipated Value to Industry	Adoption of semi-automated nematode identification and enumeration technology within the SASRI nematode analytical service will enable a sustainable increase in sample turn-around time.

Outcomes from Completed Research Projects

Research projects		
Research area	**Outcomes**	**Value to industry**
Biology and ecology of pests and diseases		
Sugar Cane Yellow Leaf Virus (SCYLV)	▪ Reaction of varieties to infection by the SCYLV is variable. In plant crops: a) significant cane yield penalties are likely in NCo376 (35 - 43% loss), N39 (18% loss) and N12 (8% loss); and b) cane yield gains are apparent in response to infection of N31 (12% increase) and N33 (15% increase). ▪ SCYLV infection results in a significant increase in the root biomass of N32. ▪ Differences in variety resistance to SCYLV are evident: N33 is more resistant and NCo376 is more susceptible. ▪ A significant increase in juice colour of NCo376 occurs in response to SCLYV infection but not in N12 or N31.	▪ While yield losses of up to 43% can occur in SCYLV susceptible varieties, some varieties are tolerant and may even show improved yields when infected. ▪ Varietal SCYLV resistance or tolerance is critical to the management of yellow leaf syndrome. ▪ Establishment of seedcane nurseries with virus-free NovaCane® plantlets is likely to be effective in reducing SCYLV levels over time.
Maize Streak Virus (MSV)	▪ In 2007, Maize Streak symptoms were observed in N44 on the Lower South Coast and subsequently elsewhere in the industry. ▪ The viral pathogen was identified as MSV-A, subtype MSV-A_4 which is the most virulent strain in maize. ▪ A new species of mastrevirus, *Saccharum* Streak Virus, was discovered as a co-infection. ▪ MSV was shown to be transmitted from grasses and maize in the vicinity of sugarcane fields by the leafhoppers, *Cicadulina mbila* and *C. anestae*. ▪ Trials conducted with potted sugarcane plants indicated that MSV reduces N44 cane yield by an average of 44%.	▪ N44 was de-gazetted in 2009 based on: a) the extreme susceptibility of the variety to the MSV-A_4 virus strain; b) the severity of the effects of MSV on yield; c) the high inoculum of MSV in natural vegetation; and d) the widespread distribution of the leafhopper vectors. ▪ Due to the severity of the biorisk posed by MSV to the industry, growers are required to eradicate N44 from their fields by June 2015.
Biological control, cultural and environmental practices		
Indigenous entomo-pathogens	▪ An isolate of the fungal epizootic, *Beauvaria brongniartii*, was found to have good host specificity, dispersal ability and environmental persistence against white grubs (endemic scarabaeids) in the Midlands. ▪ An entomopathogenic nematode (EPN) has been isolated which shows promise as a predator of all the immature life stages of eldana (larvae and pupae).	▪ Potential exists for the development of a commercial myco-insecticide (a biological agent) against white grubs. ▪ Potential exists for the development of a commercial EPN (a biological agent) against eldana.
Variety mixtures	▪ Cultivation of a mixture of selected varieties within individual sugarcane fields does not significantly or consistently alter nematode communities, eldana population size or crop yield.	▪ Cultivation of variety mixtures within individual fields is not a feasible means to control pests and pathogens or improve sugarcane yields.

Selected Highlights: Current Research Projects

Biological control and cultural and environmental practices to manage pathogens, pests and weeds

Eldana control based on eldana-Fusarium spp interactions

Sugarcane is frequently colonised by several species of the fungus, *Fusarium*. These fungal species, most often isolated from the reddened tissue associated with eldana borings, are also present as endophytes within the plant in undamaged and non-diseased stalks. Among isolates found in mature borings, most are attractive and nutritionally beneficial to eldana, such as isolate SC17. Some are repellent and toxic to eldana, such as isolate PNG40, which was isolated from an aborted eldana boring. The use of endophytes to limit pest and disease damage is being exploited in other crops. For instance, endophytic colonisation by *F. oxysporum* has been shown to be effective against *Radopholus similis*, a nematode that causes extensive damage in banana plantations. The objective of SASRI research in this area is to assess the effect of *Fusarium* endophytes on eldana (*in vitro* and *in vivo*), nematode communities (*in vivo*) and disease incidence (*in vitro* and *in vivo*).

Extracts from sugarcane stalk tissue inoculated with PNG40b, SC17 and ZN12 (*F. pseudonygamai*) were analysed for metabolites using LC-MS and GC-MS (liquid- and gas-chromatography-linked mass spectroscopy). These analyses revealed that the insecticidal toxin, beauvericin, was produced by PNG40b and ZN12 (two isolates shown to be antagonistic to eldana) but was not produced by the beneficial isolate SC17.

A field trial was established at Mount Edgecombe to investigate the effect of three *Fusarium* isolates (PNG40b, SC17 and ZN12) inoculated into tissue culture (TC) plants on pest and disease incidence. Results from the trial, which was harvested on 22 April 2013, revealed no statistically significant differences in yield, juice quality or eldana damage between treatments. However, the lowest level of damage was recorded in the hot-water plus fungicide Dynasty® treatment (which is currently being developed as a seedcane treatment). This is similar to an observation made several years ago where the fungicide Eria® reduced eldana numbers by 50% when used as a seedcane dip. Possible mechanisms underlying this beneficial effect include the potential advantages of excluding *Fusarium* isolates beneficial to eldana from the plant and the alleviation of plant stress. Research in other projects is continuing to investigate the potential of antagonistic *Fusarium* isolates serving as biocontrol agents of eldana.

Sugarcane resistance to pathogens and pests

Rapid screening for sugarcane pest and disease resistance

Screening for resistance to pests and diseases is currently limited to later selection stages within the SASRI plant breeding programme, largely due to cost and logistical complexities. Consequently, many susceptible genotypes are inadvertently progressed to later selection stages before they are discarded. Application of new screening tools at earlier stages could result in cost savings, productivity benefits and increased numbers of resistant clones entering the later selection stages.

Near Infra-red Spectroscopy (NIRS) is a non-invasive, non-destructive potential means through which the interaction between sugarcane and sugarcane pests may be examined. As such, it has great potential for screening purposes in a high-throughput phenomics[6] environment. Whereas earlier successful SASRI projects constructed NIR models using transmittance spectra from dissolved internode wax and bud extracts, the main objective of current research is to develop fibre-optic NIR methods to predict resistance using reflectance spectra from intact leaf, bud and internode surfaces.

To build NIR models for Chilo resistance it is necessary to determine resistance ratings for the calibration of predictive models. As it is not possible to work with *Chilo sacchariphagus* at SASRI due to biosafety risk, a surrogate in the form of *Chilo partellus*, which is endemic in KZN and Mpumalanga, is being used. This insect is in itself a potential invader of sugarcane in South Africa, as has already ocurred in north eastern Africa.

Chilo species are known to exhibit oviposition preferences, for example among different maize or sorghum cultivars for *C. partellus*. Therefore, ovipostion choice experiments have been conducted at SASRI using 20 genotypes selected according to their known differences in resistance to *C. sacchariphagus*. No-choice larval inoculations have also been undertaken on the same genotypes.

A number of measurements were taken in the inoculation trial and these were used to generate a preliminary ranking of genotypes for resistance. Among the South African genotypes tested, N31 and N27 appeared more susceptible than N24, N28 and N32, indicating that there is variability among genotypes and that more susceptible genotypes could lead to *C. partellus* developing the ability to become a pest of sugarcane in South Africa.

Preformed leaf chemistry might be expected to have the greatest effect on female moth oviposition choice. Using the results from the oviposition experiment, an NIR model was calibrated. Here, the NIR software attempts to make 'sense' of the results in terms of biochemical and structural differences 'seen' in the various genotypes.

Amongst the varieties tested, the Réunion Island cultivar, R570, predicted as the least preferred genotype for oviposition, whilst N28 predicted as the most preferred. Because NIR spectra vary due to preformed chemical and structural differences, this suggests

6. Although the phenotype of a sugarcane variety is the ensemble of observable characteristics displayed by that variety, the word phenome is sometimes used to refer to a particular collection of traits (e.g. pest and disease resistance traits), while the simultaneous study of such a collection is referred to as phenomics.

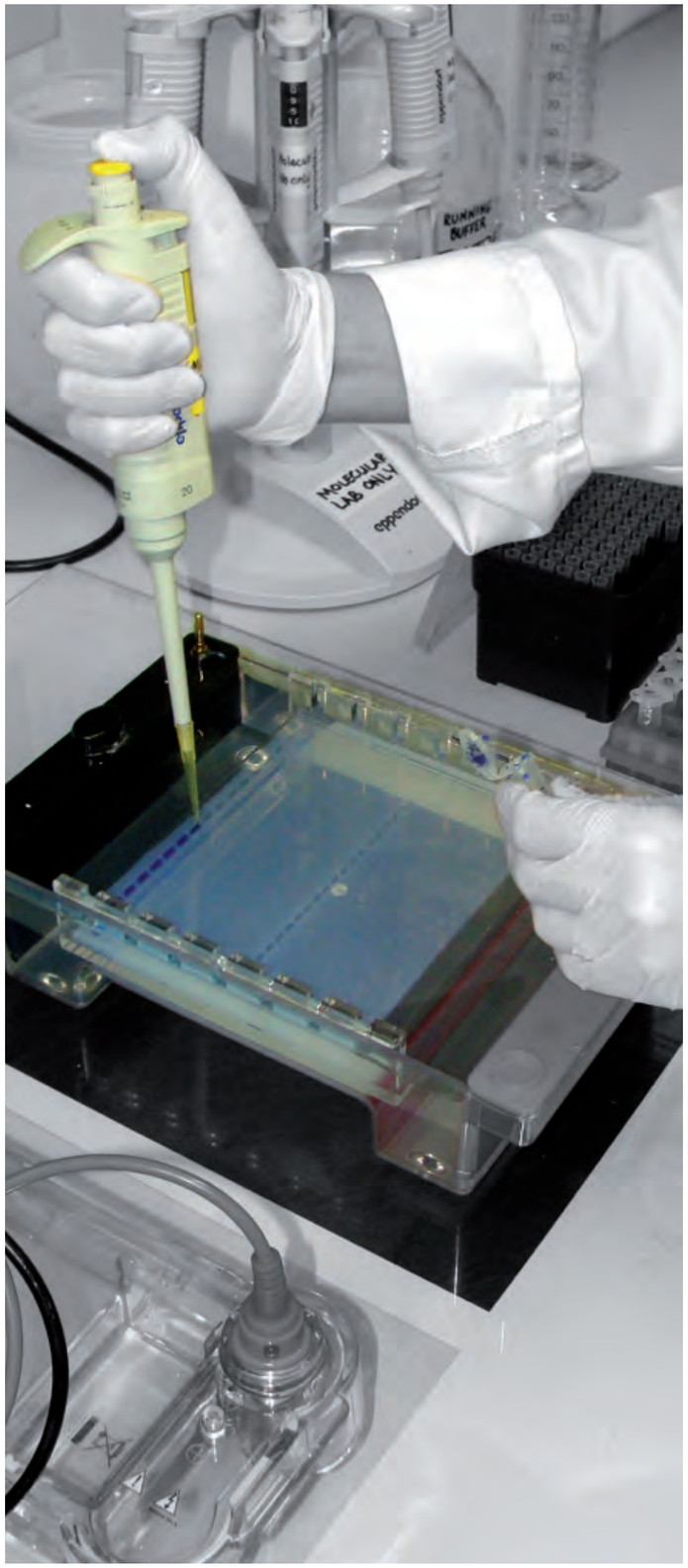
the presence of constitutive oviposition deterrence in R570 which is absent in N28 and N27, which were predicted as the second-most preferred genotypes. Similarly, the predictions of shot-hole number, number of larvae, number of borings, tunnel length and mass of larvae models suggest that R570 is more resistant than N28 and N27, which both predict as susceptible. Overall, analysis of the NIR modelling predictions led to the hypotheses that:

- R570 is constitutively resistant;
- N28 is constitutively susceptible, but mounts an efficient resistance response once attacked;
- N27 is neither constitutively resistant nor able to mount an effective resistance response once attacked; and
- N27 may therefore represent a significant risk in terms of the possibility that *Chilo partellus* may adapt to it in the field.

Technologies to reduce virus transmission in certified seedcane nurseries

Mosaic (*Sugarcane mosaic virus*) (SCMV) and yellow leaf (*Sugarcane yellow leaf virus*) (SCYLV*) viruses* are widespread in the South African sugar industry. By limiting aphid transmission within nurseries, whether planted with conventional seedcane, transplants or tissue culture plantlets, SCMV and SCYLV incidence would be reduced.

The objective of current research is to test the efficacy and feasibility of applying chemicals or mulches in certified nurseries to reduce the incidence of SCMV and SCYLV. NovaCane® plantlets of NCo376, a SCMV and a SCYLV-susceptible variety were used to establish a field trial at Phoenix Wattle in Eston. Treatments included reflective plastic sheeting and sugarcane crop residue placed between cane rows, an insecticide (imidacloprid) and a semiochemical (methyl jasmonate). Aphid populations, SCMV and SCYLV incidence in these plots and untreated control plots were compared.



The trial was inspected for mosaic in April 2013 and leaves were collected for SCYLV testing in June 2013. There were more shoots in the plots with reflective plastic sheeting ($P<0.001$) and mosaic incidence was lowest in these plots, although the difference between treatments was not significant. SCYLV incidence ranged from 14% in the control and plastic mulch plots to 23% in the plots treated with methyl jasmonate. The difference between treatments was however not statistically significant.

Aphid numbers and mosaic incidence were lower in plots with reflective plastic mulch laid in the inter-row. Shoot counts were significantly higher in these plots and weed control was easier. The practicalities of using this product, in conjunction with Bandit®, in a nursery situation, are to be tested in 2014. This technology could be of significance in the protection of high value NovaCane® plantlets from infection.

Sour rot: What influences its development?

Phaeocytostroma sacchari causes rind disease which is a common, usually minor, condition affecting weakened cane stalks. During periods of severe drought, particularly when cane is mature, rind disease may develop into sour rot, which can cause substantial loss of sucrose. Sour rot was first reported in the South African sugar industry in 1998. The disease affected mature cane in the Midlands South area after a prolonged dry winter and spring and caused a reduction in purity which resulted in cane consignments being rejected by mills. Since then, sporadic outbreaks have occurred which have largely been restricted to certain farms in that area. However, the disease is becoming increasingly common in the Midlands North area and the only advice that can currently be given to growers is to harvest their cane as soon as possible to avoid further deterioration. Alternative management strategies may be possible once more information on the development of sour rot becomes available.

The objectives of this research are to:

- investigate the rate at which sour rot symptoms develop through the stalk and the associated effect of the fungus on juice quality;
- investigate the conditions that favour the development of sour rot e.g. the effect of climate and planting date, soil nutrition and crop size;
- determine whether some varieties are more susceptible to *P. sacchari* infection than others; and
- investigate the degree of pathogen diversity.

Two trials investigating the effect of nutrition and planting date on sour rot incidence and severity were harvested in Harburg during 2013. Seven different fertiliser regimes were included in the trial along with an unfertilised control.

Although the yield was lowest in the unfertilised treatment, the difference between treatments was not significant. Sour rot incidence ranged from 8.8 to 42.5% stalks infected and was highest in the two chicken litter treatments. Due to the variability in the data, the difference between treatments was not significant. In some cases sour rot damage was severe with a number of completely reddened internodes, but generally infections were new, with evidence of limited tissue reddening in the nodal regions of affected stalks. As sour rot tends to become more common and severe from September through November when rainfall is low, the research will be continued in 2014 to obtain conclusive information on factors contributing to sour rot development.

Selected Highlights: Long-term Principal Projects

New chemistries for pest, disease and weed control

Chemical and biological pest control products play an important role in Integrated Pest Management (IPM) and other pest management strategies.

However, to maintain the effectiveness of these products, new products require evaluation in a way that will ultimately lead to their commercial use. This allows not only for product rotation but also the availability of new, potentially more effective chemistries or formulations. The objective of Crop Protection research in this area is to work towards the registration of new chemistries and application methods for the control of pests, diseases, nematodes and weeds in sugarcane.

To supplement FASTAC®, trials are in progress to investigate additional products for eldana control, as well as potentially more effective application regimes of the product. The alternative chemistries currently under assessment are Product A (chlorantraniliprole), Product B (indoxacarb) and Product C (an insect growth regulator). The treatments were applied in August 2012 to eight-month-old cane that was typical of a carry-over crop.

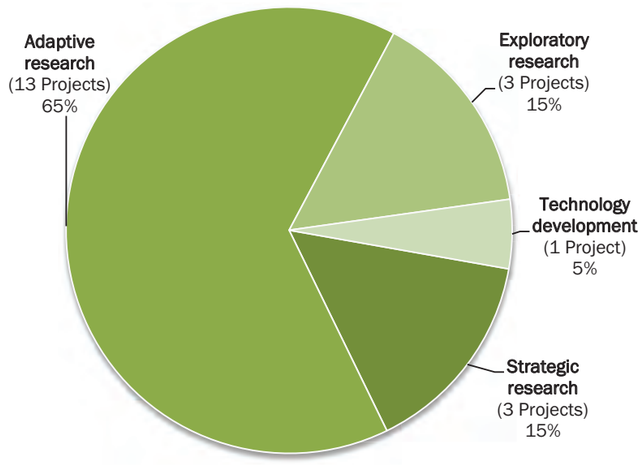
All treatments significantly increased crop yield compared to the untreated control. No treatment appeared to be significantly better or worse than the standard FASTAC® treatment. As had been previously observed, the monthly application (monthly for five months) of FASTAC® was as effective as the standard application frequency (eight two-weekly applications).

These results are very encouraging in that the agro-chemical treatments resulted in a maximum of a 60% increase in sucrose yield per hectare. The data suggest that four treatments, other than the current industry standard treatment, may significantly reduce the impact of eldana on carry-over crops. The trial is currently being repeated to verify the results. Should the efficacy of these treatments be confirmed, registration will be pursued in collaboration with the product licence holders.

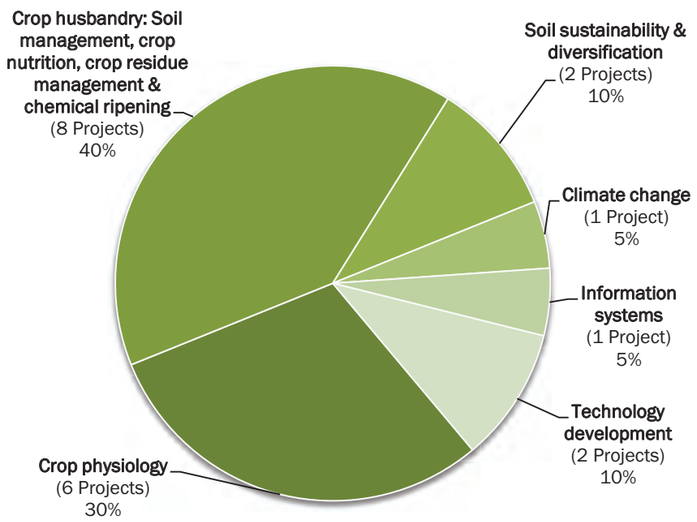
Crop Performance and Management Research

Strategic objectives

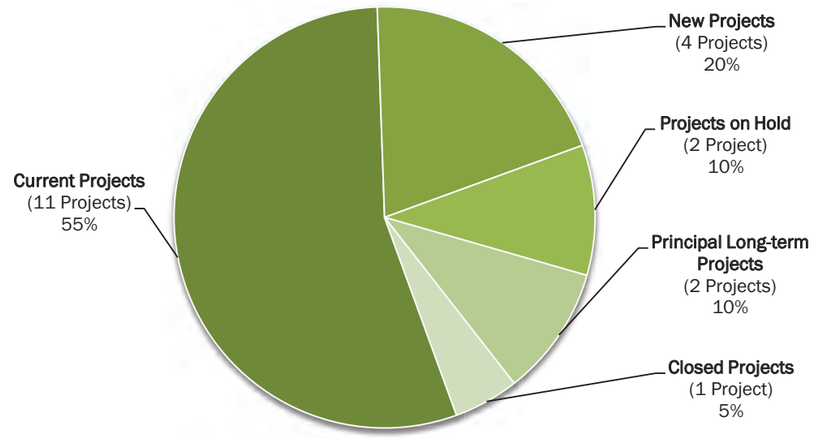
- To develop new, and fine-tune existing, crop management practices to enhance the economic and environmental sustainability of sugarcane production.
- Through basic and applied research, to increase knowledge of how climate, soil, nutrient and crop management factors affect sugarcane productivity (growth, yield and quality), and the extent to which these effects are genotype specific.
- In combination with economic analyses and the outcomes of the other SASRI research programmes, to: a) develop and refine models that predict crop performance; and b) to identify improved crop management practices.



Dr Riekert van Heerden



2013 Project Disposition



New Research Projects

An investigation into factors responsible for poor root development in many areas of the industry	ADAPTIVE RESEARCH
Need Statement	Examination of soil profiles in numerous rainfed areas of the SA sugar industry has revealed the widespread occurrence of poor root development. In such instances, roots have been found to be sparse, frequently blackened and generally confined to the top 30 cm of the soil profile. Such poor rooting may have profound effects on crop performance and, hence, identification and amelioration of factors implicated in this phenomenon are critical.
Project Objectives	The research aims to: ▪ determine the extent of poor root development in the SA sugar industry; ▪ assess the potential consequences of poor root development on yield and ratoon longevity; and ▪ identify the management and soil factors most frequently associated with good and poor root development.
Approach to be Adopted	The research is to rely on multidisciplinary expertise, encompassing agronomy, entomology, nematology, pathology, soil chemistry, soil physics and extension. With preliminary observations of poor rooting in many fields in the Midlands and Zululand, as well as on the North and South Coast, the ongoing approach will focus on detailed sampling by regional extension specialists and analysis of both well- and poorly-established rooting systems across these and other selected geographical areas. Site selection will be of paramount importance and will encompass a range of soil types, varieties and where available, histories of agro-chemical use.
Anticipated Outcomes	Comparison of chemical, physical and biological data between well- and poorly-established root systems and the surrounding soil will enable the identification of factors potentially associated with root stunting. Based on these outcomes, a second research phase will be proposed, which will focus on the development of management strategies to ameliorate poor root development.
Technology and/or Knowledge Transfer Plan	As part of the technology transfer plan, exposed soil profiles at key locations will be used to demonstrate to growers the appearance of both well-and poorly-established sugarcane root systems. Other technology transfer media, such as articles in *The Link* and presentations at grower days will be used to illustrate to growers the physical appearance of well- and poorly-established root systems and to emphasise the importance of good root vigour.
Anticipated Value to Industry	As the extent and severity of the poor sugarcane rooting in the SA sugar industry are unknown, accurate assessment of the current effect of the phenomenon on crop productivity is difficult. Regardless, however, increased root proliferation and penetration will ultimately lead to superior uptake of water and nutrients and improved growth and yield.

Resin technology for soil phosphorus testing: Field calibration for irrigated areas	ADAPTIVE RESEARCH
Need Statement	A wealth of scientific literature indicates that the accuracy of soil phosphorus (P) tests based on resin technologies are superior to those which make use of chemical extractants, particularly in terms of predicting P availability to crops grown on soils of widely varying chemical and physical characteristics. Consequently, the SASRI Fertliser Advisory Service (FAS) plans to implement a resin-based method for estimating plant-available P in the soils of a higher pH value that prevail in the irrigated northern areas of the SA sugar industry. A need therefore exists for calibration data to establish P fertiliser recommendations to growers operating in these areas.
Project Objective	To develop P fertiliser recommendations for soils with higher pH values based on crop-available P levels determined by resin-based technology.
Approach to be Adopted	▪ The methodology will be as follows: ▪ *Trial design*: Factorial, 3N x 4P x replicates ▪ *Number of trials and locations*: Two trials on ratoon crops and three on plant crops will be undertaken. The trials will be located at sites representative of the northern irrigated regions of the industry (Umfolozi, Pongola and Mpumalanga). ▪ *Duration*: As three to four crops are required from each trial, the project will have a minimum duration of four years. ▪ *Treatment levels*: Levels of N and P will be based on soil properties and are likely to vary from site to site. However, zero applications (controls) will be included at each site for both N and P. ▪ *Sampling and measurements*: Detailed soil and leaf sampling will be undertaken for each crop cycle, as well as heights and counts, stalk yields and quality.
Anticipated Outcomes	The SASRI FAS is to adopt a resin-based P determination method for use on neutral and alkaline soils in the latter part of 2013. This research will serve to calibrate the resin test by means of data obtained from P response trials conducted on appropriate soils, thereby facilitating increased reliability of P recommendations to the important irrigated northern regions of the industry.
Technology and/or Knowledge Transfer Plan	The calibration and methodology will be captured as updated and improved P norms for extending advice on FAS reports to growers. In addition, the benefits of the new technology will be transferred to growers by a variety of means, including field days at the trial sites and an article in *The Link*. The outcomes of the research will be disseminated in a science journal publication and in the *Proceedings of the South African Sugar Technologists' Association*.
Anticipated Value to Industry	The economic value of the research may be calculated in terms of savings in fertiliser, or alternatively by increased production as a result of improving P supply. Expenditure on P fertilisation within the SA sugar industry is considerable and improvements in efficiency in the use of this nutrient could translate into appreciable savings. ▪ Cost (2013) of P in fertiliser = R32.00/kg ▪ Current area under sugarcane in SA = 378,000 ha ▪ Estimated high pH area = 40% ▪ Estimated annual application of P = 25 kg/ha ▪ Annual P cost for high pH areas = R121 million

Development of reliable leaf nitrogen threshold values	ADAPTIVE RESEARCH
Need Statement	Leaf nutrient analyses are regarded as a valuable tool for assessing the nutritional status of sugarcane, and in particular the adequacy of nitrogen (N) supply to the crop. Currently, FAS analyses some 7 000 to 8 000 leaf samples annually. The Critical Nutrient Concentration (CNC) approach is highly effective for the interpretation of leaf nutrient data as it is based on the relationship between nutrient concentration and standing crop biomass at that point in time. The transition zone between the deficient and adequate zones indicates the critical level for the nutrient in question. The critical level is therefore the concentration below which supplies of the nutrient begin to limit growth and yield. Interpretation of plant analyses based on critical nutrient levels simply involves comparing the sample nutrient concentrations with established critical values and permits the development and issuing of reliable nutrient fertilisation advice.
Project Objective	To develop an N fertiliser recommendations protocol for deployment in the SASRI FAS which is based on the relationship between concentration of the nutrient in the leaf and standing crop biomass at that point in time, with a view to enabling the application of N to the level required for economically advantageous farming.
Approach to be Adopted	▪ The top visible dewlap (TVD) leaves of sugarcane plants three to nine months of age are to be sampled at monthly intervals from various treatments within existing SASRI N trials. ▪ Standing crop biomass and stalk counts and heights are to be recorded at each leaf sampling. ▪ Relationships are to be established between heights and standing crop biomass, with a view to developing models to predict biomass from stalk height measurements. ▪ Relationships between leaf N and final crop yields are to be examined and the resultant family of threshold values related to increasing crop biomass as postulated by the Lemaire-Greenwood model. ▪ Varietal effects on these relationships are to be studied and, if necessary, modifications to the model are to be introduced to account for varietal differences.
Anticipated Outcomes	FAS N fertiliser recommendations based on the relationship between concentration of the nutrient in the leaf and standing crop biomass which enables the application of N to the level required for economically advantageous farming.
Technology and/or Knowledge Transfer Plan	The calibration and revised methodology will be captured as updated and improved N norms for extending advice on FAS reports to growers. In addition, the benefits of the new technology will be transferred to growers by a variety of means, including grower days and an article in *The Link*. The outcomes of the research will be disseminated in a science journal publication and in the *Proceedings of the South African Sugar Technologists' Association*.
Anticipated Value to Industry	Current expenditure on N fertilisation in the SA sugar industry is considerable. The economic value of the research resides in the potential savings in fertiliser that may accrue due to the project outcomes or, alternatively, by increased production as a result of improving N supply. Improvements in efficiency in the use of this nutrient could translate into appreciable savings and/or improved yields ▪ Current price of N in fertiliser = R14/kg ▪ Current area under sugarcane in SA = 378 000 ha ▪ Estimated annual application of N = 130 kg N/ha ▪ Annual N cost = R688 million

Investigation of variability associated with soil sampling	TECHNOLOGY DEVELOPMENT
Need Statement	Soil testing for crop nutrition applications involves field sampling, laboratory analyses and subsequent formulation of fertiliser recommendations based on the analytical data. Of these, the process that is arguably most prone to error is soil sampling, largely due to challenges associated with obtaining a sample that is representative of sometimes highly heterogeneous fields. In-field soil sampling accuracy is of paramount importance, in that a 10 g soil sample could form the basis of fertiliser applications to the value of up to R55 000. The need for representative sampling is particularly acute for fields bearing ratoon crops, where the banding of immobile nutrients and non-uniform lime spreading may introduce significant inconsistencies into soil samples.
Project Objectives	Three principal sources of error potentially exist within the current ratoon sampling strategy: a) *Field to Bag*: error associated with collecting subsamples from a heterogeneous field; b) *Bag to Box*: error associated with subsample mixing and transfer to FAS boxes and c) *Box to Spatula*: error associated with selecting a spatula of soil from the sample box for analysis. Such sources of error remain unquantified, although it is believed that current sample collection and handling recommendations are not adequately tailored to minimise error. Hence, the objectives of this research are to: ▪ evaluate and quantify the three sources of error associated with ratoon soil sampling; and ▪ develop improved recommendations for ratoon soil sampling that aim to minimise variability and improve the accuracy of sample representations of the fields under consideration.

Approach to be Adopted	Two fields with different soil types bearing ratoon crops are to be sampled intensively to quantify the error associated with each of the three stages of soil sampling. In each case, current standard practice is to be compared with a best practice protocol, enabling calculation of error associated with standard practice. In addition, more practical 'intermediate' strategies will be tested for field applicability along with acceptable margins of error.
Anticipated Outcomes	Representative soil sampling that reflects the inherent variability of soils under ratoon cultivation will improve sampling accuracy and bolster the quality of FAS recommendations to growers.
Technology and/or Knowledge Transfer Plan	The Best Practice soil sampling protocol to be developed will be communicated to FAS clients through grower days and communications in *The Link*. The research outcomes are also likely to be suitable for publication in a science journal and in the *Proceedings of the South African Sugar Technologists' Association*.
Anticipated Value to Industry	The potential value of the research outcomes may be illustrated by a simple hypothetical example. A grower collects a soil sample from his field and does not achieve uniform mixing of the sample before decanting it into the FAS soil sample box. In so doing, the grower may have inadvertently included soil from a high-K seam, resulting in an unusually high K measurement. Based on this, no K would be recommended by FAS for this ratoon crop, which could conceivably result in a 30 t/ha yield decrease due to K-deficiency, leading to a loss of approximately R12 000 per hectare. This grower may also have filled an additional box from the same sampling bag, and sent in a box with unusually low K. Based on this, he might have been advised to apply 185 kg/ha of K, at a cost of R2 500 per hectare. Such widely differing results from the same field and even the same soil sample illustrate the importance of correct soil sampling and handling procedures.

Outcomes from Completed Research Projects

Research projects		
Research area	**Outcomes**	**Value to Industry**
Crop physiology		
Crop modelling	A new version of the DSSAT Canegro® model has been developed to encompass current knowledge of sugarcane biophysical characteristics: germination and emergence, primary shoot development, tillering, tiller senescence, leaf appearance, leaf and stalk elongation and a source-sink partitioning algorithm.	With further ongoing validation, the new Canegro® edition will enable prediction of the performance of individual varieties under different environmental conditions, which will ultimately enhance crop modelling capacity to assist sugarcane breeding and associated yield forecasting precision within the industry.

Selected Highlights: Current Research Projects

Crop physiology

Variety and crop residue blanket interactions

Distinct differences have been noted in variety responses to crop residue blankets, in terms of germination and emergence, as well as in the quantity and quality of residue produced. However, to-date, no formal study has been undertaken to document these responses for most of the commercial cane varieties.

With the advent of green cane harvesting systems there is an increased demand for information relating to aspects of residue blanket management, particularly given that SASRI promotes the practice. The interaction between variety and residues will therefore become a very important factor for consideration by growers in the future and adequate information is required to assist decision-making.

Amongst the several varieties studied in 2013, N47 was shown to produce the highest leaf residue yields in second and third ratoon crops, while N45 produced lower leaf residue yields in general. Under rainfed condition, leaf residue yields ranged from approximately 7 to 20 tons/ha depending on variety and production season. Varietal differences in leaf residue yields occur, although seasonal effects are generally of greater consequence. Residue yield information of this nature is vital for the planning of brown-leaf harvesting initiatives by both millers and growers.

Resource-use efficiency of biomass genotypes

There are indications that high biomass (energy cane) genotypes exist that use resources, especially water, substantially more efficiently than existing sucrose cultivars. As a result, these energy cane genotypes may have potential for biomass production for energy in areas where levels of these resources are low, such as low rainfall areas or areas with poor soils. For possible expansion of cultivation into these marginal areas it is necessary for the industry to know the answers to the following questions:

- Are there sugarcane cultivars that produce substantially more biomass per unit water than sucrose cultivars or other crops such as tropical sugar beet?
- How much biomass can be produced (per biomass component – leaf, stalk fibre and stalk sugars) in each of the different marginal areas and how much water and nitrogen will be required?
- Which marginal areas are suitable for production of energy cane cultivars?

During 2013, experiments were conducted on the SASRI Komatipoort Research Station to gather quantitative information on crop productivity, water use efficiency[7] (WUE) and drought tolerance of different sugarcane genotypes and benchmark these against other potential bio-energy crops. Genotypes tested were two conventional sucrose-type sugarcane cultivars (N19, N31), a biomass type sugarcane hybrid (04G73), an *Erianthus* clone (*cv*. IK76-63) and three alternative crops, namely Napier grass, forage sorghum (*cv*. Big Kahuna) and tropical sugar beet (*cv*. Python). Water treatments consisted of a well-watered and a water stress treatment (50% of crop water requirement).

Compared to *Erianthus* (*cv*. IK76-63), Napier grass, sweet sorghum (*cv*. Big Kahuna) and sugar beet (*cv*. Python), selected commercial sugarcane cultivars (N19, N31) were demonstrated to be potentially more desirable as feedstocks

7. WUE is defined as aboveground dry biomass produced per unit evapotranspiration.

for second-generation (2G) bioethanol production. Compared to these potential alternative crops, sugarcane appears to be preferable due the ease of cultivation and processing versatility.

Crop husbandry

Predicting N contributions from soil organic matter

The primary objective of this research is to develop a methodology that provides more reliable estimates of N reserves in the soil for crop uptake. For the past twenty years, the SASRI Fertiliser Advisory Service (FAS) has made use of the 'N category' approach in predicting N release in soils. Nitrogen categories, as used in FAS, are based on soil total organic matter and clay contents.

Nitrogen release in long-term laboratory incubations are widely held to provide the most reliable estimates of crop-available soil N reserves. However, in a commercial analytical laboratory such as FAS, long-term incubations of grower samples are too time consuming and laborious for routine use. During 2013, N release from 114 topsoil samples largely representative of soils of the South African sugar industry was investigated using laboratory incubations and chemical tests, with a view to effecting an improvement on the N category approach currently in use. Essentially, the approach is to identify methods more suited to routine use in providing estimates of N release than long-term incubations.

Research conducted during 2013 has revealed that N release following 28 and 112 day incubations was not closely related to predicted N release using FAS soil N categories. The correlations for N release of various chemical tests (seven-day anaerobically mineralisable N, hot water extraction and hot 2 M KCl extraction and three day CO_2 flush) with the 28 and 112 day aerobic incubation data were stronger than the correlations with N category. Total C, total N and N category were all relatively poorly related to the N-mineralisation measured in long-term incubation trials. This finding is in agreement with numerous reports in the literature of indices based on total organic matter and total N being unreliable indicators of soil-N supplying capacity. In the case of the N category parameter, currently used by FAS, these findings emphasise the need for a more reliable index of N mineralisation. The correlations for N release of various chemical tests mentioned above were highly significant and represent a potential improvement on the N category approach. Further investigations are under way with a view to identifying the most suitable index for use in a high-throughput routine laboratory. Investigations include the use of infrared spectroscopy for predicting available N reserves in soils.

Volatilisation of urea-based N fertilisers

Urea-based N fertilisers are subject to volatilisation losses, which may reduce N use efficiency to as low as 30%. Consequently, products have appeared on the market claiming to reduce such losses. At the request of growers, SASRI commenced research to compare volatilisation losses of new urea products with those of conventional fertilisers under laboratory and field conditions and to quantify the cost effectiveness of the products.

In recent experiments, volatilisation losses of various N fertilisers (LAN, urea, Urea Product A, Urea Product B) and a control were measured in a further two laboratory experiments (randomised design, with six replications). The application rate was equivalent to 160 kg N/ha. In the first trial, a soil of high volatilisation risk under dry versus wet soil conditions was investigated. The second trial followed the same approach but on a soil with low volatilisation risk.

Unsurprisingly, the measured N losses were much higher on the high volatilisation risk soil compared to the low volatilisation risk soil. Interestingly, however, the investigated soil moisture scenarios (dry soil *versus* wet soil) were of only minor influence and did not result in significant differences in volatilisation.

On the high volatilisation risk soil, the losses were highest for urea: on the dry soil, 62.9 kg N/ha (almost 40%) losses were measured and even more than 50% (81.5 kg N/ha) on the soil plus slight water application. Urea Product B did not achieve better results: the losses from this product on the dry soil were comparable to urea, although they increased only slightly when water was applied. The best performing urea-based product was Urea Product A, with losses of 30.3 kg N/ha (18.96%) on the dry soil and 34.16 kg N/ha (21.3%) on the soil plus water application. This represents a decrease in the losses by 52% on the dry soil and 59% on the wet soil compared to urea.

The measured losses on a soil with low volatilisation risk were much lower and ranged for the urea products between 13.7 kg N/ha (8.56%) and 22.4 kg N/ha (14%), with no significant differences between the products and between dry soil and soil with water application.

In terms of cost-effectiveness, on the high volatilisation risk soil, Urea Product A was the most cost effective, followed by Urea and LAN, with Urea Product B ranked last. A different ranking was obtained for the low volatilisation risk soil, with Urea showing the lowest costs per kg N followed by Urea Product A, Urea Product B and LAN.

In 2014, the project will continue to ascertain the effect of additional factors that may influence volatilisation, including lime application and a crop residue blanket. Ultimately, the project will provide an assessment of the economic efficiency of the various products under a range of conditions; information which will assist grower decision-making. Until definitive conclusions from the research are reached during 2014, the identity of the urea-based products used in the study will remain confidential.

Information systems

Irrigation decision support

The overall goal of this research is to maximise economic return from sugarcane production when water supply is limited through the development and implementation of a decision support tool for optimal water allocation. Initial investigations have focused on refining the capacity to predict crop response to water stress at different times in the growth cycle through water stress experiments. To this end, field experiments were conducted during 2013 on N49 plant and first ratoon crops cultivated in the Komatipoort region of the SA sugar industry.

The objective of the experiments undertaken during 2013 was to gain a better understanding of the crop response to mild water stress, imposed through deficit drip irrigation, during different development phases. For the water stress treatments, available soil water was maintained between 30 and 60% of capacity during the tillering phase, stalk elongation phase and through both the tillering and stalk elongation phases. Available soil water was maintained above 60% of capacity in the well-watered control and in the other treatments during periods when stress was not intended.

Cane and sucrose yields were shown to be relatively insensitive to deficit irrigation during the tillering phase of crop development. This information will be used during 2014 to develop a management tool to assist growers with farm-level irrigation scheduling decisions when water supply is scarce.

Drying-off decision support

Several tools were developed or updated during 2013 with a view to assisting grower decision-making regarding drying-off of their crops. The tools included: a) a new versatile and flexible database of recommendations; b) a MyCanesim optimisation routine and algorithms for calculation of drying-off regimes for new sites; c) an improved internet drying-off Decision Support Programme; d) simplified drying-off and Total Available Moisture tables based on soil depth and clay percentage; and e) drying-off calculators or wheels to simplify recommendations to growers. After further verification during 2014 and into 2015, these updated and new tools will be available to facilitate drying-off decision-making and it is anticipated that they will serve to promote improved cane quality at harvest in the irrigated regions of the industry.

Climate change

Predicting impacts of various climate change scenarios

The Agricultural Model Inter-comparison and Improvement Project (AgMIP) is an international project that aims to improve the characterisation of climate change impacts on global food production and security. Within the larger project, SASRI is responsible for conducting an integrated climate-crop-economic model-based assessment of climate change impacts on sugarcane production and the economic well-being of sugarcane farmers, via the collaborative 'Southern African Model Inter-comparison and Improvement Project' (SAMIIP). The basic methodology involves linking crop models, economic models and climate models to investigate the impacts of future climate on food production and trade, to explore adaptation options, and to develop capacity for assessing these impacts in future.

DSSAT Canegro® simulations conducted during 2013 suggest that future cane yields under rainfed conditions in the SA sugar industry, as exemplified by a site at La Mercy, may increase by approximately 20%. The prediction is based on future climate scenarios from three Global Circulation Models set at a future atmospheric carbon dioxide concentration of 734 ppm. The prediction has a high degree of uncertainty due to assumptions of no change in rainfall distribution, solar radiation and relative humidity between the present and future scenarios.

The outcomes of the study have indicated the potential of using an ensemble of Global Circulation Models together with DSSAT Canegro® to assess

potential impacts of climate change scenarios on cane yield in the SA sugar industry. The study has further revealed the necessity for refinements (which are currently being implemented) of the crop model to improve simulations of: a) elevated carbon dioxide concentration effects on crop photosynthesis and transpiration; and b) high temperature effects on crop development, photosynthesis and respiration.

Selected Highlights: Long-term Principal Projects

Variety responses to chemical ripening

The goal of this principal research project is to develop variety-specific chemical ripening recommendations, with specific reference to cane quality (ERC%) and sucrose yields (tERC/ha) in each variety and potential effects of ripeners on subsequent ratoon re-growth.

In addition to the formal field trial work that is conducted every season, seven commercial strip trials were also undertaken during 2013 on 12 and 24-month cutting cycle crops on grower farms in Komatipoort, Melmoth and Eston. These trials are aimed at demonstrating the economic benefits of chemical ripening under commercial conditions and will be used as knowledge transfer tools to facilitate adoption of chemical ripening as a crop management practice, as well as to encourage the responsible use of these chemicals.

Due to the very favourable rainfall in the summer of 2012/2013 throughout the industry, conditions were particularly suitable for growers to use chemical ripening as an early season cane quality management tool. As a result, presentations on chemical ripening were given at no less than eight industry contact events during early 2013. Interest in the topic was considerable, with more than 330 growers and mill representatives attending these events.

Burning crop residues versus maintenance of a residue blanket

The long-term Burning and Trashing Trial (BT1) located at the SASRI Mount Edgecombe site was the focus of considerable activity during 2013. Of note was that the trial received 544 external visitors, which reflects the educational value of BT1 to the sugar industry. The broad interest in the trial emanates from the consistent application of burning, residue blankets and fertilisation treatments over a 73 year period, which has resulted in visually marked soil property differences e.g. soil colour, surface crusting, soil aggregation, earthworm numbers and arthropod activity. During the reporting period, the trial yielded important information on: a) the value of using crop residues during a period of low rainfall; b) N mineralisation; c) crop residues as a source of Si; and d) on a potential relationship between fertilisation and thrips numbers.

Benefits of a crop residue blanket during a low rainfall period

From October 2011 to March 2012, the developing trial crop received 389 mm of rainfall, which is 346 mm less than the average for that period (or only 53% of the long-term mean) while the canopied crop (April to September 2012) received 74 mm more than the long-term mean. The value of a residue blanket (or tops spread) during this dry period before canopy closure was reflected in the 12% positive yield response that was measured in 2013.

N mineralisation

A laboratory incubation study revealed that more N is mineralised from the soil that received fertiliser and that, for both fertilised and un-fertilised treatments, more N is mineralised from soils that were under a crop residue blanket. The cumulative amount of N mineralised over a period of 56 days from the plots that received crop residue and fertiliser was 86 kg N/ha.

Leaf Si content

Evidence was obtained from the trial which suggests that a crop residue blanket enhances crop Si content. Leaf Si content of plots that did not receive any tops or residues was the lowest amongst the treatments, followed by those that received only tops.

Thrips numbers

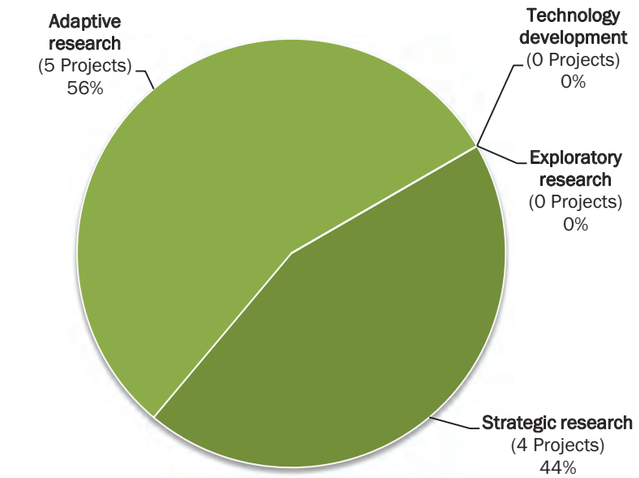
Thrips numbers tended to be higher in the fertilised soil treatments, which may be linked to the higher availability of N. Whether cane was burned or a residue blanket was left behind at harvest did not appear to have any significant effect on thrips numbers. These data provide the first indication that fertilised cane may support higher sugarcane thrips populations, while the presence of a residue blanket appears to have no effect on this pest.

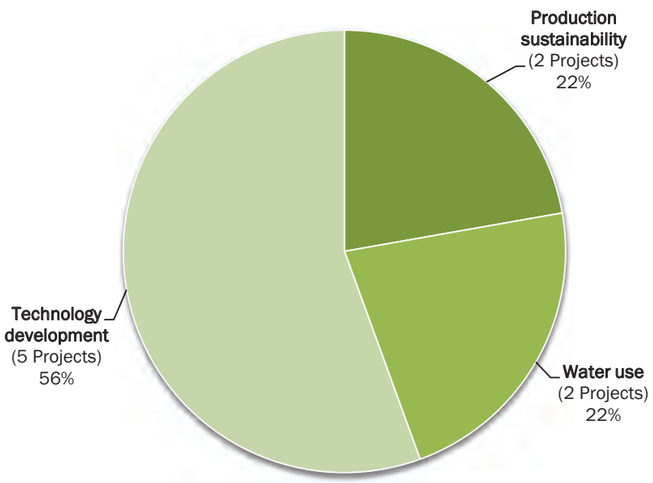
Systems Design and Optimisation Research

Dr Rian van Antwerpen

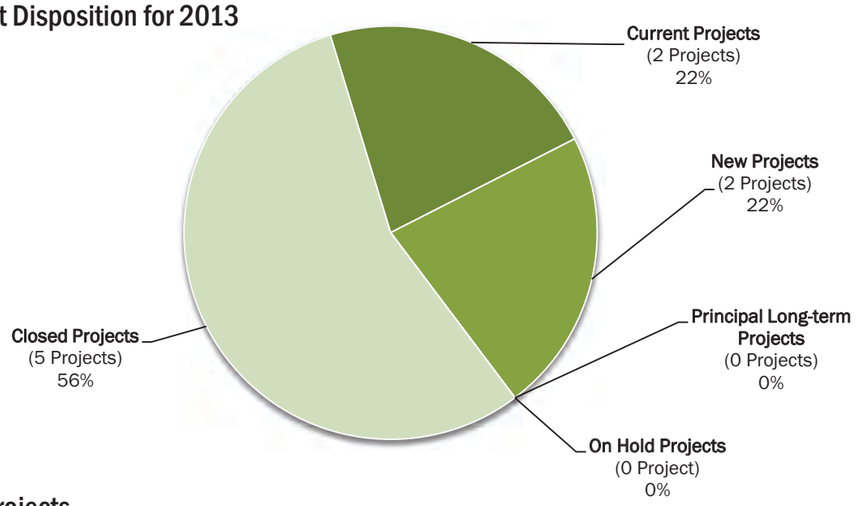
Strategic objectives

- To design and improve farming systems that account for the economic, social and environmental issues which impact on the sustainability of sugarcane production.
- To design and optimise effective and sustainable mechanisation, water management and supply chain systems for sugarcane production.
- To investigate the economic and social issues that impact on sugarcane farming in order to better understand Better Management Practice (BMP) adoption patterns.





Project Disposition for 2013



New Projects

Optimisation of in-field mechanisation during harvesting operations	ADAPTIVE RESEARCH
Need Statement	Extraction of sugarcane from fields is typically associated with intense in-field traffic. Currently, the location, extent and intensity of in-field traffic are insufficiently documented to enable effective comparison amongst available systems or to provide optimisation recommendations. In addition, significant changes to current in-field practices are anticipated once co-generation becomes a reality, in that extraction of higher amounts of biomass will necessitate increased in-field traffic. One option to effectively manage such high levels of in-field traffic is the practice of controlled traffic.
Project Objectives	To enable the formulation of recommendations to effectively manage in-field traffic, the existing practices are to be benchmarked against a controlled traffic practice scenario. The objectives are to quantify the location, extent and intensity of in-field traffic for different harvesting and extraction systems, *viz*: ▪ cut-and-stack loaders; ▪ Bell loaders loading from windrows; ▪ slew-loaders loading from windrows and ▪ various haul-out vehicle configurations.
Approach to be Adopted	▪ The project will build upon the extensive world literature regarding the implementation and benefits of controlled traffic practices. Those data are to be used to benchmark current practice in the SA sugar industry. ▪ Time and motion studies relating to in-field equipment operations will be undertaken to provide information which is to be used to model vehicle operations for various loading scenarios.
Anticipated Outcomes	The envisaged outcome of the project is a Decision Support Tool to enable comparison of alternative loading systems with a view to optimising: ▪ improved in-field loading practices; ▪ minimised cost of in-field haulage; ▪ improved equipment performance; and ▪ minimised risk of in-field traffic induced damage (compaction and stool damage). An integrated vehicle performance, vehicle costing and farm economics component is further envisaged.
Technology and/or Knowledge Transfer Plan	The Decision Support Tool will be unveiled to SASRI Extension Specialists initially with concomitant training workshops. In addition, articles in *The Link* will be used as a means to inform stakeholders of the availability and utility of the tool.
Value to Industry	The Decision Support Tool will enable informed decision-making regarding the deployment of in-field mechanical systems towards reducing costs, stool damage and soil compaction.

WeatherWeb Real Time Weather Data	STRATEGIC RESEARCH
Need Statement	Weather information plays an important role in grower decision-making regarding the day-to-day management of their crops. SASRI meteorological services provide access to weather information for growers via a network of automatic weather stations (AWS), manual weather stations (MWS) and rainfall station (RS) located throughout the SA sugar belt. The data from the AWS are made available to growers through the SASRI weather website (WeatherWeb) on a daily basis, while the data from the MWS and RS are provided monthly. Due to the need for AWS data validation, data patching and the calculation of derivations, the most recent data available on WeatherWeb are for before 10h30 of the previous day. However, as most agronomic decisions at farm-level are made before 10h30, WeatherWeb cannot always be used for every-day agronomic decision-making and planning.
Project Objectives	The objective of this project is to use a cost effective procedure to provide AWS data to users at more frequent intervals than the current daily update. Such a provision will enhance the integration of weather information into decision-making and planning for everyday management of agronomic activities.
Approach to be Adopted	The project will consist of two phases: a) an initial testing and evaluation phase on two AWS to test and evaluate the available hardware and software packages; and b) a second phase to roll-out the technology to the rest of the AWS. General Packet Radio Service (GPRS) modems will replace Global System for Mobile communication (GSM) modems to facilitate frequent weather data transfers between AWS and the receiving computer. The Loggernet software will be used to schedule data collection while the Real Time Monitor and Control (RTMC) Pro will be used to create and run graphical screens to display real time data on to a website.
Anticipated Outcomes	SASRI WeatherWeb displaying real-time weather data (temperature, relative humidity, rainfall, solar radiation, wind speed and direction) and derived indices of value to growers, including those associated with fire danger and thermal humidity (discomfort).
Technology and/or Knowledge Transfer Plan	The real-time meteorological service will be discussed with growers during field days will be advertised through articles in *The Link*.
Value to Industry	Direct benefits to growers will be in terms of monetary savings from improved efficiencies within their every-day agronomic management and planning strategies.

Outcomes from Completed Research Projects

Research projects		
Production sustainability		
Research area	**Outcomes**	**Value to Industry**
Energy use and carbon footprints	A tool has been created to enable calculation of on-farm direct energy use and associated greenhouse gas emissions. A Pump Evaluation Kit has been developed to enable assessment of the efficiency of electrical irrigation pumps.	The developed tools can be used in life cycle assessments and will enable growers to identify and evaluate opportunities for on-farm energy savings and estimate greenhouse gas emissions.
Water use		
Remote sensing	Yield predictions based on crop simulations are enhanced when the model is driven by remotely-sensed crop status information, as compared to simulations based on weather and soil water data alone.	Commercial application of the developed technology, which facilitates the incorporation of remote-sensing derived data into crop management models, is being pursued by industry stakeholders.
Technology development		
Minimising stool damage	Site visits conducted to the rainfed and irrigated northern regions of the industry gathered novel information on a variety of in-field traffic systems, farm implements and innovations used by growers to avoid stool damage.	Knowledge of grower innovations will be used to refine and enhance recommendations regarding specific practices and technologies that minimise stool damage wrought by in-field traffic.
Crop residue recovery for co-generation	The model under development has provided a preliminary breakdown of the costs associated with the activities and equipment required for different sugarcane crop residue recovery options.	Once finalised, the model will enable assessment of: a) the potential energy available from crop residues; and b) harvesting systems, energy and costs required for residue recovery and transport.

Selected Highlights: Current Research Projects

Water use

System dynamics modelling: A tool to unravel the drivers of technology adoption

Competition for water has increased the need for good water-resource management. End users (irrigators), however, have not all fully acknowledged the existence of an impending water crisis in SA. While it appears that the technology, knowledge and institutional arrangements to manage and utilise water efficiently are readily available, sub-optimal irrigation management practices still prevail on many farms.

The objective of this research is to apply system dynamics modelling[8] to understand the socio-technical factors that impact on the spread of innovations, in this case, irrigation Better Management Practices (BMPs). Specific objectives are to:

- explore the use of system dynamics modelling to understand the socio-technical factors that impact on the adoption of BMPs, in this case irrigation BMPs;
- better understand the complex operating environment, by identifying and mapping the strength of key factors and points of leverage which influence or drive decision-making processes and behavioural patterns of irrigators; and
- co-design and implement strategies and policies that will induce adoption and ultimately improve the management of irrigation water.

In South Africa, irrigation scheduling and hardware monitoring, maintenance and evaluation collectively make up the suite of irrigation BMPs. The guidelines, tools and approaches for implementing the BMPs appear to be readily available in varying degrees, so that they can be matched to different combinations of expertise, financial and time resources.

Both local and international literature, however, suggest that irrigation BMPs are not widely adopted. Various studies reported that adoption of scientific irrigation scheduling methods ranged from 18% in South Africa and Washington (USA), to 23% in Australia and 30% in large regions in Canada and Spain. A World Bank report states that 66% of the funds were allocated for premature rehabilitation of irrigation systems annually, largely as a result of lack of infrastructure maintenance.

From the literature, it is apparent that positive drivers of BMP adoption range from adequate support, ease of use and demonstrable benefits towards reducing costs and optimising crop yield or quality. Negative drivers include, amongst others, inappropriate practices which are not compatible with farm operations or goals, ineffective support systems, hardware constraints and uncertainty of benefits relating to risk. The conclusions and recommendations from the vast number of studies are, however, inconsistent and disparate, in that a multitude of factors influence and drive the system. Given this, there appears to be an opportunity, via system dynamics modelling, to untangle the web of relationships to identify and understand the core factors which are most influential and overriding in driving the adoption of irrigation BMPs.

Technology development

Sugarcane crop residue recovery for co-generation

The goals of this research are to: a) assess the potential energy available from sugarcane crop residues, taking into account the benefits of leaving a residue blanket comprised of cane tops in the field; and b) investigate harvesting systems, energy and costs required to recover residues and deliver them to a mill for the different production and harvesting systems used in South Africa, ranging from fully mechanised to manual harvesting systems.

Of particular interest during 2013 were meetings held with participants in two independent projects in the industry relating to the derivation of additional value from sugarcane crop residues. An initiative is under way to develop a torrefaction (trash pre-processing) plant that will be used to convert sugarcane residues into biochar. The biochar will be compressed into briquettes for sale. Ultimately, SASRI will have access to the feasibility study data that were collected in advance of the project, which are likely to provide additional insights to the current SASRI study. A grower who farms near Port Shepstone is investigating the potential of in-field dry leaf residue removal from standing sugarcane. The equipment under development is not economically viable at present, although, improvements are expected that will enhance the feasibility of the operation.

Profitability of sugarcane farming

The objective of this research is to document and implement an extension tool that can be used to identify the top growers for each homogeneous ward area and, through study group meetings, showcase the BMPs needed to ensure viable sugarcane production resulting in further adoption of such technologies by fellow growers.

The profitability of growers is determined by a number of economic factors, including the RV price, interest rates and the cost of essential inputs such as fertiliser, herbicides and labour. The proficiency of growers in managing these inputs and resources in achieving attainable yields is a major factor that influences the viability of sugarcane farming. When comparing growers' individual yields, cane quality and revenue on a homogeneous ward basis, it became apparent during 2013 that, within one ward, there are growers who continue to grow sugarcane at a loss and others at a profit. It has also been established that the growers who receive the highest returns within a specific ward tend to be those who adopt SASRI BMPs and have sound management policies in place, which includes good record keeping. On-farm discussion groups and the inclusion of economic considerations into the different management practices should assist in motivating and improving the adoption of certain technologies on the farm.

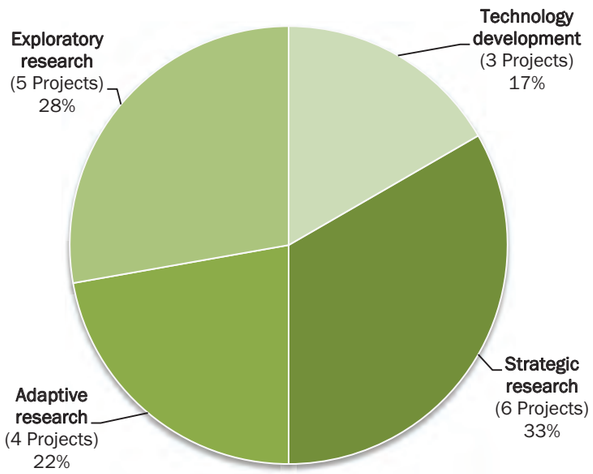
The general objective of the research is to collect both cane yield and quality data for each individual grower on an annual basis. Once these data are entered into a spreadsheet, they are then used to calculate grower revenue per hectare (gross) for the previous season. Once the homogenous eco-zones have been identified, the growers are grouped into their respective zones. Cane quality, yield and revenue trends can then be compared on a ward basis. Using this approach, differences in trends amongst wards can be detected e.g. cane yield in the Hibberdene North ward area is constantly increasing whereas other ward areas show distinct variations. One of the BMPs commonly implemented by all growers in the Hibberdene North area is green cane harvesting, which appears to be having a noticeable impact on cane yield.

8. System dynamics modelling is an approach to understanding the behaviour of complex systems over time. It deals with internal feedback loops and time delays that affect the behaviour of the entire system. What makes using system dynamics different from other approaches to studying complex systems is the use of feedback loops and stocks and flows. These elements help describe how even seemingly simple systems display baffling non-linearity

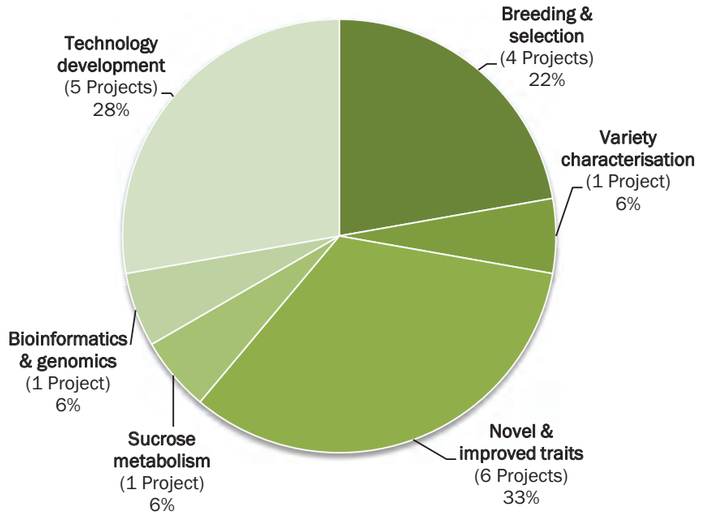
Variety Improvement Research

Strategic objectives

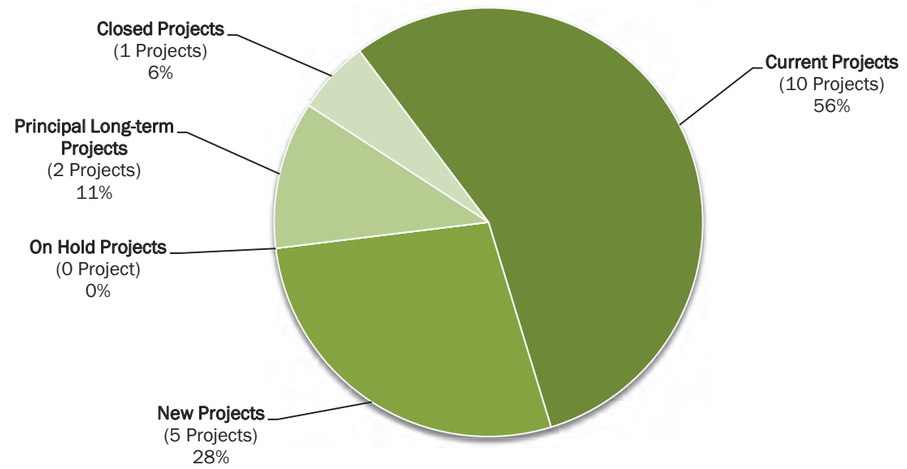
- To develop and release varieties with sucrose, yield, pest and disease resistance, agronomic and milling characteristics desirable to both millers and growers.
- To provide comprehensive variety information to assist the industry in making optimal variety choices.
- To diversify breeding strategies to exploit the full genetic potential of sugarcane.
- To implement molecular breeding and crop modelling strategies to improve variety delivery.
- To conduct basic research to develop new genetic resources for variety improvement through breeding and genetic engineering.



Dr Sandy Snyman



Project Disposition for 2013

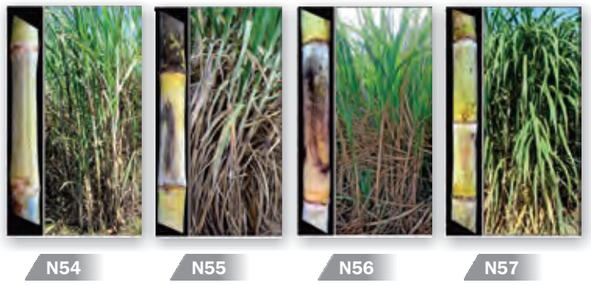


New Varieties

A significant accomplishment of the Variety Improvement Programme during 2013 was the release to the industry of four new sugarcane varieties: N54, N55, N56 and N57.

Varieties N55, N56 and N57 were released and gazetted for cultivation in the SA sugar industry.

- N54 produces high RV yields in the Midlands with higher percolation rates than N12, N16 and NCo376. It is also resistant to mosaic and rust.
- N55 has superior RV yields and yield stability under Hinterland and Coastal conditions, relative to varieties established in the region.
- N56 has good general disease resistance and consistently high cane and sugar yields on higher potential soils of the Hinterland.
- N57 has good general disease resistance and serves to complement N25 in the mid-season in the Northern Irrigated regions



New Projects

Synteny analysis and genome mapping in sugarcane	STRATEGIC RESEARCH
Need Statement:	SASRI has over the past several years co-funded a number of sugarcane genomics projects conducted under the auspices of the International Consortium for Sugarcane Biotechnology. Those projects have successfully delivered generic genomic resources with broad applicability to the variety improvement programmes of member countries, including: a) a genetic map of the reference R570 Réunion Island cultivar; b) fundamental guidelines for effective linkage disequilibrium genetic mapping: c) confirmation of the high level of genomic micro- and macro-synteny between sugarcane and sorghum; and d) deployment of a high throughput genomic technology (Diversity Array Technology [DArT]) to place a significant number of DNA markers onto the R570 reference sugarcane genetic map. To fully exploit these resources and opportunities, SASRI must now relate DNA markers on the SASRI genetic map, generated by linkage disequilibrium mapping, to markers on the R570 genetic map and then cross-reference to the fully sequenced sorghum genome. In this way, SASRI will be able to access the full DNA sequences of sorghum genes homologous to sugarcane genes responsible for important pest and disease resistance traits in SA breeding germplasm.
Project Objectives:	The objective of this project is to use the relationship between the SASRI population map and the genetic map of R570 to search for genes associated with specific traits (e.g. smut resistance) that have already been described from the fully-sequenced and annotated sorghum genome. If the specific gene affecting the desired phenotype is identified, new strategies to improve cultivars for the trait of interest may be devised.

Approach to be Adopted	▪ The trait or genome region to be targeted will depend on whether the DArT marker sequences are available for that trait. If they are available, reaction to sugarcane smut will be used as the model, as susceptibility to this disease remains a major bottle-neck in the SASRI breeding programme. If the DArT sequences are not available, the trait will be selected according to haplotypes common to the SASRI linkage disequilibrium map and the R570 genetic map. ▪ If the DArT sequences are available, a set of 20 haplotypes associated with smut resistance or susceptibility will be cross-referenced against the sorghum genome to find the corresponding chromosome position. If they are not available, another type of marker (e.g. simple sequence repeats [SSR]) on the R570 map that corresponds to linkage disequilibrium haplotypes of interest will be cross-referenced to the sorghum genome sequence to find the chromosomal position. ▪ Once putative causal genes and their positions have been established, further searches using bioinformatics tools will be conducted to assess if their function or mode of action has been described in maize, rice or barley. Should any promising candidates be found, a new project will be established to identify genetic markers or potential transgenes depicting the traits-of-interest.
Anticipated Outcomes	Identified genes from genetically well-characterised monocotyledonous crop plant species that are homologous to genes in SA sugarcane breeding germplasm delivering economically important traits, particularly with regard to pest and pathogen resistance. Such genes may ultimately serve as the basis for the development of DNA markers or as transgenes for genetic engineering.
Technology and/ or Knowledge Transfer Plan	The information generated by this research will be published in a science journal, with the detailed information being captured in the project close-out report. The genomics, bioinformatics and annotated DNA sequence data are to be curated on the SASRI bioinformatics server.
Value to Industry	This project represents the initial phase of a potentially longer-term project and will deliver information only. Genes identified in this project will be used to advance molecular breeding and/or transgenic approaches to variety improvement.

Genetic variation and phylogeny of *Saccharum spontaneum*	**STRATEGIC RESEARCH**
Need Statement	Modern sugarcane cultivars (*Saccharum* spp. hybrids) arose primarily from intentional hybridisations between *S. officinarum* and *S. spontaneum*, with the modern cultivar traits of high biomass yield, stress tolerance and pest and pathogen resistance being inherited primarily from the *S. spontaneum* germplasm. Very few ancestral genotypes of *S. spontaneum* occur in the pedigrees of SA commercial cultivars and consequently, the opportunity exists to exploit the genetic diversity within this *Saccharum* complex to develop new sugarcane cultivars adapted to marginal environments. The numerous wild eco-types of *S. spontaneum* are under threat of genetic erosion in their native environments in south-east Asia due to habitat disturbance and agricultural activity and, as the genetic variation within these *S. spontaneum* eco-types has not been systematically exploited or characterised, this is an issue requiring urgent attention.
Project Objectives	This project aims to conduct a detailed analysis of the phylogeny of *S. officinarum*,*S. spontaneum* along with related ancestral genera (*Erianthus* spp, *Miscanthus* spp) in order to characterise the genetic diversity available for exploitation in breeding novel sugarcane cultivars for the marginal growing conditions that prevail in the SA sugar belt.
Approach to be Adopted	Complete chloroplast genome of *S. spontaneum* accessions along with *S.officinarum*, *Erianthus* spp and *Miscanthus* spp are to be sequenced. The accessions selected for analysis will be representative of the entire wild and related ancestral collection available at SASRI. The sequence data are to be used to construct a detailed phylogeny describing the genetic diversity and evolutionary relationships between different species and their respective clones. The study will establish if gaps are present in existing germplasm collections and prioritise *S. spontaneum* along with related genera accessions for use in SASRI variety breeding. Based on the phylogeny and chronology, a detailed strategy will be drafted to systematically test and exploit the observed genetic diversity in collaboration with other sugarcane research institutes.
Anticipated Outcomes	Although the anticipated primary output of this research is a detailed phylogeny of *S. spontaneum* and related genera along with a documented strategy to exploit the genetic diversity, the longer-term objective is the creation of novel sugarcane cultivars. The germplasm of wild and related ancestral eco-types is likely to contain a wealth of untapped genes for adaptation to cold and drought stress and these are to be systematically exploited to develop new varieties suited to marginal environments. It is anticipated that these varieties will contribute significantly to the small-scale agricultural sector and provide new opportunities for income and job creation in rural communities. Subsequent analysis of generated data will also help to assign unknown clones to the species of origin.
Technology and/ or Knowledge Transfer Plan	The research outcomes are to be: a) published in science journals; b) documented within the SASRI Plant Breeding Manual; and c) catalogued in the SASRI breeding germplasm collection, should additional *S. spontaneum* accessions be sourced during the course of the study.
Value to Industry	The significance and value of the research to the SA sugar industry resides in the: ▪ prioritisation of *S. spontaneum* and wild ancestral accessions for breeding novel SA cultivars with higher biomass potential, increased abiotic stress tolerance and improved resistance to pests and pathogens; and ▪ enhanced collaboration between SASRI and key international collaborating research partners involved in *Saccharum* germplasm management (e.g. USDA-ARS National Clonal Germplasm Repository at Miami which maintains the ISSCT World Collection of Sugarcane and Related Grasses).

Non-radioactive detection methods for nucleic acid analysis	**TECHNOLOGY DEVELOPMENT**
Need Statement	Many technologies deployed at SASRI for the genetic analysis of sugarcane, pathogens and pests currently use biochemicals labelled with radioactive isotopes of phosphorus (e.g. ^{32}P and ^{33}P). Given the highly hazardous nature of these radio-isotopes, there is an increasing need to explore the potential for using more benign reagents. The increasing cost and scarcity of these radioactive biochemicals have provided further impetus to the need for change to current laboratory practice.
Project Objectives	To identify a sensitive, efficient and cost-effective method for genetic analysis that does not rely on the use of biochemicals labelled with radioactive isotopes of phosphorus.
Approach to be Adopted	The study will compare the sensitivity, efficiency and cost-effectiveness of two commercially available, non-radioactive systems for genetic analysis to each other and to the current SASRI methodology that deploys radioactive isotopes of phosphorus
Anticipated Outcomes	A safe, sensitive, efficient and cost-effective method for the genetic analysis of sugarcane, pathogens and pests.
Technology and/ or Knowledge Transfer Plan	The revised and optimised methodology for genetic analysis is to be included in the Biotechnology Methods Manual of the SASRI Crop Biology Resource Centre.
Value to Industry	The value to the industry derived from the genetic analysis of sugarcane, pathogens and pests will be ongoing, while the increased safety and potentially enhanced efficiencies wrought by the new technology will be of considerable value to molecular biology laboratory operations within the SASRI Crop Biology Resource Centre.

Field analysis and maintenance of transgenic sugarcane lines with altered sucrose content and biopolymer composition	**STRATEGIC PRINCIPAL PROJECT**
Need Statement	SASRI has a long-standing research agreement with the Institute for Plant Biotechnology (IPB) at Stellenbosch University. The IPB has been commissioned by the SA sugar industry to effect the genetic manipulation of sugarcane towards: a) increasing sugarcane sucrose content; b) modifying cell wall composition for potential bio-energy applications; and c) the production of high-value biopolymers. The IPB has also been tasked to undertake preliminary phenotypic assessment of these genetically-modified lines under contained glasshouse and poly-tunnel conditions. Transgenic sugarcane lines that show promise under those conditions are subsequently transferred to the SASRI Mount Edgecombe site for: a) field assessment of agronomic performance and sucrose yield, which are phenotypes with immediate commercial value (sucrose enhancement); and b) *in vitro* germplasm storage of lines displaying phenotypes with no immediate commercial value but for which a path-to-market is likely to emerge in the future (e.g. modified cell wall composition, biopolymer production). Effective and ongoing communication and co-ordination of activities between the IPB and SASRI in this regard are critical to the success of the research partnership.

Project Objectives	The objective of this principal, long-term research project is to formalise an ongoing and sustainable system for the transfer of transgenic line germplasm and information between the IPB at Stellenbosch University and the SASRI campus at Mount Edgecombe.
Approach to be Adopted	The project will formalise protocols for the transfer, testing and maintenance of transgenic sugarcane germplasm between the two research centres. Emphasis is also to be placed on the development and scheduling of processes for the communication of information and data required for field trial permit applications, progress tracking and publishing.
Anticipated Outcomes	Formalised and documented protocols for the transfer of materials, information and resources (transgenic sugarcane germplasm) between the Institute of Plant Biotechnology and SASRI. A further outcome will be explicit processes for progress tracking.
Technology and/ or Knowledge Transfer Plan	SASA/SASRI stakeholders are to be informed of the inception of this principal long-term project to mitigate any potential risks associated with the loss of information or materials developed under the terms of the SASA/SASRI research agreement with IPB at Stellenbosch University.
Value to Industry	This long-term principal project will serve to mitigate any potential risks associated with the loss of information or materials developed under the terms of the SASA/SASRI research agreement with IPB at Stellenbosch University.

NovaCane® bulking of new varieties for release	ADAPTIVE PRINCIPAL PROJECT
Need Statement	Two years prior to the release of new varieties, limited volumes of seedcane (approximately 15 to 25 tons) of promising genotypes are available for conventional vegetative propagation (bulking) on the relevant SASRI Research Stations. Thereafter, distribution of the seedcane to approved control areas takes place through Local Pest, Disease and Variety Control structures for further bulking. Given this, bulking is a slow process, often resulting in insufficient availability of seedcane of new varieties to meet grower demand. In addition, the logistical complexities involved in the planting of several bulking plots of pre-release genotypes increases the risk of mislabeling, while the extended period required for bulking also increases the risk of seedcane infection by pathogens.
Project Objectives	The objective of this long-term principal project is to establish an operational procedure for the deployment of the SASRI NovaCane® technology in providing plantlets of new genotypes at the point at which SASRI Research Stations receive material for bulking. The process to be implemented will increase the availability of seedcane of new varieties to growers thereby enhancing adoption. Production of the NovaCane® plantlets will be conducted under contract by DubeTradeport AgriLab until such time that a tissue culture facility is constructed on the SASRI Mount Edgecombe site.
Approach to be Adopted	In January of each year, field material of pre-release genotypes selected by the SASRI Variety Selection and Release Committee for bulking is to be sourced from SASRI Research Stations, disease indexed and DNA fingerprinted to ensure the phytosanitary status and identity of the material, respectively. Until such time that a tissue culture facility is constructed on the SASRI Mount Edgecombe site, the initiated material will be provided to DubeTradeport AgriLab for implementation of the NovaCane® technology. AgriLab will then undertake to provide SASRI with material of the genotypes in September each year for subsequent plantlet distribution to approved control areas through Local Pest, Disease and Variety Control structures. During plantlet production, SASRI will provide DNA fingerprinting services to AgriLab for quality control purposes.
Anticipated Outcomes	Provision of sufficient true-to-type, disease-free NovaCane® plantlets to Local Pest and Disease and Variety Control structures to improve grower access to new varieties.
Technology and/ or Knowledge Transfer Plan	Supply of new varieties as NovaCane® plantlets will be communicated as appropriate to Local Pest and Disease and Variety Control Committees. General announcement of the improved procedures for accessing new varieties will be communicated to all industry stakeholders through relevant articles in *The Link*.
Value to Industry	Supply of sufficient certified, true-to-type seedcane of new, superior varieties will enhance the adoption rate of new varieties by growers, leading to yield improvements.

Outcomes from Completed Research Projects

Research projects		
Research area	**Outcomes**	**Value to Industry**
Variety characterisation		
Drought tolerance	A statistical-modelling method was developed for characterising variety drought-stress tolerance.	The method developed will permit broad characterisation of the drought-stress response potential of varieties at or soon after release.

Selected Highlights: Current Research Projects

Breeding and selection

Synteny analysis and genome mapping

During 2013, considerable attention was devoted to ensuring the effective functioning of the SASRI bioinformatics server (CLC Bio Genome Station). Proxies were reset and a new software tool was designed to allow services such as CVS (a software repository tool used by the public domain) to work with the SASA firewall. Due to the outdated nature of the software on the server, standard system and programming tools (Perl, C/C++/Fortran, MySQL, Apache, mod_perl) had to be re-installed, primarily through compiling from source. Over 300 pieces of software were installed on the machine. The underlying architecture of the server was also altered to allow communication in and out of the server. In addition, the entire EnsEMBL[9] genome platform (the plant-specific version) was brought in-house.

Currently, the server software is being upgraded to the latest version in an attempt to solve incompatibility issues. In the meantime, automated software has been developed to bring all the grass and plant genomes of interest in-house whenever there is a new public domain release of the software. Once the data have been downloaded and then loaded into local databases, the software automatically extracts the genome sequence (whole genomes or supercontigs, depending on the completeness of assembly) and creates databases suitable to run BLAST[10] analyses. The advantage of using EnsEMBL and Gramene genomes is that they have associated annotation and gene calls. With the *Sorghum propinquum* genome now available at SASRI, SASRI scientists now have a unique opportunity to compare with *Sorghum bicolor* and to produce an assembled and annotated genome based on synteny, using *Setaria italica* (foxtail millet) as a related out-group. This way, SASRI will have two, rather than a single comparator for sugarcane.

Mapping all the current sugarcane markers to the two sorghum genomes will also allow a model sugarcane genome to be constructed based on breaking-up the sorghum genome and re-assembling it into the sugarcane configuration. This will yield a scaffold for potential mapping of sugarcane sequences and marks a completely novel approach. The sugarcane markers can also now be mapped to a range of grass and model genomes. Because SASRI now has EnsEMBL, all the genes on matching regions can be easily extracted and compared. When the plant and species pathway data are brought in-house, SASRI will have the capacity to also map those genomic regions onto pathways.

Variety characterisation

Midlands

During 2013, comprehensive variety post-release analyses were conducted under a wide range of conditions in the Midlands, which confirmed the superiority of newer varieties: a) N36, N41 and N48 outperform N16, N21 and N48 in frost pockets; and b) RV yields of N48 and N50 superior to that of N12 and N31 in the Midlands. Such confirmation of the superior performance and characteristics of new varieties, relative to established varieties under a wide range of conditions, serves to promote adoption by growers.

Hinterland

A variety trial at upper Tongaat during 2013 confirmed that variety N45 has the potential to outperform some of the more popular commercial varieties. N45 was released for coastal production in 2006 and has generally not performed as expected in coastal trials and under commercial conditions. However, 2013 trial results showed that when this variety is grown under hinterland conditions (lower temperatures, longer cutting cycle), it performs better than other varieties currently recommended for these conditions.

Novel and improved traits

Overcoming gene silencing in GM sugarcane

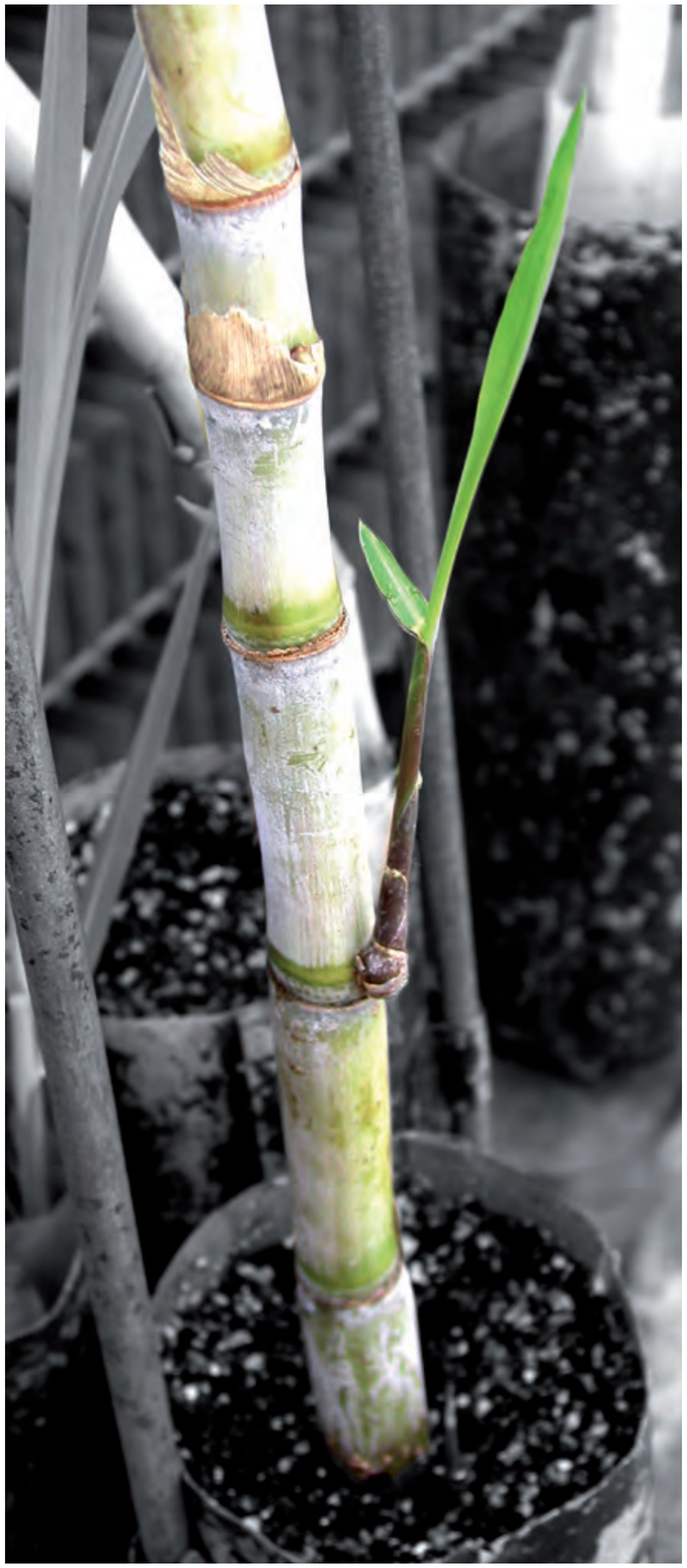
Growing evidence suggests that epigenetic modifications[11] are an important part of the regulation of gene expression in many plant and animals systems. One of the likeliest reasons for transgene silencing in sugarcane is (hyper) methylation[12] of the promoter region of the newly inserted gene.

9. EnsEMBL is a joint scientific project between the European Bioinformatics Institute and the Wellcome Trust Sanger Institute. It provides a centralised resource for geneticists, molecular biologists and other researchers studying the genomes of a multitude of organisms and is one of several well-known genome browsers for the retrieval of genomic information.
10. In bioinformatics, the Basic Local Alignment Search Tool, or BLAST, is an algorithm for comparing primary biological sequence information, such as the amino-acid sequences of different proteins or the nucleotides of DNA sequences. A BLAST search enables a researcher to compare a query sequence with a library or database of sequences (e.g. EnsEMBL), and identify library sequences that resemble the query sequence above a certain threshold.

Therefore, SASRI scientists are investigating the methylation status of a tissue-specific promoter in both its functional environment (sorghum) and its silenced environment (sugarcane). Once mapped, the cytosine residues (where methylation occurs) that appear to have an essential role in the silencing mechanisms will be mapped and mutated. The mutated promoter will then be re-rested for functionality in transgenic sugarcane plants.

The promoter that is being investigated at SASRI is root-specific and is present in multiple copies in the sorghum genome. Three alleles (possibly four) have been identified that are mostly expressed in the roots but not in the leaves. The DNA from root tissues (where the promoter is active) and the DNA from leaf tissues (where the promoter is inactive) were extracted and subjected to a bisulfite treatment[13]. This treatment changes the un-methylated cytosine residues into a thymine residue. The methylated cytosines remain unchanged. Specific portions of the targeted promoter are then PCR-amplified, cloned and sequenced to identify which cytosines were methylated (by comparison to the initial sequence). Using this approach, 263 sequences from sorghum have been identified.

SASRI scientists are currently investigating different software that will help to visualize the data and identify regions



11. Epigenetic modifications are heritable changes in gene expression or cellular phenotype, caused by mechanisms other than changes in the underlying DNA sequence.
12. DNA methylation is the modification of a strand of DNA after it is replicated, in which a methyl (CH3) group is added to any cytosine molecule that stands directly before a guanine molecule in the same chain. Since methylation of cytosines in particular regions of a gene can cause suppression, DNA methylation is one of the methods by which gene expression is regulated in organisms.
13. Treatment of DNA with bisulfite converts cytosine residues to uracil, but leaves 5-methylcytosine residues unaffected. Thus, bisulfite treatment introduces specific changes in the DNA sequence that depend on the methylation status of individual cytosine residues, yielding single- nucleotide resolution information about the methylation status of a segment of DNA.

of hyper or hypo-methylation. In this way, it has been observed that some regions of the promoter in leaf DNA (inactive promoter) are more methylated that in the root DNA (active promoter).

Currently under investigation is the methylation status of a root-specific promoter that had been previously transferred (in a separate, completed project) into sugarcane as a promoter-GUS reporter gene construct. This promoter is silenced in transgenic sugarcane. Three plants that carry a single copy of the transgene have been identified, but focus is being placed on determining the methylation status of the introduced promoter in only two of the plants. The same methodology is used, *viz*. bisulfite treatment of the DNA, PCR amplification of portions of the promoter, cloning and sequencing, followed by comparison with the original sequence. So far, 34 sequences have been obtained for two of the plants. SASRI scientists are continuing to generate more sequences to acquire a reasonable coverage of the silenced promoter and a small portion of the GUS coding region.

Testing of GM sugarcane lines with modified cell wall metabolism

A replicated field trial, planted in a randomised block design, with four lines genetically modified by down-regulating an enzyme, UDP-glucose dehydrogenase. This modification, according to preliminary analysis at the Institute of Plant Biotechnology (IPB), results in higher sucrose content and changes in cell wall composition - the latter may have a future application for ethanol production. The trial was harvested and samples were sent to: a) IPB for metabolite analysis; and b) Department of Process Engineering at Stellenbosch University for fibre digestibility for ethanol production.

Agronomic measurements (stalk height, mid-stalk diameter and population count) were taken when the cane was nine months old. All four transgenic lines had increased heights (significant – ANOVA) and smaller diameters than the control line (untransformed, wild type line). Three of the transgenic lines (05TG008, 05TG010 and 05TG018) had higher stalk population counts per hectare than the control line, with only 05TG007, showing a reduced population count (significant – ANOVA). Frequently with *in vitro* generated material, these differences in stalk characteristics are common, often not persisting in the ratoon crop.

Yield measurements were taken at harvest (13 months old). All transgenic lines had a lower cane and sucrose tonnage per hectare when compared with the control, but none of the differences were significant (ANOVA). Sugar content data obtained by means of high performance liquid chromatography (HPLC) on pressed juice (Java roller) showed significant differences between line 05TG008 and the control, where the transgenic line had significantly higher glucose and fructose contents. HPLC data to analyse sugar content from internodes of different maturity (immature – internodes 4/5 and 9/10; mature – internode 22) showed no significant differences when sucrose, glucose and fructose concentrations were compared for the transgenic lines against the control line. Based on these results, the trial will not be continued to the ratoon crop in 2014. However, the lines will be preserved *in vitro* using the minimal growth technology developed at SASRI.

Producing herbicide-tolerant sugarcane by non-GM approaches

Seven somaclonal variant[14] sugarcane lines tolerant to the herbicide imazapyr (active ingredient [a.i.] of Arsenal® [BASF]) were identified previously at SASRI. Line isolation involved the *in vitro* use of a chemical mutagen ethylmethane sulfonate (32 mM EMS) and an imazapyr selection procedure. Those lines showed increased tolerance to imazapyr compared with the N12 control. The aim of research conducted in 2013 was to characterise and isolate the tolerant acetohydroxyacid synthase (AHAS) gene from these lines, to test the level of tolerance to the herbicide and assess agronomic attributes in-field.

14. Somaclonal variation is the variation seen in plants that have been produced by plant tissue culture and which can be increased through exposure of cells to chemical and physical mutagens. Chromosomal rearrangements are an important source of this variation.

Enzyme assays of AHAS activity have been conducted on field material. Optimisation of the assay was necessary to determine the mass and protein concentration of each mutant plant and N12 control resulting in an absorbance of 1.5 at a wavelength of 530 and 595 nm respectively. Two mutant lines, Mut 6 and Mut 7, showed the highest AHAS enzyme activity per µg protein.

The second objective of the research was to assess the tolerance of these seven lines to imazapyr under in-field herbicide applications. Imazapyr was applied at two different rates (312 and 625 g a.i. ha^{-1}) to plants in the field. SPAD[15] chlorophyll readings were taken both before and after spraying to assess the chlorophyll content of the leaves. The SPAD instrument is able to detect subtle changes in chlorophyll long before they become visible to the human eye. In addition to SPAD measurements, leaf samples were taken to measure activity of the AHAS enzyme. Three lines are being further characterised in field trials and by sequencing of the AHAS gene to identify the specific mutation.

Genomics and bioinformatics

The Sugarcane Genome Sequencing Initiative (SUGESI) aims to provide a partial sugarcane genome sequence template. The initial effort is focused on sequencing gene-rich regions of the genome of the Réunion Island variety, R570, for which a genetic map and Bacterial Artificial Chromosome (BAC) library exist. These essential R570 resources, which are required for genome sequencing and subsequent application of the sequence data, have been developed steadily over the years though International Consortium for Sugarcane Biotechnology (ICSB) projects that the South African sugar industry has co-funded through SASRI. SASRI is contributing to the collaborative effort by sequencing and annotating specific BACs containing genes of interest and potential value to the South African sugar industry. The first batch of sequencing data was received in February 2013 from Inqaba Biotec in Pretoria (the 454 sequencing service provider). The assembly of the small sequencing fragments into a single sequence is being conducted on the SASRI CLC Genomics Workbench. Currently, the BAC sequences have been assembled into ten larger fragments. Once the unified sequence has been prepared, it will be submitted for annotation to the automated pipeline located at CIRAD in Montpellier, France.

A second selection of BACs is currently being sequenced by Inqaba Biotec and the selection of BACs for the third round of sequencing is almost complete. The results of a recent ICSB project conducted in the University of Georgia laboratory of Professor Andrew Paterson (ICSB Project #24: *Physical mapping of the gene-rich euchromatin of sugarcane*) were used to select sugarcane BACs that have been end-sequenced and whose end-sequences match the sorghum genome in one or two locations. Based on the high level of colinearity between sugarcane and sorghum, it is expected that the R570 BACs will contain most of the genes described in the sorghum sequence. Some of the BACs overlap and span a contiguous region, which will provide a longer sequence when fully assembled. Currently, the possibility of using another service provider to sequence a larger batch of BACs (>500) at a much reduced cost is being investigated.

15. The readings taken by the SPAD meter indicate chlorophyll content of a leaf and give an indirect measure of crop health, once suitably calibrated.

Contract Research

Area-Wide Integrated Pest Management of Sugarcane Borers

External Research Service Provider:
Dr Pia Addison and Professor John Terblanche, Department of Conservation Ecology and Entomology, Stellenbosch University.

Duration of Research Agreement:
2013 - 2016

Stalk borer temperature responses: Predicting spread and optimising laboratory rearing conditions

The temperature biology of the sugarcane stalk borers eldana and *Chilo sacchariphagus* in the wild is not fully understood although it is clear that this abiotic factor significantly influences behaviour, energetics, reproductive performance and survival. The overall goal of this study is to provide an empirical framework for predicting temperature-dependent population dynamics of eldana and *C. sacchariphagus* at short and intermediate time-scales. These results will have direct relevance to understanding seasonal phenology and abundance of this pest in response to environmental temperature variation. Furthermore, these results will provide information of direct relevance to aspects of moth performance, culture and storage in sterile insect release programmes and also to cold sterilisation protocols.

The objectives of this aspect of the collaborative research project are to determine:

- the temperature tolerance of eldana and *Chilo sacchariphagus* life stages under ecologically-relevant conditions;
- if eldana and *C. sacchariphagus* can cold- or heat-harden to obtain enhanced thermal protection at daily time-scales; and
- if thermal history (season or rearing temperature) influences temperature limits and inducible thermal tolerance in eldana and *C. sacchariphagus*.

The lower chill coma temperature (CT_{min}) is defined as the point where reduced motor function (i.e. spastic muscle movements) is displayed and moths are unable to cling to a paintbrush. Results showed that the Stellenbosch population (semi-wild) did not differ significantly from the established laboratory reared colony. The mean CT_{mins} for the warm, coastal population (Umfolozi) and the northern irrigated population (Malelane) were in the region of 7°C in comparison to 2.8°C for the colder, inland population (Midlands South).

The results ontained during 2013 appear to indicate that eldana has genetically adapted, or is currently adapting, to the colder temperatures experienced at altitude. Given the nature of the Midlands crop (24 months harvest) this is an extremely important finding that suggests eldana will continue to spread and increase in the Midlands and will require aggressive interventions to limit its impact and slow its spread.

Sterile insect technology: Performance of sterilised eldana males in field trials

For over 50 years, the sterile insect technique (SIT) has been employed as a strategy for pest eradication and, more recently, for suppression, containment and prevention of unwanted insect pest populations. The use of sterile insects in area-wide integrated pest management (AW-IPM) programmes continues to expand as increasing constraints are placed on the use of chemical pesticides in relation to the public's growing demand for a cleaner environment and residue-free food. However, before SIT can be adopted, the amenability of the target species to this approach must be determined.

The objectives of this aspect of the collaborative research project are to:

- conduct behavioural studies to compare lek[1] and mating behaviour of irradiated versus normal eldana male moths in laboratory bench-top trials;
- determine the mating competitiveness of irradiated males compared to wild males;
- investigate the thermal physiology of lab reared irradiated and un-irradiated moths with wild moths; and
- conduct pilot release trials on the feasibility of SIT as an AW-IPM strategy in shade house and field trials, and to test transport logistics of sterilised moths should *Chilo sacchariphagus* incursions be recorded in South Africa.

Results obtained during 2013 have demonstrated the efficacy of partially sterilised and released adult male moths in reducing crop damage and lowering the number of fertile progeny from F1 to succeeding generations in an eldana population under controlled cage-house conditions. Effects of inherited sterility were demonstrated using a treated to untreated adult over-flooding ratio of 10:1. At selected field sites, pilot releases are being planned, although such releases will only be conducted after extensive consultation with all relevant stakeholders.

UNIVERSITY OF KWAZULU-NATAL

Profiling, Issue Identification and Comparing Different Sugar Milling Areas in South Africa

External Research Service Provider:
Professor Carel Bezuidenhout, School of Engineering, University of KwaZulu-Natal

Duration of Research Agreement:
2013 - 2015

During the first year (2013) of the project, five post-graduate students were recruited and the following milestones accomplished: a) review of the international literature on stochastic seasonal rainfall generators, sugarcane deterioration under different conditions and sugar quality; and b) participation of six South African mills was secured. The study will ultimately deliver mill-specific models that will facilitate stakeholders decision-making regarding system efficiency improvements.

International Consortium for Sugarcane Biotechnology (ICSB)

Testing new generation sequencing-based methods for high throughput genotyping in sugarcane

External Research Service Provider:
Dr Angélique D'Hont, CIRAD, Montpellier

Duration of Research Agreement:
April 2012 - April 2013

The restriction-site reduced complexity (RAD) approach to Genotyping-by-Sequencing (GBS) under investigation facilitated the detection of 9 906 single-dose single nucleotide polymorphisms (SNPs), 6 292 of which permitted the identification of the parent-of-origin of the mapping population studied (R570 x MQ). The research has clearly demonstrated that GBS is a viable approach to enhance marker-trait discovery for sugarcane breeding in South Africa.

Pilot project on whole-genome profiling to generate a core physical map of sugarcane

External Research Service Provider:
Dr Angélique D'Hont, CIRAD, Montpellier

Duration of Research Agreement:
April 2013 - April 2014

The state-of-the-art Whole Genome Profiling (WGP) technology under investigation generated 455 656 unique tags (37 tags per BAC) of which 20% (90 953 tags) corresponded to unique sugarcane Bacterial Artificial Chromosomes (BACs) that aligned once to the sorghum genome sequence. The application of the technology indicates that 5 029 sugarcane BACs need to be sequenced to develop a minimum tiling path (MTP) spread across the ten chromosomes of the sugarcane monoploid genome. The South African sugar industry, through SASRI, is participating in an international collaborative effort to sequence these BACs.

Genetic Engineering of Sugarcane to Enhance Sucrose Accumulation and to Improve Fermentability of Remaining Biomass

External Research Service Provider:
Professor Jens Kossmann, Institute for Plant Biotechnology, Department of Genetics, Stellenbosch University

Duration of Research Agreement:
2013 - 2015

Several transgenic sugarcane lines were produced at the Institute for Plant Biotechnology to: (1) enhance sucrose concentration (separate over-expression of glucoronokinase, uracil monophosphate synthase and adenylate kinase); and (2) modify cell wall composition (separate over-expression of ferulic acid esterase; down-regulation of cell wall peroxidase, 4-coumarate CoA ligase and laccase). Preliminary proof-of-concept demonstration has been obtained of the potential of GM technologies to increase sugarcane sucrose content (sugar yield) and modify cell wall composition to improve amenability of sugarcane biomass as a feed-stock for second-generation bio-ethanol production.

1. A lek is a gathering of males, of certain animal species, for the purposes of competitive mating display.

Research Events

International Consortium for Sugarcane Biotechnology

The Annual Business Meeting of the International Consortium for Sugarcane Biotechnology (ICSB) took place in San Diego on 11 January 2013. At the meeting, progress reports were received and discussed on the SASRI co-funded projects: a) '*Identification of domestication genes for sugarcane*' by Professor Ray Ming (University of Illinois) (ICSB Project No. 29); and b) '*Testing New Generation Sequencing (NGS) based methods for high throughput genotyping in sugarcane (genotyping-by-sequencing)*' being conducted by Dr Angélique D'Hont (CIRAD) in conjunction with the J. Craig Venter Institute in Rockville, Maryland (ICSB Project No. 30). A final report was tabled for ICSB Project No. 28, '*Extent of hom(oe)ologous sequence variation in sugarcane*' (Dr Angelique D'Hont). All three projects have achieved the stated research objectives and milestones.

Two new research proposals were presented for consideration by the ICSB membership: a) '*Whole genome profiling to generate a core physical map of sugarcane*' (Dr Angélique D'Hont); and b) '*Beyond the sequence: new resources and strategies for accelerated forward and association genetics of sugarcane*' (Professor Andrew Paterson, University of Georgia). Interest was expressed in both proposals, although only Dr D'Hont's received sufficient financial pledges for project implementation. SASRI, according to the mandate received from the industry, supported Dr D'Hont's proposal for an amount corresponding to the expected contribution, based on the production figures of the SA industry relative to those of the ICSB member countries supporting the project.

SASRI has been requested by the ICSB Corresponding Secretary, Dr Paul Moore of Hawaii Agricultural Research Centre (HARC), to conduct an analysis of how the outcomes of ICSB projects that the SA industry has co-funded have impacted on SASRI research and development and delivery of value to the industry. A small team of SASRI breeding and biotechnology specialists is currently busy with the analysis, with completion set for early 2014.

Sugarcane Genome Sequencing Initiative

A meeting of representatives of the countries participating in the Sugarcane Genome Sequencing Initiative (SUGESI) (Australia, Brazil, France, South Africa and United States of America) took place in San Diego on 13 January 2013. Presentations by delegates indicated that a few members were pursuing sugarcane genome sequencing objectives beyond the scope of the original SUGESI informal agreement. Of interest was participation by Monsanto; the company has embarked on the sequencing of the genomes of two ancestral species of modern sugarcane hybrids, *Saccharum officinarum* (LA Purple) and *S. spontaneum* (Coimbatore). This research is focused on marker discovery for breeding purposes. In a subsequent follow-on meeting, delegates representing Australia (CSIRO, BSES Ltd and SRDC), Colombia (Cenicaña), France (CIRAD) and South Africa (SASRI) renewed their commitment to pursuing the original SUGESI objective of sequencing gene-rich genomic regions of the variety R570. This decision has restored the impetus of SUGESI, albeit with a reduced number of participants. The smaller group should not result in delays and increased costs, as there have been several recent developments in sequencing technologies that have increased efficiencies.

External Expert Review of the Crop Protection Programme

As part of an ongoing commitment to excellence in science and service to the industry, SASRI each year subjects one of the four research programmes to external expert review. A panel of three external scientists, each recognised as experts in relevant disciplines, are tasked with scrutinising the programme in terms of quality, relevance, delivery, governance and stewardship of research projects managed within the programme.

Dr Max Suckling (Principal Scientist: Biosecurity, The New Zealand Institute for Plant and Food Research Ltd, Lincoln, New Zealand), Dr Jack Comstock (Research Pathologist, Sugarcane Production Research, USDA-ARS Sugarcane Field Station, Canal Point, Florida) and Matthew Addison (Deciduous Fruit Growers' Trust and Department of Conservation Ecology and Entomology, Stellenbosch University) generously agreed to review the Crop Protection Programme (CPP) between 9 and 13 September 2013. The Reviewers possessed strongly complementary expertise that was highly suited to reviewing the progress and strategic intent of the CPP.

The review commenced with a gathering of the Reviewers, the SASRI senior management team and members of the SASRI Committee Working Group to discuss: (a) the review Terms of Reference; (b) the industry and the review context; (c) the research, knowledge management, extension continuum; and (d) the specific industry context within which CPP operates. The two subsequent days were devoted to providing the Review Panel with an overview of the research conducted within the programme.

At the end of the second day, the Reviewers met with members of the SASRI Committee Working Group to provide a preliminary overview of their opinion of the CPP.

During the final two days of the review, reviewers viewed pest and disease screening trials and agrochemical efficacy trials at the SASRI Pongola Research Station, as well as the new sugarcane rust and the emerging grasshopper problem in the Empangeni area. During these visits, the reviewers had an opportunity to interact with SASRI selection, farm management and extension staff.

The final recommendations received from the Review Panel, together with responses from SASRI management, were tabled for noting by the SASRI Committee on 22 October 2013. The report provides: (a) a summary provided by the Review Panel of their findings; (b) specific strengths noted by the review panel; (c) concluding comments from the review panel; and (d) a SASRI analysis of points of learning, including specific responses to recommendations made by the review panel.

The review is to be followed by a discussion session during the November Staff Colloquium and a planning workshop at the end of January 2014.

Achievements and Awards

Achievements

Dr Sandy Snyman, Biotechnologist and manager of the Variety Improvement Programme, has been awarded Incentive Funding for Rated Researchers (IFRR) by the National Research Foundation (NRF). The IFRR programme aims to incentivise excellent research, while collateral objectives include encouraging researchers to maintain their ratings and attain ever higher ratings. Dr Snyman's recent grant brings the number of SASRI recipients of NRF IFRR awards to six.

Dr Sandy Snyman

Dr Marvellous Zhou, Plant Breeder, was appointed Affiliated Associate Professor in Plant Breeding by the Executive Council of the University of the Free State (UFS). This is a significant accolade for Dr Zhou, given the level of the appointment and that UFS maintains one of the most reputable plant breeding academic programmes in South Africa. The appointment is advantageous for SASRI, as Dr Zhou will now be able to fulfil the role of primary academic supervisor of UFS-registered post-graduate students conducting sugarcane breeding research at SASRI.

Dr Marvellous Zhou

Dr Neil Miles, Senior Soil Scientist, won the Fertiliser Society of South Africa Gold Medal award for 2013, which is the highest honour, for "his exceptional contributions to Agriculture, and more specific, his major influence on the judicious application of fertiliser in KwaZulu-Natal over the past 34 years". He was acknowledged for his significant publication record, the respect he has earned from his peers as well as the significant contribution he has made towards promoting the use of fertiliser and lime by growers.

Dr Neil Miles

Dr Miles was also awarded Agriculturalist of the Year in KwaZulu-Natal by Agricultural Writers SA in recognition of his outstanding achievements and significant scientific contributions to the agricultural sector.

William Gillespie won the silver medal award in the Training and/or Mentor Award in Small-Scale Farming category at the Fertiliser Society of South Africa. He was acknowledged for his outstanding contribution to working with small-scale farming and the demonstration plot approach, including his close relationship with his growers, commitment to improving their lives and sustained energy and enthusiasm for his work.

William Gillespie

Conference Awards

The paper presented by Dr Abraham Singels, Principal Agronomist, at the XXVIII ISSCT Congress in São Paulo was awarded the prize of Best Paper in the Agronomy Section. Dr Singels' paper was entitled "*Predicting climate change impacts on sugarcane production at sites in Australia, Brazil and South Africa using the Canegro® model*" and was co-authored by Matthew Jones (SASRI) and Drs Fábio Marin (EMBRAPA, Brazil), Alex Ruane (NASA Goddard Institute for Space Studies, USA) and Peter Thorburn (CSIRO, Australia).

Prabashnie Ramouthar, Nematologist, won the South African Sugar Technologists Association (SASTA) award at the 86th SASTA conference for her paper "Intercropping in sugarcane: A practice worth pursuing?", co-authored by R Rhodes, T Wettergreen, U Pillay, MR Jones, R van Antwerpen and SD Berry.

Dr Sanesh Ramburan, Senior Agronomist, won the South African Sugar Technologists Association (SASTA) Kynoch prize for his paper "Review and analysis of variety distribution trends in the South African sugar industry: A 2013 perspective"

Bongi Bhengu, Extension Technology Resource Specialist, won the award for best Agricultural poster at the South African Sugar Technologists Association (SASTA) Conference. Her poster was titled "Effective technology transfer for small-scale sugarcane growers through radio broadcasting" and co-authored by T Masondo, S Hlela, V Dlamini and S Mngomezulu.

Bongi Bhengu was also awarded best paper at the South African Society for Agricultural Extension (SASAE) for her publication titled "Structured service delivery: A review of small-scale grower extension partnerships within the sugar industry", co-authored by J Neen, W Gillespie and K Moodley.

Dr Abraham Singels

Prabashnie Ramouthar

Dr Sanesh Ramburan

Bongi Bhengu

Extension

SASRI's Extension team comprises a group of conversant Specialists who play a significant role in agricultural technology transfer within the sugar industry. Their main objective is to mediate the communication of comprehensive agronomic advice to growers, as well as provide additional agricultural support to meet their needs.

Geoff Maher

The continued involvement of the Research, Development and Extension committees in each of the relevant extension areas has enabled a better understanding of local area needs, resulting in the provision of a more focussed extension programme. The SASRI Extension team has continued to evolve into a unique and efficient service to all growers in the sugar industry. The ability of the individual Extension Specialist to communicate directly with some of the world's top class scientists in sugarcane agriculture is an enormous advantage and one which sets SASRI apart from many other institutions.

Weather

The 2013 season started with much promise with regards to climatic conditions in most of the extension areas across the industry. The good summer rainfall which started in 2012 continued into the first few months of 2013, although in some instances the rainfall was excessive. This paved the way for an ideal period for ripening and most of the mill groups took up the opportunity. Unfortunately, some areas subsequently experienced fairly severe fluctuations in rainfall and this interfered with the ripening programmes.

Very dry spells during the winter periods were common for coastal regions, leading to the crop yield decreasing significantly from the first estimates in some areas. Late season rains in October played havoc with the harvesting and transport of cane in some areas.

Heavy winds in the midlands and lower south coast areas caused lodging of cane, while the midlands also had to contend with the occasional hail storms which caused some problems.

Cane Yield and Quality

Many areas began the 2013 season with carry-over cane from the previous year. In some cases this had a negative impact on the cane quality of early season deliveries because of moisture stress due to excessive summer rainfall.

Generally, throughout the industry, cane quality was good, and this was largely attributed to the increased use of ripeners. Extension Specialists dispensed advice on ripener use through various field days and grower study groups.

Malelane and Komatipoort were first and second in the industry in terms of cane quality. These Mpumalanga mills have attributed the excellent quality to the high adoption of ripeners and to the correct timing of harvest for each variety.

In Pongola, RV was well above the seven year average. Here also, the use of chemical ripeners was identified as the main factor. The crop grew well throughout the season resulting in a yield surpassing the long-term average. Due to the good crop, a large volume of cane had to be diverted to other mills, and a large area had to be carried over to the 2014-15 season.

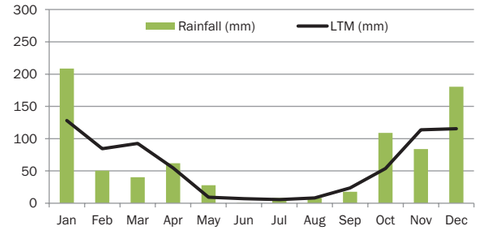
The very dry conditions in Amatikulu, coupled with the extensive chemical ripening saw RV's of up to 17% being recorded. The seasonal RV average was 12.35%, a welcome improvement over the last two seasons.

Gledhow Mill embarked on a vertical yield expansion programme during this period in an effort to increase growers' average yields by 10% over the previous season. This would ensure both grower and miller sustainability.

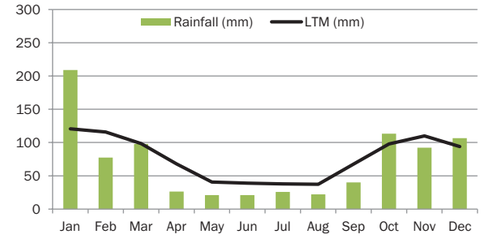
For the Midlands North UCL mill area, 2013/2014 season was a huge success

Rainfall graphs per mill area

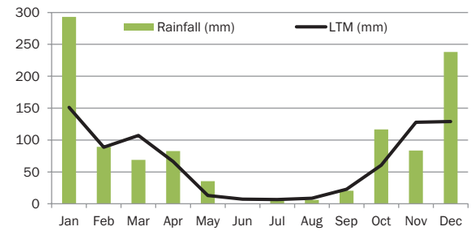
Komati



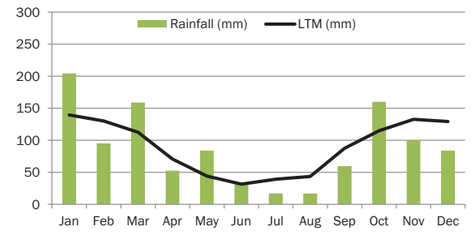
Felixton



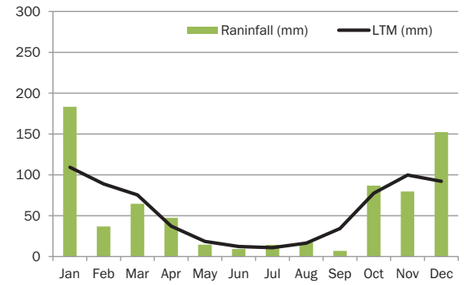
Malelane



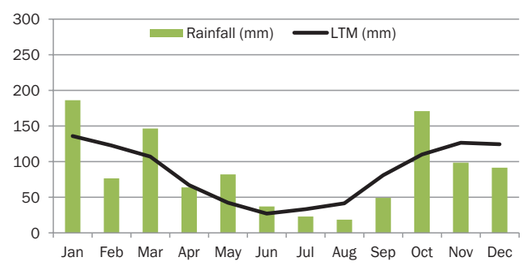
Darnall



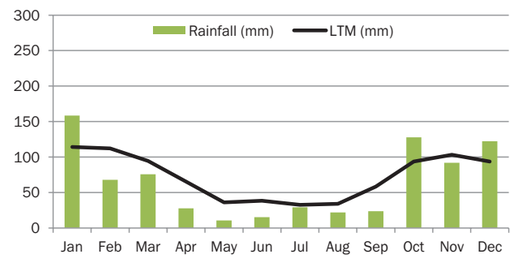
Pongola



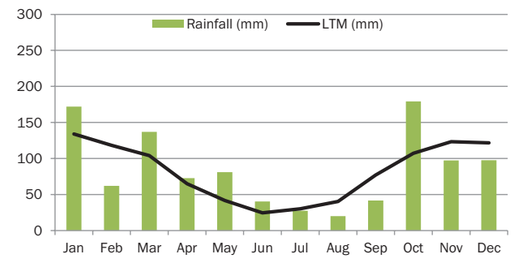
Gledhow



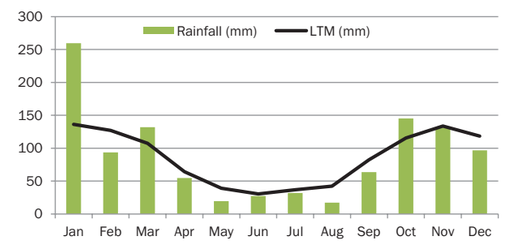
Umfolozi



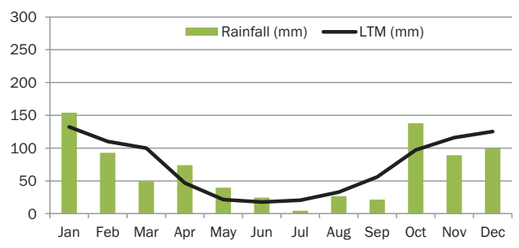
Maidstone



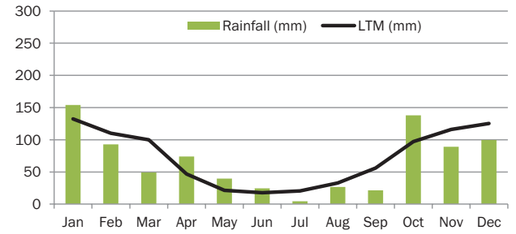
Amatikulu



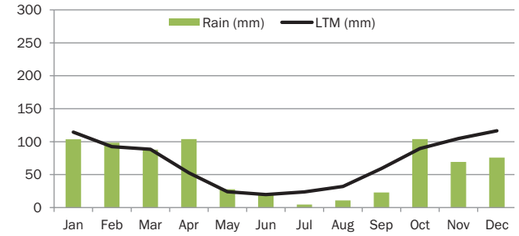
Noodsberg



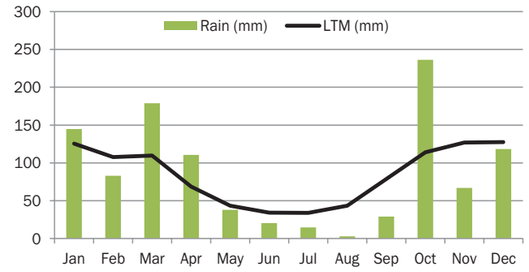
UCL



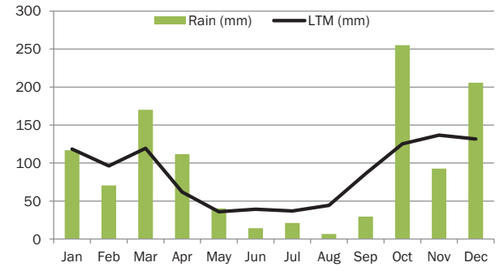
Eston



Sezela



Umzimkulu



with the production of one of the largest crops seen in a long time. With such a large crop, the dynamics of diversion became quite a challenge, with cane having to be sent to four different mills viz. Gledhow, Maidstone, Noodsberg and as far away as Sezela.

On the Lower South Coast (Umzimkulu), the recorded RV was 13.07%, which was the second highest since the RV payment scheme was introduced. The year ended positively in this area with carry-over cane looking healthy and ratoons growing favourably.

Pests and Diseases

The incursion of new pests and diseases such as the Yellow Sugarcane Aphid (YSA) and Tawny Rust presented further challenges to the industry, with Extension Specialists responding accordingly. These new problems, coupled with existing pest and disease threats led to a growing awareness of the importance of good clean seedcane amongst growers. A drop in Ratoon Stunt (RSD) levels in some areas was directly attributed to the introduction of mandatory seedcane schemes and the promotion of long fallow periods over the past few years. The increase in the number of hot water treatment plants throughout the industry and the increasing number of on-farm nurseries using certified seedcane is promising. Of concern is the fact that the number of off-types in seedcane and commercial fields continues to be high, increasing the risk of disease spread in newly planted fields.

Yellow sugarcane aphid (YSA)

YSA was observed the industry for the first time in 2013. The incidence of YSA was widespread geographically and present in a range of different varieties. Across the industry, 28 of the 36 varieties surveyed were infested. This does not imply, however, that the unaffected varieties are resistant or immune to infestation.

Many YSA predators such as ladybirds were recorded frequently in the fields. In the Lowveld, no aphids were recorded, even though there was visible leaf damage. The aphids were probably dislodged from the plants by the high rainfall.

While the aphid has not been found in large numbers in the Midlands North area, it has been widespread in that area.

Eldana

Generally, infestations and damage decreased across the industry. However, records showed that there were some fields with excessively high numbers of larvae, and this was addressed during the course of the season. The reduction in eldana numbers was attributed to improved climatic conditions and more extensive spraying of FASTAC®.

Thrips

Regular seasonal trends were evident in leaf spindle samples with numbers increasing during summer and decreasing over winter. Better control of thrips has been achieved in some areas with the application of Bandit® to plant fields and Allice on ratoon fields. This practice helped to protect plant cane for the first three months of its germination, thus ensuring a better crop performance.

Grasshoppers

An outbreak of grasshoppers occurred in Zululand North (Felixton) during the beginning of the year but this was brought under control by spraying the nymph as well as hopper stages with insecticide. However, some estates were not timeous with application and damage was quite severe. There was a noticeable increase in red locusts travelling in swarms.

Rust

Moderate to severe brown rust infections were observed in some fields of N37, N39 and N42. Fungicide sprays have generally been effective in reducing the severity of brown rust in young cane but persistence into the drier months has made spray decisions difficult. Uptake of the fungicide is best when applied to actively growing cane and before the development of severe symptoms - as the cane dries off, uptake is less efficient and the chemical less effective.

Tawny rust (previously known as African sugarcane rust) was widespread in the industry but was particularly severe in the midlands and the Pongola and Entumeni mill supply areas. Varieties most commonly and severely infected were N16, N25, N46 and N49.

Yellow leaf (Sugarcane yellow leaf virus – SCYLV)

An industry-wide SCYLV survey showed that the virus was found to be widespread in South Africa, with more than 50% of the fields in the Lowveld, Pongola, Umfolozi and Maidstone areas being infected. Incidence was lowest in Eston with 14% fields infected - there has been little change in this area and Felixton since the previous survey in 2003. Incidence was highest in NCo376, N17 and N19 and lowest in N25, N41 and N46.

Mosaic

Mosaic incidence in the industry was similar to previous seasons with the disease present in 5% of the fields inspected and a mean of 0.05% stools infected. However, mosaic continues to be problematic in N12 in the midlands despite efforts to establish clean Nova-Cane® seed sources.

Smut

Smut incidence in the northern irrigated areas was markedly lower in commercial fields than the previous season. Twenty percent of the fields inspected in the irrigated north were infected with smut compared to 39% the previous year. Minimum winter temperatures in the Lowveld were similar to 2012, but rainfall was lower. This would normally favour smut development but the rainfall distribution differed, with more rainfall events occurring through the 2013 winter. This is likely to have reduced the smut spore load leading into spring in this area.

Smut was common in NCo376, N19, N25 and N32 while increased incidence was noted in N41 and N48.

Ratoon stunt (RSD)

RSD levels were relatively low in commercial fields with 7% testing positive compared to the five year mean of 10%. RSD was detected in 2.3% of the samples submitted from intended seedcane sources.

SUSFARMS®

Much effort was spent on the roll-out of SUSFARMS® in each of the mill group areas across the industry. In total, 11 grower days were held from 24 January 2013 till 9 July 2013.The objective was to introduce growers in each of the Extension areas to the SUSFARMS® manual and Progress Tracker, and encourage them to use this very important management tool. Unfortunately not all areas responded as well as expected to these events.

The interaction with growers and other role-players during the roll-out proved to be invaluable and have enabled the development of a process to update SUSFARMS® in 2014. This will include alignment with other certification schemes, the development of suitable metrics and verification scheme along with appropriate training programmes.

During the year, the Midlands North Region made the submission of a SUSFARMS® Progress Tracker report mandatory. The report is to be submitted with the second estimate of the season. Due to sustainability targets being set by major buyers of Noodsberg sugar, it was agreed that this was necessary in order to ensure cane farms become more sustainable and have documented proof of improvement over time.

Small-scale Grower Extension under the Extension Venture Agreement (EVA)

The small-scale grower (SSG) sector of the sugar industry performed favourably during 2013, with cane deliveries increasing by as much as 23% in comparison to 2012. Final deliveries surpassed the previous year by as much as 302 000 tonnes. Cane quality and sucrose also showed much improvement from the previous year. The tables below outline the performance of the SSGs in terms of cane delivered and cane quality as at December 2013.

A total of 130 grower days were held in all SSG areas with an overall attendance of 3 266 growers. A variety of aspects were covered, including sugarcane production and business skills. These events aim to transfer knowledge in a classroom-like environment along with practical training sessions so that SSGs clearly understand and implement best management practises on their farms.

There are still many challenges and knowledge gaps in the SSG sector of the industry which are currently being addressed. The main knowledge gaps identified through grower days and workshops were cane quality and soil nutrition. Of concern in the northern irrigated region, was the lack of understanding in terms of variety and disease control. Due to inadequate border governance, growers are sourcing foreign sugarcane and planting locally. Other challenges for SSGs generally included seedcane production, poor contractor performance as well as EVA extension capacity due to more staff also supporting land reform.

Additional activities held by SASRI during the course of 2013 included eight refresher course training sessions for the Department of Agriculture, Environmental Affairs and Rural Development (DAEARD) Extension staff, an agricultural radio programme covering eight topics, four EVA Monitoring Committee meetings (quarterly) and 11 demonstration plots planted across all SSG regions. These plots served as a source of seedcane as well as field training sites for schools.

Table 1: Table of SSG cane land (ha) and cane delivery estimates.

	Area under cane (ha's)	No of growers delivering throughout season	1st Estimate	Final delivery
All SSG	24 498	18 235	1 293 173	1 311 418

Table 2: Table of average cane quality.

All SSGs	Mill average to date figures					
	Sucrose %	Non-sucrose %	Fibre %	RV %	Purity %	Moist %
Average	13.71	2.53	15.97	12.38	84.88	68.31

Extension Activities

There have been positive reports of successful outcomes stemming from the various grower contact events that took place during the year. Study groups, in particular, have helped growers to understand important aspects of sugarcane agriculture such as use of ripeners, seedcane management and sustainable farming through initiatives such as SUSFARMS®.

Mpumalanga

Grower Day
- Ripeners
- Weeds and Herbicide Trials
- Pest and Disease

Field day
- Ripening Workshop and Tour
- Evaluating Irrigation Activities
- Physical Responses of Ripeners (Komatipoort).
- Ripener Demonstration

Road Show
- SUSFARMS® Roll-out

Study group
- Evaluation of Contolled Traffic
- Varieties and Seedcane

Umfolozi

Grower day
- Ripening
- Labour Relations/Legislation
- Fertiliser and Rust Trial

Study group
- Green Manuring and Statistics Analysis
- Fertiliser Strategies
- Fertiliser Strategy: Abacus® and Allice Use
- Soil Pit Inspections
- Water Management Issues
- Annual Directors visit: Varieties

Road show
- SUSFARMS® Roll-out

Zululand North (Felixton)

Grower day
- Ripeners

Road Show
- SUSFARMS® Roll-out

Training Course
- The SABI Irrigation Training Course

Zululand South (Amatikulu)

Grower day
- Chemical Ripening

Field day
- Variety Field Day

Road Show
- SUSFARMS® Roll-out

Pongola

Grower day
- Managing Sugarcane Roots.
- Controlled Traffic Project
- Weed control, Ripeners & Irrigation Scheduling
- P&D Workshop with KwaJobe Growers – Smut Control, Illegal Varieties

Road show
- SUSFARMS® Roll-out

Field day
- Controlled Traffic

Study group
- Wonderfontein Study group: Weed Control, Green-manuring and Planting
- Variety selection
- RV Price, Fertilisers
- Wonderfontein Study Group: Variety Selection

Modular course
- Irrigation Users Course

North Coast (Darnall, Gledhow, Maidstone)

Road Show
- SUSFARMS® Roll-out (Upper Tongaat)

Study group
- Green Manuring (Upper Tongaat)
- Use of LUP to Farm Effectively (Upper Tongaat)
- Sterile Insect Technology programme
- Implementing A LUP and the Advantages of Using a LUP (Upper Tongaat)
- Green Manuring, Use of Lime and Gypsum and Ageing of Cane (Upper Tongaat)
- Single Stick Planting, Lime and Gypsum Incorporation, Mechanical Covering (Upper Tongaat)
- Farming for RV (Maidstone)
- Importance of Using Quality Seedcane (Kearsney/Darnall)

Field day
- Assessment of BMP and LUP

Grower day
- Seedcane Scheme (Gledhow)
- Liming and Green Manuring

Midlands North (Noodsberg)

Road show
- SUSFARMS® Roll-out

Grower Days
- Illovo Grower Information Day: Fly Ash and Midlands Ripening
- Soil Acidity Workshop
- Frost Variety Grower Day and Mechanical Harvester Demo
- Chemical Ripening

Study group
- Green Manuring/Fallows
- Seedcane Schemes, Varieties and Nurseries (Ecozone 1 and 2 Study group)
- Seedcane Schemes, Varieties and Nurseries (Ecozone 5 and 6 Study Group)
- SUSFARMS® Progress Tracker, Agrochemicals and Wetland Rehabilitation

Field day
- LEC/Government Field Day

South Coast (Sezela)

Study group
- Ifafa NFG Study Group (Re-ripening)
- Annual Yield Comparison Project and BMP's
- Ripening NFG Study Group (Equeefa, Humberdale, Ifafa)
- Ripening Programme for NFGs (Illovo Sugar Ltd Ripening Scheme)
- Illovo Sugar and SASRI Database Workshop
- Illovo Sugar Strategic Workshop
- Umzumbe Farmers' Association Meeting
- Umdoni Farmers' Study Group
- Hibberdene Study Group
- Umzumbe Farmers' Association Meeting
- Hibberdene Farmers' Association Meeting
- Highflats Farmers' Association Meeting

Road show
- SUSFARMS® Roll-out

Field day
- Coastal & Hinterland Varieties, IPM Eldana and Habitat Management
- Cedara Student Visit to Ellingham Farm
- Small-scale Growers (Seedcane, Varieties and Planting)

Grower day
- Advanced Nitrogen Fertilisers
- Highflats Cane Competition
- Seedcane and Varieties

Lower South Coast (Umzimkulu)

Road Show
- SUSFARMS® Roll-out

Field day
- Sugarcane Nutrition
- Nematodes, Yellow Sugarcane Aphid, Rust and Thrips
- Sezela Transplant Nursery, MCP Sezela First Stage Nursery and Umzimkulu Grower Visit

Study group
- Soils Identification and Management
- Ripening Study Group
- Genetically Modified Sugarcane

Midlands South (Eston)

Study group
- Soil Identification
- LUP and Varieties
- Fertiliser Discussions
- Mechanical Planting and Thrips Control
- Ripening Cane, Thrips Control and Biosecurity Issues
- Seedcane Planter Demonstration

Road Show
- SUSFARMS® Roll-out

Field day
- Soil Acidity: Farm Issues and Better Soil Quality
- Mosiac in Plant Cane
- Soil Fertility

Technology Transfer

> Knowledge Management is the concept under which information is turned into actionable knowledge and made available effortlessly in a usable form to the people who can apply it.
>
> (Patel J and Harty J (1998). Knowledge Management: Great concept but what is it? Information Week, March 16, 1998)

Publications

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

In 2013, three editions of *The Link* and *Ingede* magazines, aimed at our English and isiZulu speaking growers respectively, were published. These 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.

Michelle Binedell

Soil sustainability was one of the main subjects that was addressed. Articles covered micronutrients, green manuring, root health, fertigation, CMS and correct leaf analyses.

2013 has seen the release of four new varieties which hold much promise for the industry: N54 for the midlands, N55 and N56 for the coastal and hinterland areas and N57 for the northern irrigated areas. Each of these varieties was described in a *Link* article, highlighting their attributes and characteristics. Growers were also told about the latest varieties recommended for frost pockets as well as drought tolerance of coastal varieties.

Articles on eldana control continued to raise attention of this persistent pest and recommendations on carry-over cane were provided. Control of thrips and grasshoppers was also addressed along with advice on good stewardship and the consequences of using unregistered agrochemicals.

Spatial planning and the use of Land Use Plans were highlighted along with correct procedures for field measurements. These articles (and many others listed right) encapsulate the latest SASRI knowledge and best practice and serve to inform and encourage their adoption by the industry.

The *Ingede* focussed on important aspects of sugarcane agriculture for the small-scale grower. Topical Tips (a regular feature of each *Ingede*) are appropriate for each month in the farming calendar and provided clear guidance on management interventions and necessary activities to ensure a good crop.

Soil conservation and details on how to understand a soil sample analysis report were provided along with correct advice on fertiliser application for waterlogged areas.

Since cane estimates are important for small-scale growers, their importance was stressed along with explanations on how to understand a mill cane statement and how to order seedcane.

During the harvesting season, *Ingede* readers were warned of the safety risk to children by cane haulers and were also provided with advice on fire control during cane burning.

Over the year, SASRI published nine articles in the *South African Sugar Journal* and ten articles in *Coastal News,* once again show-casing SASRI's achievements and promoting best practice.

Link Articles Published in 2013

Regular features
- Topical Tips - (SASRI Extension)
- Weather
- Messages from the Director

Weed control
- Summer weed control

Stewardship
- Good stewardship of agrochemicals
- Sustainable Sugar: From Farm to Fork
- The use of unregistered agrochemicals in the sugar industry

Pest control
- Silicon-mediated resistance to eldana
- Carry-over cane and eldana control
- Thrips control in sugarcane
- Biosecurity awareness
- Grasshopper update
- Spray on profits

Irrigation and mechanisation
- Variable speed drives: The answer to high electricity bills
- Updated Mechanisation Reports

Ripening and flowering
- Chemiese rypmaking maak betekenisvolle bydrae tot RV opbrengste in Pongola
- Predicting sugarcane flowering (via the SASRI WeatherWeb)
- Does 24-month cycle respond to chemical ripeners?

Soil sustainability
- CMS (Condensed Molasses Solids)
- Fertigation
- Micronutrients of macro importance
- Does green manuring make rands and sense?
- Getting to the root of the problem!
- Soil Health: Worn out soils
- Leaf Analysis

Varieties
- Drought tolerance of coastal varieties
- Latest variety recommendations for frost pockets
- Promising new varieties
- Quality Seedcane
- Germination of varieties after hot water treatment

Spatial Planning
- Accurate field measurements
- Land Use Plans: Planning for optimum yields

Ingede Articles Published in 2013

January 2013
- The importance of cane estimates
- The farming calendar
- Radio broadcasts
- Topical tips

May 2013
- Fertiliser application in waterlogged areas
- Soil conservation
- Understanding your mill cane statement
- New employees at SASRI
- Broadcasting Times
- Topical Tips

September 2013
- Fire Protection
- Seedcane ordering system
- Understanding your soil sample analysis report
- Warning to Growers and all community members on child injuries by cane haulers.
- New employees at SASRI
- Topical Tips

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

Radio

During 2013, over 80 radio programmes were broadcast at ten radio stations within KwaZulu-Natal. Since many of the rural population in South Africa have access to radio, this medium is being used very successfully to broadcast agronomic advice to isiZulu speaking growers.

Career Days

Since the promotion of agriculture amongst our youth is a key priority of our institute, SASRI attended the UKZN Career Day in August 2013. Hundreds of university undergraduates from a number of faculties attended and were exposed to the post-graduate and internship opportunities available at SASRI. They were also made aware of the vast contributions that they could play in the future of the industry through their studies in science and agriculture.

Certificate Courses

The demand for skills development and training in sugarcane agriculture has continued to increase into 2013. SASRI responded to this demand again by delivering two three-week Junior Certificate Courses in Sugarcane Agriculture in April and October 2013. A total of 102 students attended the Junior Courses, 79% from South Africa and the balance from Swaziland and Zambia.

Two Senior Certificate Courses, which are aimed at tertiary-level students, were held in February and June 2013 with 103 students attending. Over 70% of students were South African applicants, while the balance of students was from Malawi, Swaziland, Zambia, Mozambique and Tanzania.

Information Sheets Published in 2013

Updated Sheets	
4.8	Industrial guidelines for burning sugarcane
7.17	Guidelines for the interpretation of leaf analyses for sugarcane
8.2.1	Nematodes
8.2.2	Nematode management
12.2	Registered chemicals for ripening sugarcane: Ethephon
5.2.1	Irrigation strategies during water limiting periods
New Sheets	
13.39	Variety N54
13.40	Variety N55
13.41	Variety N56
13.42	Variety N57

Grower Interaction

Significant face-to-face interaction with industry stakeholders in 2013 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 1 400 visits to growers, hosted 157 grower days and exhibitions and were involved in 413 conferences, workshops, refresher courses, seminars and demonstrations. SASRI also hosted 1 100 visitors in 2013.

InfoPack CD

One of the most valuable resources produced by SASRI is the newly updated 2013 InfoPack CD 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 2013 version of the InfoPack had a number of new additions.

RD&E feedback

A booklet, Feedback to RD&E Committees: 2013 Stakeholder Issues. This contained SASRI's response to 88 industry issues raised at the RD&E AGM of 2013.

Disease manual

The manual, Sugarcane Diseases in southern Africa was updated with information related to Tawny Rust and Maize Streak.

Training videos

Two new videos in isiZulu: Soil Sampling and Leaf sampling.
A new video: Introduction to SASRI.

SUSFARMS®

An e-version of the SUSFARMS® Manual and Progress Tracker (2nd Edition).

New book on soils

A newly published book on soils written by SASRI scientists for sustainable farming: Understanding and Managing Soils in the South African Sugar Industry.

Throughout 2013, staff at SASRI have been committed to transferring both new research outcomes as well as established, "back-to-basics" practices that have been shown to benefit the industry. Relevant and appropriate technology transfer mechanisms have been chosen to achieve this. Throughout the coming year, SASRI will continue to explore new tools and new communication technologies that will be effective in addressing a diversity of stakeholders and their needs.

Publications and Presentations

Peer Reviewed Papers in Journals or Congress Proceedings

Buthelezi NM, Conlong DE and Zharare GE (2013). A comparison of the infestation of *Aproaerema simplexella* (Walker) on groundnut and other known hosts for *Aproaerema modicella* (Deventer) (Lepidoptera: Gelechiidae). *African Entomology* 21(2): 183-195.

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Munsamy A (2013). Towards the production of sugarcane somaclonal variants with useful traits by 5-Azacytidine-induced mutagenesis. *MSc Dissertation,* University of KwaZulu Natal (Supervisors: Prof MP Watt (UKZN) and Drs SJ Snyman (SASRI) and RS Rutherford (SASRI)).

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Books & Book Chapters

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Statistical Snapshot

Reporting period: 01 January 2013 – 31 December 2013

Research projects as at 31 December 2013

Closed:	23
Ongoing:	52
New:	7

Staff complement - (excluding contract staff)

Crop Biology	45
Plant and Environment	21
Breeding and Field	248
Diagnostic and Analytical	32
Extension	27
Knowledge Management	6
Human Resources	5
Administration and Management	6
Senior Management	4
TOTAL	**394**

Number of Honorary appointments at tertiary institutions:	9
Number of post-doctoral researchers associated with SASRI:	4
Number of post-doctoral researchers based at SASRI:	2
Number of postgraduate students associated with SASRI:	15
Number of postgraduate students based at SASRI:	21
Number of SASRI staff registered for post-graduate studies:	8

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