

REFEREED PAPER

SERVICE AND INNOVATION: THE SASRI R&D VALUE CHAIN

WATT DA, BINEDELL ML AND MAHER GW

South African Sugarcane Research Institute, P/Bag X02, Mount Edgecombe, 4300, South Africa
Derek.Watt@sugar.org.za Michelle.Binedell@sugar.org.za Geoff.Maher@sugar.org.za

Abstract

As primary provider of agro-technical expertise to the South African sugar industry, the South African Sugarcane Research Institute (SASRI) delivers diverse research and development (R&D) outcomes to the industry, including: (a) pertinent and robust agricultural solutions, products and services; (b) novel and improved in-house technologies to enhance the scope and quality of service provision; and (c) innovations to support industry strategic initiatives, particularly those pertaining to sustainability. Consequently, SASRI maintains a differentiated project portfolio, of which relevance, balance and rigour are routinely monitored quality indicators. Over several years, SASRI has developed and refined processes to enhance the quality and scope of service delivery, central to which have been: (a) full alignment of the R&D programme with industry research, development and extension structures and requirements; (b) complete integration of internal R&D, knowledge management and extension functions; (c) embedded quality assurance and benchmarking mechanisms; (d) development of industry mandated R&D key performance areas and related performance indicators; and (e) establishment of research collaborations and formalisation of partnerships to enhance capacity and delivery in areas of strategic importance to the industry. These developments and refinements are located within the context of the institute's vision of being the recognised global leader in innovative sugarcane research at the forefront of a thriving industry. The objective of this paper is two-fold, viz. (i) to review the advances that have been made towards optimising service delivery and innovation across the SASRI R&D value chain; and (ii) to discuss emerging challenges regarding the advancement of technology adoption and service delivery to meet a diversity of grower needs.

Keywords: research and development, knowledge management, extension, technology transfer and adoption, grower demographics

In service of the South African sugar industry*The South African sugar industry*

The South African sugar industry is considered to be one of the world's leading cost-competitive producers of high quality cane sugar, which contributes significantly to rural employment, sustainable development and the national economy. The industry produces an estimated average of 2.2 million tons of sugar per season (Anon, 2012) and, based on the costs of production, has since the 1950s consistently ranked amongst the top 15 of more than 100 global sugar producers (Fischer *et al.*, 2008). In addition, between 2008 and 2010, South Africa was ranked as the sixth largest sugar exporter, after Brazil, Thailand, Australia, India and Mexico (OECD-FAO Agricultural Outlook 2011-2020, 2011).

South African Sugar Association

The South African sugar industry comprises approximately 27 036 registered sugarcane growers, including around 25 200 small-scale growers, and 14 mills that are owned by six

milling companies. Within the industry, the South African Cane Growers' Association (CANEGROWERS) administers the interests of the independent growers, while the South African Sugar Millers' Association NPC (SASMA) represents the interests of all sugar millers and refiners. The partnership between CANEGROWERS and SASMA is mediated by the South African Sugar Association (SASA), which is an entity incorporated by statute (Section 2 of the Sugar Act, Act No. 9 of 1978 [Government Gazette No. 6419 on 27 April 1979]) for this purpose. In addition to facilitating the relationship between the South African sugarcane growing and milling communities, SASA provides a range of specialist services to promote industry sustainability.

South African Sugarcane Research Institute

The South African Research Institute (SASRI) is the division of SASA that serves as the primary provider of agro-technical expertise, services and products to the South African sugar industry. The purpose of the institute is to:

- develop and deliver new sugarcane varieties that provide increased economic returns for all sectors of the industry;
- undertake research and provide services that advance nutritional, agronomic and engineering practices and pest and disease control measures;
- transform research outputs into practical knowledge and technology products;
- facilitate the adoption of technology and best management practices that encourage responsible and sustainable land use and deliver optimal productivity and profitability;
- generate new ideas with the potential to enlarge the scope of sugarcane agriculture and sustain the industry into the future.

Relevant and innovative sugarcane research and development

The vision of SASRI is to be 'the recognised global leader in innovative sugarcane research at the forefront of a thriving industry'. In striving to realise this bold vision, the research and development (R&D) programme of the institute has been tailored to address the immediate agro-technical needs of stakeholders, while also maintaining a strategic focus on innovation to support the long-term sustainability of the industry it serves. The R&D programme is at present facilitated by a cohort of 40 SASRI scientists and engineers, and a recently appointed research economist, 17 of whom have PhD degrees. The R&D programme is also facilitated by a number of experts in supporting technologies (biometrics, programming, geographical information systems, database systems and management, electronics, mechanics and laboratory and field methodologies).

To broaden and sustain innovation within the R&D programme, SASRI scientists and technologists draw on support from national and international networks of discipline experts. A number of mechanisms are particularly useful in this regard, including: (a) the assumption, upon invitation, of honorary academic and research positions at universities, which allow the qualifying SASRI scientists to supervise post-graduate students and host post-doctoral researchers on the SASRI Mount Edgecombe campus; (b) memberships of international research consortia, which permit SASRI to participate in technologically advanced collaborative projects and initiatives that would otherwise be beyond the scope of available resources; and (c) establishment of formal research contracts with universities according to the need for supplementary research capacity and expertise.

Configured for delivery

Matrix structure in support of formal project management system

SASRI is configured as a balanced matrix organisation, which, in general terms, may be described as a two-dimensional management structure in which personnel are assigned to two organisational groups; a functional group based on skill sets which has a functional manager (vertical), and a specific project group where employees report to a project manager (horizontal). The project manager defines the skills needed for a project, and the functional manager monitors the allocation of scientists, technologists and engineers to fulfil those needs. In a similar way, functional managers are responsible for maintaining and assigning infrastructure and resources required for specific projects. A matrix structure offers a number of advantages for agricultural research institutes over more traditional configurations (e.g. department-based). Such advantages include: (a) greater ease of facilitating inter-disciplinary approaches to solving complex agricultural problems; (b) increased focus of scientists, technologists and engineers, particularly those at a senior level, on their core area of expertise, viz. research; (c) compatibility with formal project management systems; and, arguably the greatest advantage, (d) improved ease of facilitating integration of functions across the entire R&D value chain, from research, technology development and knowledge management through to extension services.

All SASRI scientists, technologists and engineers are vertically managed within four functional groupings, viz. two resource centres and two resources units. The resources and staff for scientific endeavours are primarily located within the two resources centres: the Crop Biology Resource Centre (CBRC) for the biological disciplines; and the Plant and Environment Resource Centre (PERC) for the agronomic and engineering disciplines (Figure 1). The two resource units have a service focus that is both internal to SASRI and external to industry stakeholders.

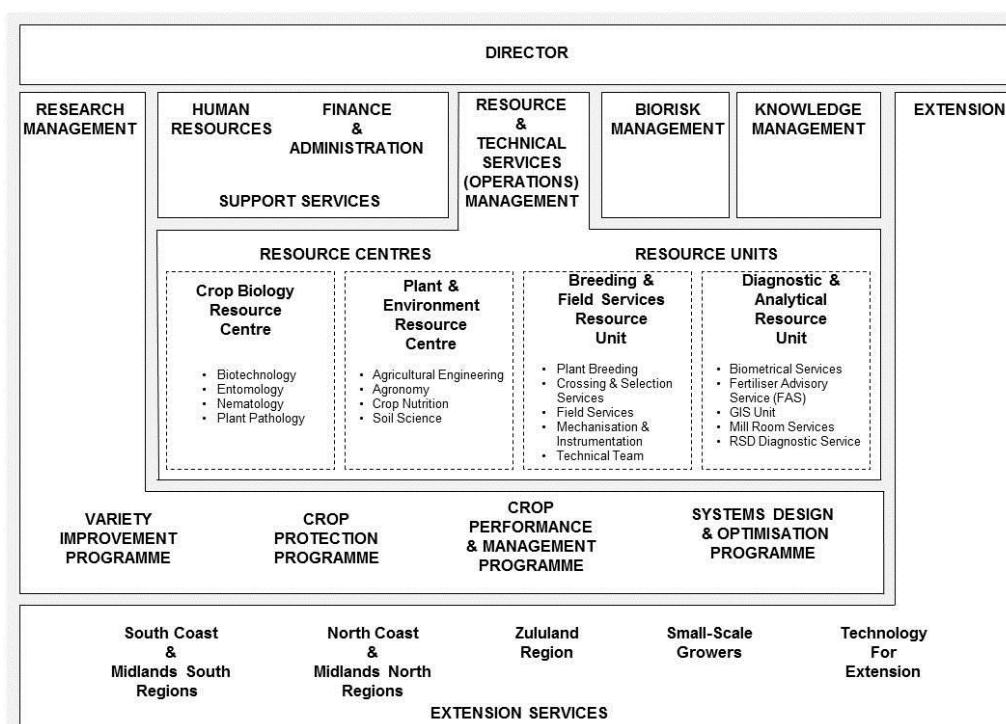


Figure 1. SASRI configuration. The organogram depicts the configuration that supports a balanced matrix organisation and a formal project management system.

The R&D programme is managed horizontally

At project initiation, Project Managers draw the appropriate discipline specialists, technologists and resources necessary for project execution from the resource centres and source the required services and technical resources from the resource units. For example, Project Managers would request appropriate trial sites on one or more of the eight research stations which SASRI maintains for field research. These stations are representative of the primary agro-ecological zones within the South African sugar belt (Figure 2A).

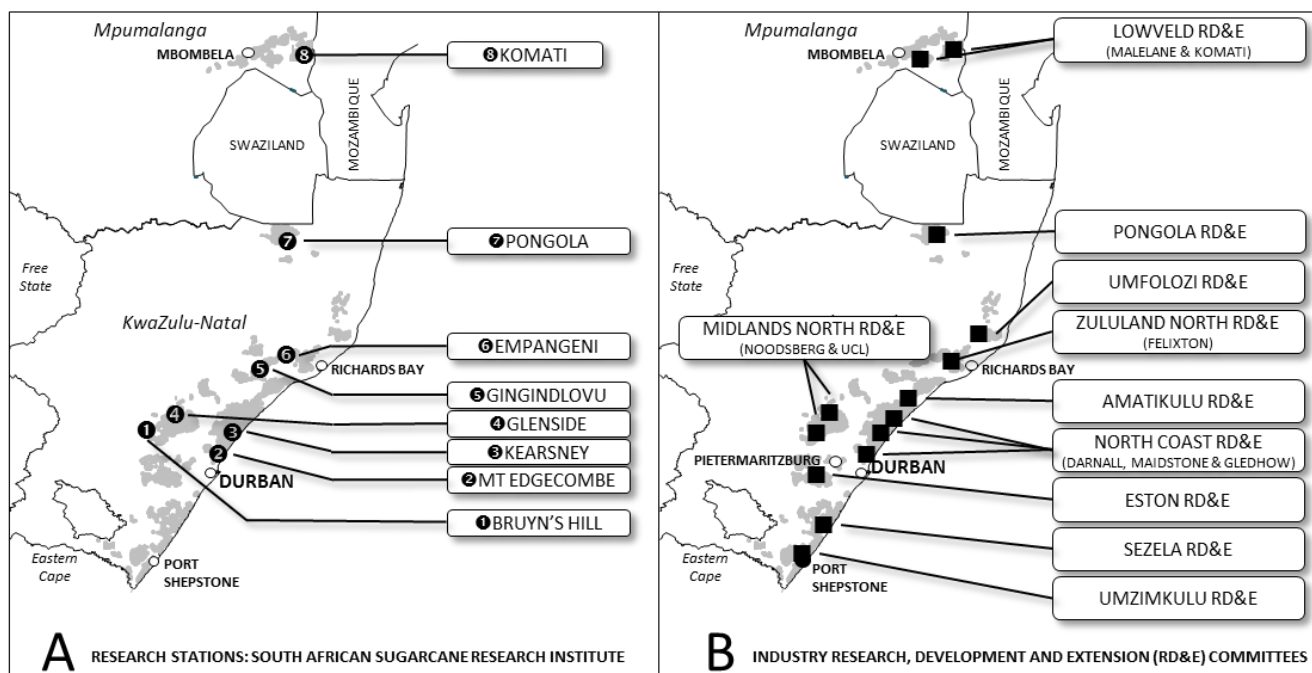


Figure 2. Geographical distribution of key industry resources across the South African sugar belt. Indicated are the locations in KwaZulu-Natal and Mpumalanga of: (A) Research Stations of the South African Sugarcane Research Institute; (B) Industry Research, Development and Extension (RD&E) committees that play a pivotal role in informing the SASRI R&D programme.

The project portfolio is managed horizontally in four research programmes, into each of which cognate research projects are assigned (Table 1). Each programme is co-ordinated by a Programme Manager, to whom Project Managers report on research progress and other scientific matters. The four Programme Managers are permanent SASRI senior scientists appointed to this management role on a part-time basis (30% of full-time) for a defined contract period.

A tailored R&D programme

To deliver relevant agro-technical services, recommendations and products to stakeholders, while also addressing long-term issues regarding industry sustainability, the composition of the annual R&D project portfolio is carefully monitored and adjusted. This ability to manage the composition and balance of the R&D programme is a further advantage of a formal project management system, due to the flexibility afforded by project turnover.

Table 1. Four research programmes comprise the SASRI R&D programme. Cognate research projects contributing to the attainment of the stated goal are managed within the relevant programme.

Research 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 that add value and enhance productivity.

Balanced R&D research portfolio

It is widely recognised that diversified project portfolios in agricultural research ultimately deliver greater value than those that are solely reactive (Pannell, 1990; Stirling *et al.*, 2006). Given this, SASRI strives to maintain a 70% to 30% ratio between needs driven, reactive research and innovation focused research; a ratio that is deemed most appropriate for successful agricultural R&D programmes (Pannell, 1990). As SASRI strives to be responsive to all stakeholder needs, adaptive research (Table 2) comprises 46% (37 projects) of the current 2013/14 R&D programme, while technology development, which is also reactive to stakeholder needs, forms a further 20% (16 projects). In contrast, strategic and exploratory research forms 21% (17 projects) and 13% (11 projects) of the 2013/14 programme, respectively.

Table 2. Categories of applied research undertaken at SASRI. The purpose and scale of each category of research are reflected, as are the underlying philosophies. All SASRI research activities are applied, as they consist of original investigation undertaken to acquire new knowledge that is ultimately directed towards a specific practical aim or objective of benefit to the industry.

Category	Purpose	Philosophy	Scale
Adaptive research	Needs-driven research to solve problems of immediate consequence.	Reactive	Short term
Technology development	Search for new technology within the limits of existing scientific knowledge set by exploratory or strategic research.	Proactive and reactive	Short to medium term
Strategic research	Directed towards meeting perceived medium to long term development needs of stakeholders, which are strongly informed by international scientific progress and potential local industry innovations.	Proactive and reactive	Medium to long term
Exploratory research	Establishes the boundaries within which innovation is possible.	Proactive	Long term

Assessing and addressing stakeholder needs

As the SASRI R&D programme endeavours to become increasingly responsive to the needs of the South African sugar industry, wide consultation with and participation by stakeholders in the formulation of the annual R&D programme have become core activities. Central to such participation are the industry Research Development and Extension (RD&E) structures, consisting of ten RD&E committees operating throughout the industry (see Figure 2B). Every year, the committees supply SASRI with a list of the most pressing issues from each region. The lists are then discussed, clarified and prioritised at an annual RD&E Committees Workshop convened at Mount Edgecombe. The resulting priorities are then presented to SASRI specialists, who for each issue consider whether:

- new research is required;
- scientific data exist but require development of a technology that is suitable for transfer to growers;
- information exists but requires re-packaging before communication to growers;
- knowledge exists that is suitable for communication to growers by means of Information Sheet updates, revised or new Recommendations, Extension Newsletters, *The Link* or *Ingede* articles, Grower Days or Director's Visits.

For issues falling within the first three categories, SASRI specialists are invited to prepare and submit proposals outlining research, technology development or knowledge transfer projects they believe will provide solutions to the identified stakeholder priority issues. The fourth category of issues, for which knowledge exists, immediately enters into the work programmes of the SASRI Extension services and Knowledge Management Unit. In 2012, 52 issues were assigned priority across the entire industry. Information existed to provide appropriate solutions to 45 of these issues (Figure 3). Seven new projects entered the SASRI work programme as a result of the RD&E Committee consultation process, of which five were research projects and two knowledge transfer projects.

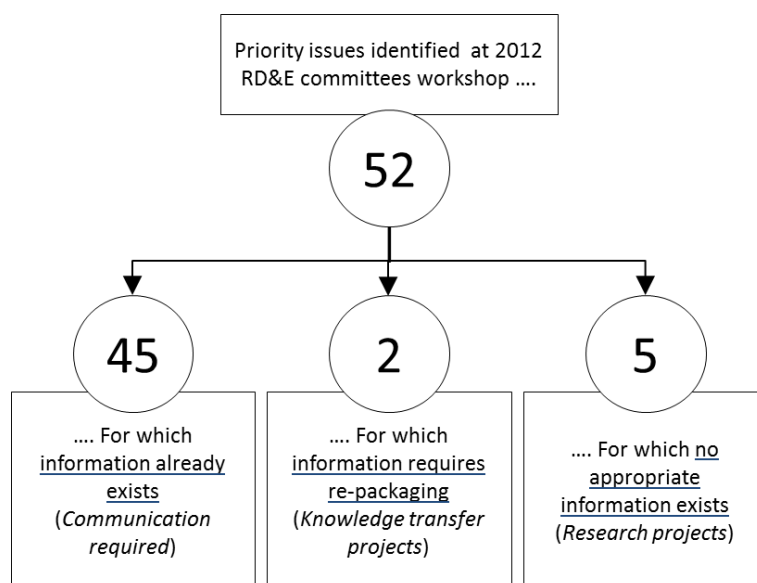


Figure 3. Categorisation of 2012 stakeholder issues. For the 52 issues prioritised by stakeholders at the 2012 RD&E Committees Workshop, sufficient information existed to provide solutions to 45, while seven new projects commenced in 2013 as a direct consequence of the issues raised.

Managing expectations: communication

The issues informing the annual SASRI R&D programme are those that have been prioritised by stakeholders and, as a result, the institute makes every effort to provide the required information and advice timeously. As SASRI cannot address every issue simultaneously for practical reasons, communication with stakeholders on these matters is managed carefully. Subsequent to the annual RD&E Committees Workshop, each issue is discussed in depth in SASRI specialist forums, which results in the formulation of comprehensive feedback documents for each of the ten RD&E Committees shown in Figure 2B. These communiqués provide a detailed specialist response to each of the issues raised and indicate, where appropriate, how the issues are to be addressed in the annual SASRI work programme, whether it be research, technology development or knowledge transfer. Such feedback is reinforced through participation of the SASRI research management team in regional meetings of the RD&E Committees, at Grower Days and during SASRI Director's Visits. By means of this communication plan, SASRI strives to keep stakeholders and their elected representatives abreast of the nature and specific relevance to them of the SASRI R&D programme.

Innovation for sustainability

To maintain balance according to accepted norms for agricultural research institutes (Pannell, 1990), approximately 70% of the SASRI R&D portfolio is comprised of projects that are directly responsive to stakeholder RD&E priority issues, with the remaining 30% focusing on applied research of a more exploratory or strategic nature. The latter research has a focus on issues that might affect the long-term sustainability of the SA sugar industry, including potential impacts of predicted climate change scenarios on sugarcane agriculture and the breeding of abiotic stress-tolerant varieties by means of molecular¹ and introgression² technologies. Two further major areas of current strategic research focus are the investigation of near-infrared (NIR) and sterile insect technique³ (SIT) technologies to enhance sugarcane variety selection and *Eldana saccharina* integrated pest management (IPM) strategies, respectively.

As for adaptive research and technology development (Table 2), stakeholder consultation and participation play an important role in determining the nature and direction of exploratory and strategic applied research in the SASRI R&D annual work plan. Such involvement is based on the SASRI strategic plan that was developed in 2007 by elected members of the industry leadership, working together with the SASRI leadership team that was comprised of SASRI senior managers and specialists. Key areas of performance and associated measures of delivery were agreed upon, and it is these that now form the overarching framework of the SASRI R&D Programme.

¹ Modern plant breeding makes use of molecular biology technologies to select or insert desirable traits into crops. SASRI is active in the development and verification of technologies for marker-assisted breeding, genetic engineering and mutagenic breeding.

² Introgression in plant genetics refers to the movement of a gene from one species into the gene pool of another by the planned and repeated backcrossing of an interspecific hybrid with one of its parent species. To enhance potential variety biomass yield, stress tolerance and pest and disease resistance, SASRI is to embark on the crossing of varieties with sugarcane ancestral species (e.g. *Saccharum officinarum*, *S. spontaneum*) and close relatives (e.g. *Miscanthus*, *Erianthus*).

³ Sterile insect technique (SIT) is a method of biological control, whereby overwhelming numbers of sterile male insects are released (the insects are mostly sterilised with radiation). The sterile males compete with the wild males for female insects. If a female mates with a sterile male then it will have no offspring, thus reducing the next generation's population. Repeated release of insects can eventually wipe out a population, though it is often more useful in controlling the population rather than eradicating it.

Much of the applied research falling under the exploratory and strategic categories is conducted in-house at Mount Edgecombe, often with participation from the SASRI cohort of post-graduate students and post-doctoral researchers. Facilitating this are the honorary academic or research positions held by a SASRI principal and senior scientists at South African universities, which permit the on-site location and supervision of post-graduate students, at MSc and PhD level, and post-doctoral fellows at Mount Edgecombe. The increased capacity and insights that are accrued from this programme greatly enhance the scope of exploratory and strategic applied research in the SASRI R&D programme.

R&D synergies: partnerships and collaboration

In some instances, the nature of the research required to support industry innovation demands expertise and resources that are beyond those available in South Africa or at SASRI. As a result, the institute, on behalf of the industry and SASA, participates in research consortia and enters into formal agreements with research service providers. For example, the institute was a founder member of the International Consortium for Sugarcane Biotechnology (ICSB), the International Consortium for Sugarcane Modelling (ICSM) and the Sugarcane Genome Sequencing Initiative (SUGESI). The ICSB was established in 1992 and currently has 17 member organisations representing 13 sugarcane growing nations (Argentina, Australia, Brazil, Colombia, Ecuador, France, Guatemala, India, Mauritius, South Africa, Thailand, the United States of America and the West Indies). Since the inception of the ICSB, SASRI has supported 22 projects, which have produced valuable outcomes, including: (1) technologies that are currently supporting the development of DNA markers linked to pest and disease resistance in sugarcane; (2) DNA markers linked to a major gene conferring resistance to brown rust; (3) methods for detecting the pathogens that cause Yellow Leaf Syndrome (YLS); and (4) resources and technologies that have enabled sugarcane variety DNA fingerprinting. More recently, SASRI has co-funded ICSB projects that will lay the foundation for the elaboration of the SUGESI objective of sequencing of gene-rich regions of the sugarcane genome⁴ to encompass the entire genome. Ultimately, it is likely that availability of the sugarcane genome sequence will lead to advances in variety improvement potentially similar to those that have occurred in rice since the *Oryza sativa* ssp. *indica* and *O. sativa* ssp. *japonica* genome sequences became available in 2002 (Feuillet *et al.*, 2011).

In addition to research consortia, the institute has entered into formal agreements with South African universities for the provision of specific research competencies, for which sugarcane supply chain logistics research at the University of KwaZulu-Natal and sugarcane metabolic engineering research at Stellenbosch University are good examples. A further advantage of these relationships is that the university researchers are eligible for the receipt of matching funding from the Technology and Human Resources for Industry Programme (THRIP) of the Department of Trade and Industry, a programme that aims to foster closer links between academia and industry. The leveraged funding enables an enhanced research scope, which is of benefit to the industry partner, and improved post-graduate student training throughput and research infrastructure development for the academic partner. Through these partnerships, the industry has achieved a greater capacity for resolving problems related to cane transport for processing and has recently co-licenced with Stellenbosch University an experimental sugarcane gene technology for higher sucrose content to a leading multi-national agrobiotechnology company.

⁴ The genome is the entirety of an organism's hereditary information encoded by DNA and includes both the genes and the non-coding sequences of the DNA.

Technology design and transfer: reverse engineering

The term ‘reverse engineering’ broadly refers to the deduction of design decisions from end products and originated in the analysis of hardware for commercial or military advantage. The concept also resonates with agricultural researchers, in that consideration of the end-product desired by the farmer or extension specialist should precede and inform the research approach to be used. Not only should the formulation of a recommendation, product or tool be based on close and continual interaction amongst researchers, extension specialists and farmers, but so should the intended strategy for transfer of the technology to the end-user.

The SASRI R&D portfolio comprises projects spanning research, technology development and knowledge transfer and, as such, project outcomes are at varied levels of readiness for delivery to end-users. For example, products of knowledge transfer projects are specifically designed for immediate delivery, while outcomes from research projects are frequently more removed from end-user application. In many instances, research projects give rise to technology development projects or knowledge transfer projects in order to facilitate technology transfer. At SASRI, however, knowledge transfer plans are integral to the planning of all research and technology transfer projects, which ensures that research is conceived and conducted with a clear vision of how project outcomes will ultimately be of practical value to target end-users. This ‘reverse engineering’ of research is increasingly based on information gathered during workshops and interactions with target end-users during the planning or initial phases of projects.

Full integration across entire R&D value chain

The formal project management system on which the SASRI R&D programme is founded permits a high level of integration and flexibility in the design and execution of projects that aim to deliver outcomes that add value to the industry. Not only are multi-disciplinary scientific approaches to solve complex agricultural problems facilitated by the system, but full integration across R&D, agricultural economics, knowledge management and extension functions are also attainable (Figure 4). Integration of economic considerations during project development was previously through collaboration with CANEGROWERS. However, at the request of the industry, this important aspect of project design has now been further entrenched by the appointment of a research economist to the staff of SASRI.

Researchers, a research economist, knowledge management practitioners and extension specialists are involved in the conception of research projects, which ensures that focus is maintained on the delivery to stakeholders of relevant, practical and cost-effective agricultural solutions.

Promoting relevance and quality

Before implementation, the proposed annual SASRI R&D programme is scrutinised by representatives of the sugarcane growing and sugar milling sectors. These industry principals consider whether the proposed project portfolio: (1) is aligned with the industry strategic vision; (2) addresses the needs of their constituencies; (3) is sufficiently focused on issues that might impact on industry sustainability; and (4) represents a judicious investment by the industry. Once stakeholders are sufficiently assured on these matters and any concerns have been addressed, the R&D programme proceeds to implementation.

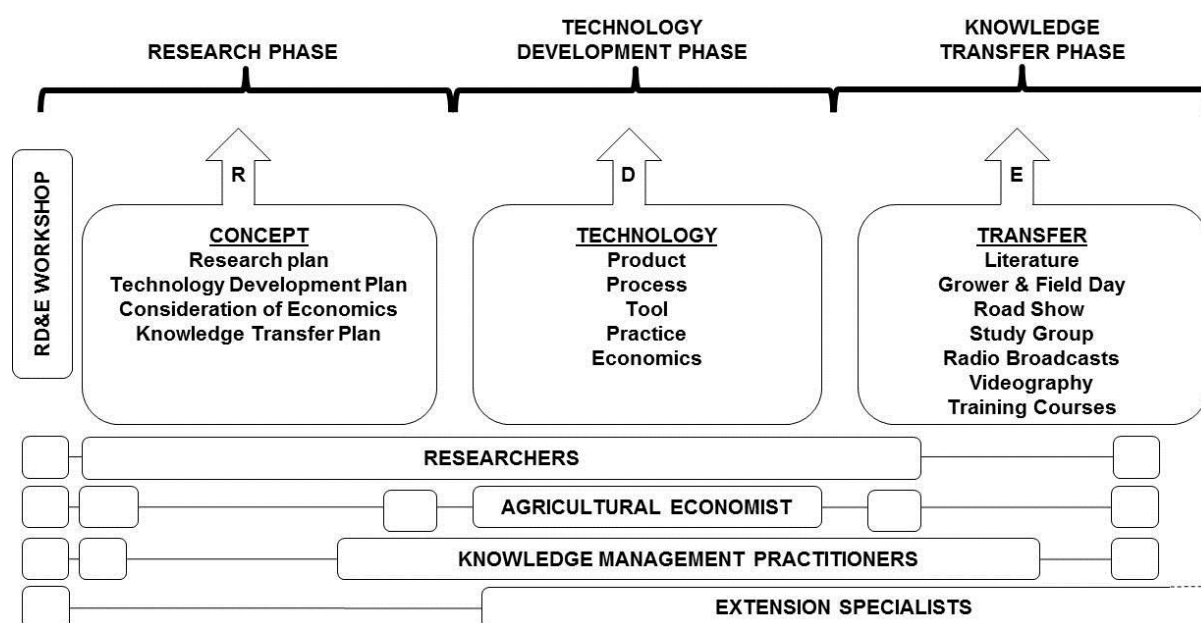


Figure 4. The SASRI research, technology development and knowledge transfer continuum. The diagram depicts the continuum from concept development in response to issues raised during the annual RD&E Committees Workshop and the subsequent research, technology development and knowledge transfer activities. Research, Agricultural Economics, Knowledge Management and Extension practitioners work together to ensure the delivery of knowledge products and technologies appropriate to identified stakeholder needs.

As a further quality assurance measure, each of the four research programmes (see Table 1) is subjected to external review every four years. A panel of three international and national experts in relevant disciplines are invited to review the programmes according to specific terms of reference that address scientific rigour, quality and level of innovation, benchmarked against international standards and trends, as well as perceived relevance of the programme to industry needs and the associated delivery of value. The outcomes and recommendations of these reviews are presented to the industry leadership for noting and comment, after which pertinent recommendations are used to inform the development of subsequent annual R&D work programmes. This review process serves as an important means to assess programme performance in key areas according to industry requirements and international scientific and technological developments.

High calibre research expertise is central to the success of the SASRI R&D programme and, as such, provision of support for the career development of SASRI scientists and technologists is an important objective of the institute. To benchmark their standing as scientists against national and international norms, scientists at the institute participate in the evaluation and rating mechanism of the National Research Foundation (NRF). Of note is that six SASRI scientists have been awarded a rating by the NRF, which represents 38% of the scientists eligible for rating. SASRI scientists have also been appointed into 13 honorary academic or research positions at four South African universities, which serves to increase research capacity at the institute through on-site supervision of 19 post-graduate students and post-doctoral fellows. These appointments are also a reflection of the standing of SASRI scientists in South Africa, as the criteria for an honorary appointment are the same as those which apply for all university permanent academic appointments. Of note is that five of the SASRI honorary appointments have been at the professorial level.

Challenges: catering to the needs of the changed and changing industry and national landscapes

Industry commitment to transformation of the South African scientific milieu

SASA and the SASRI division are committed to the principles of redress, equal opportunity for all South Africans and the creation of an internationally competitive science and technology economy. As part of this commitment, SASRI has since 2006 engaged actively, through the Agricultural Sector Education and Training Authority (AgriSETA), in the learnership programme of the Department of Labour and has hosted numerous research internships since that time. For example, SASRI currently hosts 18 research interns, many of whom are expected to either progress to post-graduate studies at SASRI or secure permanent employment at SASRI or elsewhere. The success of the interns hosted by SASRI has been facilitated by the standards of excellence in science and technology research and development espoused by the institute and its scientific staff.

In concert with mechanisms of the national Departments of Labour, Science and Technology and Trade and Industry, SASRI and its scientists strive to promote the sustainability of the South African sugar industry through research and development outcomes and also, more broadly, to contribute to the science and technology base of South Africa. For example, for the period 2000 to date, SASRI scientists have successfully supervised the research of 43 post-graduate students (9 BSc Hons/BTech, 26 MSc, 9 PhD), a number of whom now occupy leadership positions in the South African science and technology economy. Of this cohort of graduates, 19 were from designated South African population groups (10 Black, 1 Coloured and 8 Indian graduates), while 32 (74%) were female. In the same period, SASRI scientists have published in excess of 73 scientific articles in journals accredited by the Institute for Scientific Information (ISI), thereby elevating the international profile of SASRI and the industry it serves.

In diversity lie strength, resilience and opportunity

Diversity is a hallmark of the South African sugar industry, both in terms of the composition of the grower sector and the current strategic intent of the industry to diversify and harness the full value of the crop biomass. Arguably, different approaches to sugarcane cultivation and processing within a single industry add strength and resilience to the system, and also enhance economic opportunities and prospects for the medium to long term sustainability of the industry. However, as primary provider of agro-technical expertise and services to the industry, SASRI is faced with a number of challenges in catering for such diversity.

Technology transfer: alignment with realities

The advancement of technology adoption amongst sugarcane growers is fraught with a number of challenges. Differing degrees of experiential knowledge exist amongst growers, and geographic dispersion is coupled with differing agro-climatic zones requiring tailoring of varietal and agronomic advice. Language differences, low levels of literacy and cultural differences all play a role in forming and moulding the technology transfer strategy of the institution. In addressing these challenges, it is recognised that the technology transfer efforts of the organisation require deliberate and careful crafting, taking into consideration the most appropriate form or manner of interaction required to deliver effective transfer of knowledge or technology. This is a growth area for the institute and one which will receive considerable attention into the future.

Language differences amongst stakeholders are currently addressed through the provision of regular publications in English and isiZulu, with occasional articles in Afrikaans. A suite of publications, with differing levels of technical content, are also available to address the diverse readership of the industry as well as the different knowledge and skills levels. Apart from printed publications, videos serve as excellent media for sharing best practice. SASRI maintains a suite of training videos in both English and isiZulu with the intent to deliver a graphically pleasing product that holds the interest of its audience. Regional grower days and face-to-face interactions are a regular feature in the SASRI calendar and provide regionally-focused advice, knowledge sharing and personal contact opportunities for researchers, extension and stakeholders. These forums are used to develop trust and personal relationships which are important elements for technology adoption. Cultural differences are respected through observing the correct protocols during contact events. For example, grower days in the small-scale grower areas will often see growers and Extension Specialists sharing a meal together. With 89% of the rural population in South Africa having access to radio, this medium is being used very successfully to broadcast agronomic advice to isiZulu speaking growers. Staff from Knowledge Management and Extension present regular programmes on ten radio stations, mostly community radio stations, as well as the national broadcaster Ukhozi FM. The popularity of this medium is high, demonstrated by the frequent phone calls received during live broadcasts.

Technology transfer efforts also require a fair degree of resilience towards the resistance to change. In addressing this challenge, the technology transfer efforts of the institute take cognisance of this fact by developing convincing arguments backed by scientific data that demonstrate the value of best management practices, both in terms of profitability and productivity. While the challenges for effective technology transfer are diverse, so too are the various mechanisms through which knowledge and scientific know-how are expressed. SASRI is committed to exploring new tools and new communication technologies that will be effective in addressing a diversity of growers and their needs.

Changing role of extension

Agricultural extension is a general term used to describe the application of scientific research outcomes and new knowledge to the improvement of agricultural practices through ongoing two-way communication between research service providers and farmers. Hence, critical to effective extension is the availability of tailored knowledge transfer products and appropriate vehicles for two-way communication with growers. Due to the diversity of pressures and challenges faced by modern agricultural enterprise, extension now also encompasses communication of information sourced from a wider range of disciplines, including those associated with the environmental and social sciences, economics and business studies.

The extension function at SASRI was established in 1964 and remains central to the effective delivery of value by the institute to stakeholders from the grower and miller communities. Since that time, extension has continued to serve as the critical interface between the researchers and stakeholders; with this ongoing and increasingly close relationship representing a major and, arguably, unique strength of the industry. In addition to close articulation between research and extension, SASRI has also ensured integration of the knowledge management function, such that the institute functions as a continuum of research, technology development, knowledge transfer and extension. Of course, such integration is ultimately meaningless if not appropriately focused, and it is in this area that the ten regional RD&E Committees and the industry focused and mandated strategic plan are essential.

Working in concert, the SASRI continuum of functions, RD&E mechanism and SASRI strategic plan are focused on the transfer of R&D outcomes to promote grower and industry sustainability.

Farming conditions in South Africa have become extremely challenging in recent years. Modern extension is required to support the grower in meeting multiple challenges, including economic, social and environmental demands, which requires a new set of skills and methodologies. The challenge to extension is to play the role of 'enabler', to create opportunities that enable the grower to satisfy a range of needs in a combined or co-ordinated manner. It is essential that extension moves away from the more traditional instructive type role of imparting new technology of 'what and what not to do', to an interactive role that embraces dialogue amongst growers, extension, researchers and other role players. Participation by the growers encourages ownership and belief in the technologies, and encourages empowerment to foster effective change. All grower needs must be clearly understood by extension, irrespective of race or culture, to enable extension to provide the right type of service. This may require bringing in other role players, should SASRI extension not have the necessary skills to provide the answers.

While it is apparent that the sugar industry has all the required tools to provide a successful extension service, they require co-ordination and reorganisation. SASRI extension is very well positioned and experienced to play the role of co-ordinator for the industry. All the relevant service providers and stakeholders need to be identified and brought together. It is envisaged that a multi-party type joint venture with the various role players is required, that encompasses all growers in the sugar industry under a single amalgamated extension service operating through the RD&E committees.

Economics: the constant factor

The development of SASRI varieties, recommendations, best management practises, decision support tools and advice is based on a comprehensive analysis of stakeholder needs, followed by the rigorous application of the scientific method to uncover appropriate agro-technical solutions. Subsequent transfer of these products to end-users is based on sound knowledge transfer and extension practice. Ultimately, however, the adoption of SASRI products by individual stakeholders is frequently driven by the unique economic context in which the end-user operates. Consequently, economic considerations should be central to the SASRI research, technology development, knowledge transfer and extension continuum, and SASRI frequently collaborates with CANEGROWERS in this regard. However, in recognition of the central role played by economic considerations in technology adoption, the industry recently supported the appointment of a research agricultural economist to the SASRI specialist staff. The appointment has empowered SASRI to further ensure that all agro-technical solutions provided to stakeholders are based on thorough and sound consideration of economic implications throughout the entire R&D value chain, from recommendation to adoption to adaptation. The institute is confident that this recently expanded capacity will promote adoption of SASRI technology and, ultimately, enhance industry sustainability into the future.

Concluding comments

Support of SASRI by the South African sugar industry over the past 88 years has resulted in a modern, lean, dynamic and flexible sugarcane agricultural research institute that is responsive to stakeholder needs, focused on long term industry sustainability and operating at the cutting

edge of science and technology. The complexity of the agronomic, economic, social and socio-political environment in which the industry now operates is unprecedented and, by virtue its unflagging support, the industry has empowered SASRI to provide agro-technical solutions that will assist in embracing these challenges into the future. The current research, technology development, knowledge transfer and extension systems and capacity, together with a renewed focus on providing cost-effective solutions and an enabling extension service to Stakeholders, will assist SASRI in moving towards the bold vision of being ‘the recognised global leader in innovative sugarcane research at the forefront of a thriving industry’.

Acknowledgements

The authors would like to thank the representatives of the grower and miller communities who give of their time to serve on regional RD&E Committees. Without this commitment and generosity, SASRI’s delivery of meaningful R&D outcomes to the industry would be severely compromised. The authors acknowledge the commitment and excellence of all SASRI staff, past and present, whose efforts and hard work have contributed over the years to the proud reputation of the institute.

REFERENCES

- Anon (2012). South African Sugar Industry Directory 2012/2013. Annual publication of the South African Sugar Association, Mount Edgecombe. 49 pp.
- Feuillet C, Leach JE, Rogers J, Schnable PS and Eversole K (2011). Crop genome sequencing: Lessons and rationales. *Trends Plant Sci* 16: 77-88.
- Fischer G, Texeira E, Hizsnyik ET and van Velthuisen H (2008). Land use dynamics and sugarcane production. pp 29-62 In: Zuurbier and van de Vooren (Eds), *Sugarcane Ethanol. Contributions to Climate Change Mitigation and the Environment*. Wageningen Academic Publishers.
- OECD-FAO Agricultural Outlook 2011-2020 (2011). Chapter 6: Sugar. Publication of the Organisation for Economic Co-operation and Development, Paris, and the Food and Agriculture Organisation of the United Nations, Rome. pp 119-132.
- Pannell DJ (1990). On the balance between basic and applied agricultural research. *J Agric Res Econ* 43: 91-113.
- 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.