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2022 RDE COMMUNIQUÉS

FEEDBACK TO REGIONAL RDE COMMITTEES

SOUTH AFRICAN SUGARCANE RESEARCH INSTITUTE
MOUNT EDGECOMBE

Unlocking The Potential of Sugarcane

Website: http://www.sugar.org.za

PREFACE

Contained within these pages are informative communiqués from SASRI specialists on the topics raised in 2022 by representatives of the regional RD&E committees from the northern irrigated regions of the industry. In instances where essential knowledge is lacking, certain issues have led to proposals for new projects for implementation in 2023/2024, subject to funding approval by the industry. These new projects are highlighted in the document. In addition, due to the complexity of some of the topics raised, communication more comprehensive than that contained within these communiqués is required. In these instances, a brief description of communication planning is also provided.

The 2022 RD&E Committees' workshop was held on the RCL Tenbosch Estate in Komatipoort on 8 March 2022 and hence, issues relevant to sugarcane cultivation under irrigated conditions predominate in this document. As agreed by the RD&E committees, the annual workshops will alternate between the irrigated and rain-fed regions, with the next workshop planned for Mount Edgecombe in March 2023.

ACKNOWLEDGEMENTS

SASRI would like to thank the representatives of the grower and miller communities who give of their time to serve on regional RD&E committees and participate in the annual workshops. Without this commitment and generosity, SASRI's delivery of meaningful research outcomes to the industry would be severely compromised.

Thanks go to RCL Foods Sugar and Milling (Pty) Ltd for generously allowing SASRI to use the RCL Tenbosch Estate lapa as the venue for the 2022 RD&E Comittees' Workshop.

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VARIETIES, CROP MANAGEMENT AND DIGITAL AGRICULTURE

1. Round-up ready sugarcane and where are we with this?

Priority Topic

No

SASRI Response and Action

The SASRI biotechnology facility is developing genetically modified (GM) sugarcane that is eldana resistant [via expression of the bacterium *Bacillus thuringiensis* (Bt) CRY proteins] and tolerant to the imazapyr-containing herbicide, Arsenal Gen 2 (BASF) effective at controlling creeping grasses. Current progress includes optimising genetic constructs and assessing GM lines in eldana bioassays in the shadehouse.

Glyphosate tolerance (i.e., Roundup Ready) was not supported by growers as a trait for introduction via GM technology as it was desirable to retain the herbicide efficacy to kill off cane during minimum tillage practices.

For further information contact Dr Sandy Snyman (Principal Scientist: Biotechnology; Manager: Variety Improvement Research Programme) (Sandy.Snyman@sugar.org.za).


Dr Sandy Snyman

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2. Pongola and Irrigated Regions: High yielding and high RV varieties - issues of carry-over cane – all-round varieties broadly adapted in all seasons.

Priority Topic

Yes

Background

All-round varieties (not early/late season). Can new varieties be developed with good RV yield throughout the season e.g., like N49, N53 and N36?

Desired Outcome

Varieties that can be harvested throughout the season with high TRV/ha and less focus on early and late season and must have a good P&D profile, good ratooning ability (e.g., like N23) and proven performance pre-release in the local area.

SASRI Response and Action

The challenge to developing all round (i.e., widely adaptable) varieties for the irrigated regions has been the limited testing sites in the current variety trials testing network. Irrigated varieties are currently tested in two trials at the Mpumalanga Research Station near Komatipoort, two trials planted at Pongola Research Station and one trial at Delmont farm. The SASRI Research Stations are high yield sites on uniform and good soils. These soils, while representative of some parts of the industries may not be representative of the shallow, sandy and other poorer soil types prevalent in parts of the industry in Pongola, Komati, and Malelane areas. Because 80% of the trials are based on SASRI Research Stations, the results may not necessarily represent the performance of the varieties when grown in those areas that have poorer growing conditions in the industry. Therefore, to develop all round varieties, there is a need to test varieties at sites that are more diverse than the current testing sites. Further, it's important to note that breeding programmes improve by accumulating genes from germplasm populations. Therefore, when testing is done on diverse sites

to develop all round varieties, future parents that are more broadly adapted will be developed and further used as sources of genes to develop more broadly adapted varieties, thus creating positive feedback for development of the varieties required by the industry.

Recently, approval has been granted by SASRI management to establish the required diverse testing sites for the irrigated breeding programme. Currently, efforts are being made to establish new sites: two in Pongola, one each in Komati and Malelane. The two potential sites identified in Pongola have been through the assistance of the Extension Specialist in the region and the local grower leadership. Of these two possible sites, one is high potential, and the other is average potential. A further two sites will be sourced in Mpumalanga with the assistance of Extension Specialists in the region and will be set up to represent the environments in the Mpumalanga irrigated region. Trials will be established at these new sites starting in 2023 and late and early season trials will be planted at each site. It is expected that the results from trials planted in 2023 will be available in 2027 to provide a full evaluation of the broad adaptability of genotypes in the irrigated breeding populations and start to guide future of breeding for all round varieties. Thereafter, all round varieties will begin to emerge, and these will be recommended for release.

Efforts are also being made to test the existing irrigated and rainfed varieties in Pongola, Malelane, and Komati areas through the Variety Evaluation programme. Two trials (early and late season) were planted in Malelane under the same soil type with the same varieties tested for both early and late season harvesting. Two more trials will be planted in Komati with similar objectives to the Malelane trials. The trials will investigate the performance of the current released variety adaptability to both early and late season harvesting. Varieties that have an ability to consistently perform well both in early and late season over three to five crops cycles will be recommended to the growers, while efforts are being made by plant breeding to develop all round varieties.


Dr Marvellous Zhou

A communication plan has been developed to improve knowledge exchange on this topic.

For further information contact Dr Marvellous Zhou (Senior Scientist: Plant Breeding; Manager: Plant Breeding Project).

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3. Fast maturing varieties that can be harvested at young age.

Priority Topic

No

SASRI Response and Action

Growers have expressed interest in fast or early maturing cultivars (i.e., 10-12 months) in the irrigated regions. The expectation is that early maturing cultivars must produce high cane yield and high RV% at 10 to 12 months. These cultivars will enable growers to harvest cane at 10 months and will result in higher productivity over time, equivalent to four crops in three years thereby increasing profitability in their farming businesses. These cultivars are expected to be broadly adapted or all round varieties and therefore less sensitive to time of harvest and thus can shift from early to mid to late harvest with no penalty on cane yield and sucrose content.

It must be noted that pre-harvest sampling either by testing brix content of stalks or using mill-room samples will be required to estimate the maturity of the varieties tested in the Plant Breeding trials. Pre-harvest sampling will also be done for cane yield based on the established protocol for non-destructive sampling used in early stages of Plant Breeding trials. Non-destructive sampling to estimate cane yield is based on a calculation using number of stalks, stalk height and stalk diameter. The combined analysis of the data from cane yield and RV% estimate will provide insights into the

potential suitability of genotypes in trials for early maturity. This approach will be implemented in trials established now and all future trials when the budgets for the extra data collection is approved.

The second approach to develop early maturing varieties requires increasing the genetic background for the population. This will be done by increasing the import of early maturity germplasm from the USA, especially Canal Point and Louisiana, where the breeding programmes have been successful at producing cultivars that mature at 8 - 10 months. These cultivars produce high cane yield and high RV% and could provide an ideal source of genes for early maturity to a subset of SASRI irrigated breeding programmes as part of the efforts to breed for early maturity. The expected strategy is to produce early (10 - 12 months) and normal maturity (12 months) options in the mix of cultivars produced for the irrigated regions.


Dr Marvellous Zhou


Thobile Nxumalo

For further information contact Dr Marvellous Zhou (Senior Scientist: Plant Breeding; Manager: Plant Breeding Project) or Thobile Nxumalo (Scientist: Variety Evaluation).

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4. Demonstration of pre-release varieties at later stages of plant breeding / more locally sited variety evaluation trials.

Priority Topic

No

SASRI Response and Action

This topic was discussed at a grower day in Pongola in March 2022. Currently, all promising genotypes are planted in plots suitable for showcasing at Grower days. These plots are planted at Pongola (PRS) and Mpumalanga (MPRS) Research Stations alongside plant breeding trials, where Grower days will be held annually. In addition to demonstrating the performance of promising genotypes, the Grower days will also be used to explain the breeding strategy and efforts towards the development of higher sugar yield cultivars and early maturing cultivars. These events will evolve to include Grower days at the new sites on grower farms to show the differences in promising genotypes under different growing conditions. The grower events will be carried out at all SASRI Research Stations hosting Plant Breeding programmes. The events will be part of increasing grower awareness, participative research in the breeding programmes and will be used by the breeders to solicit grower variety needs and feedback to enable adjustment of the Plant Breeding strategy to adequately address grower needs.

It is envisaged that the Grower days will also provide grower input into the release of varieties. Grower comments and views will form part of the discussions when the Variety Release Committee (VRC) considers genotypes for release. Further, the grower input and awareness of genotypes being recommended for release will increase the anticipation and knowledge of the potential of the new varieties and is expected to increase new variety uptake and adoption. Grower days at the various sites will enable growers to benchmark their own environments with those of the sites and guide the best choice varieties for their own farms.


Dr Marvellous Zhou

For further information contact Dr Marvellous Zhou (Senior Scientist: Plant Breeding; Manager: Plant Breeding Project).

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5. Annual updates of variety information sheets.

Priority Topic

No

SASRI Response and Action

Variety information sheets are prepared when a new variety is going to be released. At that stage, plant breeding data is the only information available. Approximately three years after release, new information is generated in the Variety Evaluation project on the newer varieties. This information is disseminated to the growers via different platforms (e.g., grower days, study groups, newsletters from Extension Specialists etc.).

The development of the online Variety Guide tool (SASRI project 17TD01), which is currently available to local Extension Specialists, has made it easier to update all variety related information as new information becomes available. The Variety Guide tool assists with the choice of variety for different growing conditions. The tool is constantly updated with new information whenever it is available and is linked to an existing project (19KE06) which aims at reviewing and updating all existing publications on varieties. In addition, the current data from plant breeding and variety evaluation trials was re-analysed by July 2021 and the Variety Guide tool was updated in October 2021. The same information available in the Variety Guide will packaged and presented in the Information Sheets and variety booklet during the next few months. Moving forward, the data will be analysed annually and updated frequently or whenever there is new information available.


Dr Marvellous Zhou


Thobile Nxumalo

For further information contact Dr Marvellous Zhou (Senior Scientist: Plant Breeding; Manager: Plant Breeding Project) or Thobile Nxumalo (Scientist: Variety Evaluation).

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6. Herbicide screening trials.

Priority Topic

Yes

Background

Herbicide tolerance of newer varieties is not known, growth stunting in some varieties are severe.

Desired Outcome

Knowledge on herbicide sensitivity of new SASRI varieties

SASRI Response and Action

A survey is being developed to review the use of herbicides in the industry. The survey will assist with investigating the potential cause of concern and determine the extent of the problem. Points to be included in the survey will focus on the type of herbicides applied, method of herbicide application and the varieties that are affected. Information gathered will provide valuable insights that could potentially be incorporated in future variety trials.

A communication plan has been developed to improve knowledge exchange on this topic.


Anushka Gokul

For further information contact Anushka Gokul (Scientist: Agrochemicals).

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7. More testing of dryland varieties with good P&D characteristics in the irrigated north e.g., N41, N55, N72.

Priority Topic

No

SASRI Response and Action

The interest in dryland cultivars for irrigated regions is largely a symptom reflecting the slow release of cultivars for the latter region. Historically, N41 is the only dryland variety that excelled in irrigated regions and few genotypes tested have shown promise in recent years. When more irrigated cultivars with higher sugar yield potential are released, this interest is expected to decline. Presently, dryland varieties are being tested: (a) in Variety Evaluation (VE) trials as requested by growers; and (b) in irrigated Plant Breeding trials as part of the genotype transfer system. In addition, testing promising genotypes across regions will continue as part of Plant Breeding trial testing strategy.

Further analysis and evaluation of Plant Breeding data will be used to predict genotypes that are likely to show promise in other areas of the industry outside the regional breeding environment. Previous research (Zhou, 2018) has shown certain trait combinations impart adaptability to environments and this knowledge will be used as a guide.

Reference

Zhou, M.M. (2018). Using logistic regression models to determine optimum combination of yield components among sugarcane breeding populations. *South African Journal of Plant and Soil 2018: 1-9.*

For further information contact Dr Marvellous Zhou (Senior Scientist: Plant Breeding; Manager: Plant Breeding Project) or Thobile Nxumalo (Scientist: Variety Evaluation).


Dr Marvellous Zhou


Thobile Nxumalo

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8. There is a need to maintain and identify suitable older varieties for P&D resistance e.g., N46 - KE issue - clean seedcane availability of the older varieties.

Priority Topic

No

SASRI Response and Action

Good quality seedcane in the form of NovaCane® plants can be ordered from either DuRoi or Dube AgriLab. However, it is noted that there are sometimes difficulties associated with the delivery of material from those service-providers. Extension Specialist, Marius Adendorff, enquired whether SASRI could provide seedcane. He has been advised to liaise with SASRI staff, Albert Walton, Mzo Mchunu and Sbonelo Shezi, at the Pongola Research Station to find out what seedcane sources may be available. Material would need to be fingerprinted and disease indexed prior to planting (Albert Walton [SASRI Selection Manager] to co-ordinate).


Kerry Redshaw

For further information contact Kerry Redshaw (SASRI Operations Manager).

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9. Identification of suitable niche areas for older varieties.

Priority Topic

No

SASRI Response

Most of the released varieties have been and are currently being tested in Variety Evaluation (VE) trials. A large yield data set is available from commercial crops, VE, and Plant Breeding (PB) trials.

Analysis of this data is expected to generate knowledge to guide and determine potential niche areas where the older cultivars continue to demonstrate commercial advantages. It is envisaged that the commercial data made available by the growers and from the mill will provide more insights into the potential niche areas where these cultivars will provide an advantage. Further, it is hoped that this analysis will provide insights into those niche areas where cultivars with different trait combinations are required. Such knowledge can be used to guide the breeding programme in identifying niche varieties for these environments so that benefits of higher genetic gains can benefit all growers. Some varieties may be recommended for niche areas, or where growers are located long distances from the mills or for small-scale growers or other specific environments.

Sophisticated statistical analysis using mixed models will be used to analyse the commercial data from several years as well as the data from VE and PB trials. This analysis has used commercial crop data for Illovo Malawi and Zambia as part of the SASRI variety exchange visits and produced results that provide recommendations for specific niche environments as well as all round cultivars in commercial production.


Dr Marvellous Zhou

For further information contact Dr Marvellous Zhou (Senior Scientist: Plant Breeding; Manager: Plant Breeding Project).

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10. Commercial evaluation of NovaCane© derived varieties.

Priority Topic

No

SASRI Response and Action

NovaCane® plants are disease-free sugarcane plants that have been reproduced by means of tissue culture techniques in a laboratory. Occasionally NovaCane® plantlets can develop into thin reedy plants that tiller profusely. These characteristics may make the plants susceptible to lodging far earlier than expected and create negative perceptions around the newer varieties particularly those varieties that may be more susceptible to lodging.

A project is being fast-tracked to investigate recent observations regarding high tillering and rapidly growing NovaCane© varieties where premature lodging events have occurred. These events are of major concern as the varieties are under scrutiny.

The project has various objectives:

- Investigate the conditions that lead to the occurrence of the premature lodging event/s.
- Investigate the existing protocols used for plantlet production and hardening off operations and identify possible interventions that may help to improve the health/resilience/rooting of plantlets for field propagation.
- Potentially establish a trial to compare various baseline (control) and intervention plots. Control plots will contain typically recommended planting of both existing (traditional) sett planting and NovaCane® planting operations.


Dr Peter Tweddle

For further information contact Dr Peter Tweddle (Agricultural Engineer: Mechanisation).

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11. What is the carbon footprint of sugarcane throughout the whole value chain?

Priority Topic

Yes

Background

Carbon footprint of sugarcane production for the whole value-chain, required for alternative uses of sugarcane e.g., jet fuel production.

Desired Outcome

Quantitative data on the carbon footprint of sugarcane – required by legislation.

SASRI Response and Action

A substantial amount of work has already been completed on this topic. For this reason, no immediate research is required. However, should there be some specific issue within the Agricultural portion of the sugar value chain that requires investigation, SASRI is available to assist with further research. In this communiqué, a summary is provided on what was done thus far and information that is readily available from the literature database.

In the context of South Africa sugarcane production, there are four independent studies that report on carbon footprints either for the entire value chain, or specific aspects within the agricultural sector. These studies are summarised below:

Mashako Study

In 2010, Mashako and co-workers (Mashako *et al*. 2010) conducted a Life Cycle Assessment (LCA) of the South African Sugar Industry. The study considered sugarcane farming operations, manufacture of fertilizer and herbicides, cane burning, sugarcane transport, as well as the production of raw sugar and co-generation of electricity in factories (electricity for internal use in the factory, not exported to the national electricity grid). The results, however, combined cane production (agricultural) and processing systems (factory). The last segment of the value chain, where processed sugar is sold in the various markets to consumers, are not included in the study. Furthermore, the agricultural input data reflected industry wide averages and does not consider regional differences. The study reported that 5350 MJ of non-renewable energy was consumed to produce a tonne of raw sugar, with 40% of this required for fertilizer and herbicide manufacture.

Boote Study

A study undertaken by Darren Boote and his colleagues in 2014 (Boote *et al*. 2014) aimed to investigate the on-farm primary energy used (electricity and diesel) in sugarcane production. For that reason, the calculations did not include agro-chemical production, soil emissions from fertilizer application, pre-harvest burning, sugar milling processes or raw sugar storage and transport to markets. In addition, the study made use of two case studies (supplementary irrigation in Umfolozi and full irrigation on SASRI's Pongola research station). For these reasons, the study is not necessarily representative or typical of the SA sugarcane industry. Nevertheless, the study reported that irrigation accounted for 68 and 81% of the total GHG emissions for Case Studies 1 (Umfolozi) and 2 (Pongola), respectively, even though they account for only 34 and 51% of the total non-renewable energy use.

van der Laan Study

In a study led by Dr Michael van der Laan in 2015 (van der Laan *et al*. 2015), an LCA approach was also used to look at the effects of improved management of cane production in an irrigated area of South Africa. They identified the potential for emissions reductions with more efficient management of irrigation and fertilization based on model data for cane growing in the irrigated Pongola area of South Africa. While the study focused on irrigated sugarcane production only, as shown in Figure 11.1, the LCA methodology accounted for determining the non-renewable energy use and associated carbon emissions for the manufacture and packaging of Agrochemicals, as well as sugarcane farming operations including mechanised operations, fertilizer and pesticide application,

pre-harvest burning, irrigation, harvesting and transport of cane to the mill. They also considered the effects on other environmental indicators including water consumption and eutrophication.

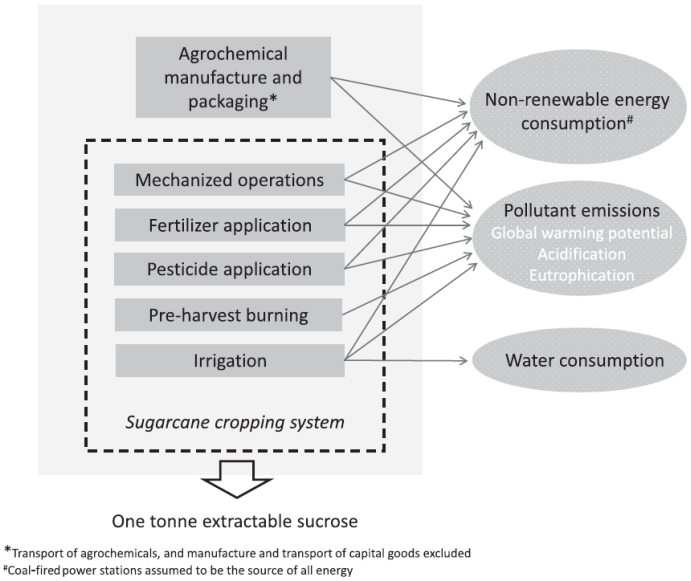

Figure 11.1

System delineation and operations involved: a broad flow chart (from van der Laan *et al*. 2015)

The study did not include factory processes or storage and transport of raw sugar to the marketplace. van der Laan *et al*. (2017) reported that the non-renewable energy input was 1685 MJ per ton sucrose, aligning to an equivalent of 383 kg CO_2 emissions for a baseline scenario where irrigation was not scheduled. In the baseline scenario, electricity use, fertilizer (manufacture, storage, transport and application) and burning before harvest contributed 31, 27 and 23% of the greenhouse gas emissions, respectively. Scheduling irrigation and adjusting Nitrogen fertilizer input down because of less leaching resulted in a 22% decrease in greenhouse gas emissions.

Pryor Study

Following the van der Laan study, Professor Scott Pryor and co-workers in 2017 (Pryor *et al*. 2017) published a more comprehensive and updated paper on the energy use and greenhouse gas emissions for South African sugarcane production. The study is considered to be more comprehensive, because life cycle assessments were conducted for both rainfed (North Coast: Amatikulu and Maidstone mill supply areas) and irrigated regions (Pongola and Malelane). In addition, those authors also considered combinations of green cane harvesting versus burning, as well as manual versus mechanical harvesting, for both the rain fed and irrigated regions. The study, however, did not consider factory operations to process sugarcane into sugar, or storage and transport of raw sugar to the marketplace.

As shown in Figure 11.2, the greenhouse gas emissions ranged from approximately 550 to 650 kg CO_2-e per ton sucrose for the range of production scenarios (rainfed vs irrigated, green cane vs burning & manual vs mechanical harvesting). The corresponding fossil fuel use amounted to ± 2600 – 3800 MJ per ton sucrose (results not shown).

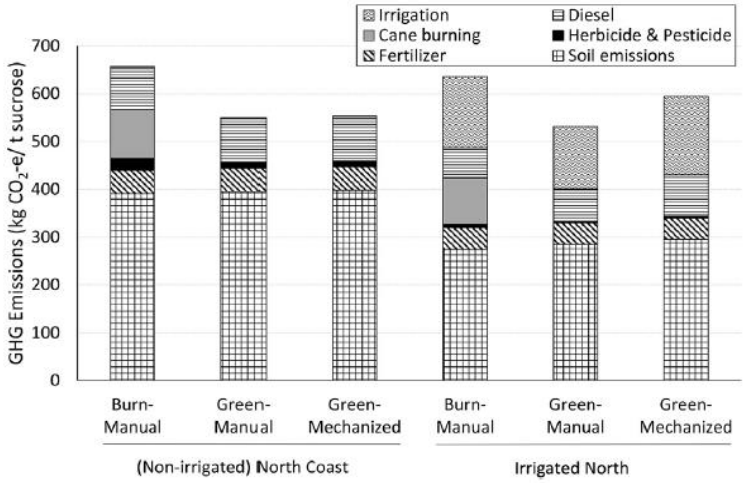

Figure 11.2

Contributions of input categories towards net greenhouse gas emissions for South African sugarcane production on the North Coast and in the irrigated North under different production scenarios (from Pryor *et al*. 2017).

Current LCA work at the Sugar Milling Research Institute (Dr Kitty Foxon)

In 2021, SASRI were requested by the Sugar Milling Research Institute (SMRI) to provide LCA inputs for the agricultural operations in sugarcane production. The SMRI in collaboration with Stellenbosch University is undertaking a project investigating the potential to diversify sugarcane processing to new products using green manufacturing techniques. This work will undertake life cycle assessments for the new product value chains but is not focussing specifically on the value chain for raw sugar (refer to Nieder-Heitmann *et al*. 2019 and Petersen *et al*. 2015).

Reference list and additional reading

- Mashoko L, Mbohwa C and Thomas VM (2010). LCA of the South African sugar industry. *J. Environ Plan Manag* 53(6): 793 - 807.
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- Pryor SW, Smithers JC and van Antwerpen R (2017). Impact of agricultural practices on energy use and greenhouse gas emissions for South African sugarcane production. *J Clean Prod* 141: 137 – 145
- van der Laan M, Jumman A and Perret SR (2015). Environmental benefits of improved water and nitrogen management in irrigated sugar cane: a combined crop modelling and life cycle assessment approach. *Irrig. Drain.* 64: 241 - 252.

A communication plan has been developed to improve knowledge exchange on this topic.

For further information contact Dr Rian van Antwerpen (Senior Scientist: Crop Nutrition and Soils; and Manager: Systems Design and Optimisation Research Programme) or Dr Ashiel Jumman (Agricultural Engineer: Irrigation).


Dr Rian van Antwerpen


Dr Ashiel Jumman

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13. Using remote sensing as a management tool for SSGs.

Priority Topic

Yes

Background

Use of remote sensing as a management tool for SSG. How to use it and get the most value out of it?

Desired Outcome

Detecting anomalies in crop performance that allows in field investigation. Development of a useful management tool and knowledge on what additional layers can be added to derive maximum value. A practical way of reporting back to the growers.

SASRI Response and Action

SASRI has commenced two projects that are exploring the use of geospatial (remote sensing and geographic information system) data and related technologies for this ultimate purpose. The projects are developing the necessary foundations for a variety of potential applications.

- Project 20SD02 aims to develop a workflow for delineating and monitoring of field boundaries. Accurate boundary information is key to modelling biomass and yield.
- Project 21SD01 seeks to develop a system for mapping and monitoring land cover and land cover change.

A pre-proposal for a new project to potentially start in 2023 has been developed. The aim of the study will be to develop an early warning system for detecting anomalies, that is plant stress. The stress may be primarily attributed to pests and diseases, but may also include water, salt, and nutrient related stress. The planned system should be able to provide for near real-time monitoring of sugarcane fields, alerting the user to anomalies that require further investigation.


Dr Nitesh Poona

For further information contact Dr Nitesh Poona (Scientist: Digital Agriculture).

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14. Using NDVI as a management tool.

Priority Topic

No

SASRI Response and Action

The Normalized Difference Vegetation Index (NDVI) provides a relative indication of plant vigour. NDVI values range from -1 to +1. In the context of vegetation/agriculture, high NDVI values (closer to 1) indicate healthy vegetation/crops, whereas low NDVI values (closer to 0) indicate unhealthy/stressed vegetation/crops. As a management tool, NDVI could be employed as an indicator of stressed cane; such stress resulting from irrigation, pests and diseases, or mechanical damage. The NDVI values alone cannot provide an explicit indication of the stressor/stress agent. Additionally, the NDVI must be used together with other vegetation indices for crop management. Nonetheless, SASRI is investigating opportunities to exploit the NDVI as a management tool.


Dr Nitesh Poona

For further information contact Dr Nitesh Poona (Scientist: Digital Agriculture).

15. More refined crop forecasting tool per field.

Priority Topic

No

SASRI Response and Action

Growers have two options for field level crop forecasting:

- MyCanesim Lite (https://sasri.sasa.org.za/agronomy/mycanesimlite/), a web and mobile app-based sugarcane simulation tool linked to the Canesim model and the SASRI weather database, offers easy to follow steps for simulating crop growth and water use. Applications include: cane yield; cane quality and water use benchmarking; and limited yield forecasting. The mobile version can be downloaded from Play Store and iStore.
- MyCanesim (https://sasri.sasa.org.za/agronomy/mycanesim/), a web-based sugarcane simulation tool linked to the SASRI weather and soil water data base for simulating crop growth and water use for registered users. Applications include cane yield, cane quality and water use benchmarking, real-time irrigation scheduling and yield forecasting.

A communication plan has been drafted to help raise awareness about these and related SASRI DSPs that sugarcane growers can use for yield forecasting and benchmarking.


Phil Sithole

For further information contact Phil Sithole (Agrometeorologist).

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IRRIGATION AND MECHANISATION

16. Matching irrigation systems to soil types: Planning, design, and management thereof. Irrigation systems – planning and design protocols are required to optimize irrigation systems to varying soil conditions.

Priority Topic

Yes

Background

Rising input costs: How to best match the irrigation systems to the soils to optimize profits (cost and returns). For example, when replanting, drip systems require complete replacement compared with pivots (multi crop cycles). Need to have a view of both economics and system requirements to compare the different irrigation systems. Eskom costs are high and escalating – thus there is an important need to optimize systems.

Desired Outcome

Determine broad principles to guide growers on the irrigation systems best matched to different soil types. Comparative cost reports for different systems. Assess irrigation system options (drip vs pivot

vs sprinkler or low-flow drip versus higher-flow drip) on a range of soil types. Identify long term cycle economics for the different options that farmers have.

SASRI Response and Action

A research project will be proposed to address this issue. The project will aim to evaluate the irrigation and associated life cycle costs (water, electricity, labour and maintenance) and crop yield performance for a combination of soils and irrigation design and management alternatives for a range of irrigation systems. To a large extent, the project will be a desktop study. A selection of soils will be incorporated in the study. Special attention will be given to soils which are typically difficult to irrigate (e.g., very low and very high clay %, shallow rooting depths and/or poor internal drainage). A range of irrigation systems will be designed and costed (Capital costs) for a reference site. Thereafter, for each soil type, the array of irrigation systems and the associated irrigation operating rules will be programmed into a crop model in order to simulate the yield performance and irrigation demand over the life span of the respective systems. The irrigation demand will be used to determine the operating costs of the systems (water, electricity, and labour), and yield will inform the revenue earned for each soil and system combination. Finally, a comparative analysis of Gross Margins (for each soil and system combination) will be conducted to develop broad guidelines and or recommendations for suitable systems, design and management alternatives, as well as levels of technology, for difficult soils.


Dr Ashiel Jumman

For further information contact Dr Ashiel Jumman (Agricultural Engineer: Irrigation).

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17. Probe management and scheduling: Best depletion levels based on irrigation system and system design capacity. To guide on probe placement to best represent the field conditions.

Priority Topic

Yes

Background

It has been noted from areas in the field where there are over irrigation/saturated conditions where the cane growth appears much better than the probe scheduling recommendations. Clarity and confidence building is sought on whether the (pre-determined) depletion levels using probe readings are optimal. Clarity on placing of the probes. What are the crop water requirements for different times of year and phases of the crop? Is 50mm per week enough in summer?

Desired Outcome

Need to evaluate whether the probe recommendations/calibrations (setting calibration lines) are correct. Validation on scheduling best practices when following current service provider recommendations. Clarification on placement and positioning of probes. Clarification on whether the irrigation system (design application rate) can meet peak crop water requirements.

SASRI Response and Action

Calibration of irrigation scheduling probes

A technology development project will be proposed to engage with this issue. The proposed project objectives are as follows.

1. To document explicitly the protocol used by capacitance probe suppliers and service providers to set the management lines on the software interface for irrigation scheduling.
2. To evaluate the current practice of setting management lines for irrigation scheduling with probe data only.

3. To develop recommendations for an improved/refined protocol for setting management lines for capacitance probes.
4. To evaluate the merits of installing probes vertically or at an angle for irrigation scheduling purposes.

The intention is to use laboratory techniques in soil physics to calibrate capacitance probes and soil water tension sensors in order to assess the current protocols for setting irrigation management lines (field capacity (full) line and allowable depletion (refill line)) in the probe software interface. Thereafter, various other refinements will be conceptualised and investigated (including in situ protocols and measurements) in order to develop recommendations for refining the process of setting the management lines for capacitance probes.

Placement and positioning of probe

While this issue will be investigated to some extent in the above-mentioned proposed project, SASRI is in the process of publishing an information sheet that provides guidelines and recommendations on this issue. The text below is a summary of the content in the new information sheet (5.17: Placement of soil water sensors for irrigation scheduling).

How many soil-water-measuring stations to install per field?

The criteria for selecting the number of measuring stations can include uniformity (or variability) of the soil, size of the total area to be scheduled, irrigation infrastructure (i.e., block layout/control area), cost of instruments, total time to read all sensors, maintenance of sensors, diversity of crops and crops with a similar age. There are therefore no definitive rules to guide the number of stations to be installed. The following can be used as a general guideline:

Uniform soils

I. In fields where soils are uniform in soil colour, depth and texture (clay %), **one monitoring station per irrigation control area (irrigation block) will be adequate**, provided that the control area contains crops of a similar age.
II. In larger irrigation blocks/fields with uniform soil, changes in slope or topography may require additional measuring stations.
III. The area represented by a measuring station should ideally not exceed 30 ha.

Non-uniform soils

I. As soil variability increases, the number of measuring stations should also increase (within reason). Homogenous (similar) management zones should be defined within a field or irrigation block, according to grouping of soil colour, depth, texture (clay content), slope, or a combination thereof. Ideally, each zone should be equipped with a measuring station. The following are guidelines for the placement of measuring stations and the associated irrigation scheduling in fields with variable soils.

    a. Areas with the sandier (or shallower) soil will have a lower water storage capacity and thus needs more frequent irrigation compared to the areas with more clay (or deeper soil). We recommend installing the measuring station in the sandier (or shallower) soil and to bring the whole field (all the soils in the field) to field capacity (this will result in an initial over-irrigation on shallow/sandy soils). Thereafter irrigation should be scheduled for the entire block according to the soil water sensors installed in the shallow/sandy soils. The water levels in the deeper/clayey soil should be periodically assessed using augers or soil pits and extra irrigation applied if required.
    b. If the sandier (or shallower) area is relatively small, then the block should still be irrigated according to the weaker area. However, if the grower is prepared to allow this small area to stress between irrigations, then the irrigation requirement of the

area with a higher water holding capacity (higher clay content or deeper soil) should be followed.

Figure 17.1 summarises the above guidelines.

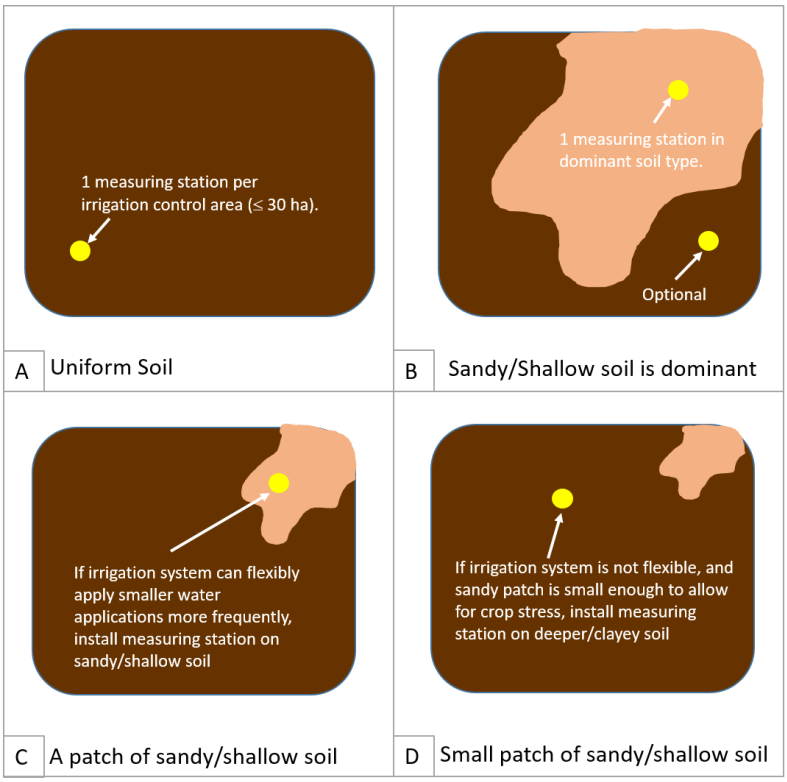

Figure 17.1

Guidelines for the placement of measuring stations: (A) soil of the total block is uniform; (B) two distinctly different soils are present with the weaker sandy (or shallow) soil dominant; (C) two distinctly different soils are present with the weaker sandy (or shallow) soil not dominant but still contribute significantly to the overall yield of the field; and (D) two distinctly different soils are present with the weaker sandy (or shallow) soil not dominant and its yield contribution is insignificant to the overall yield of the field.

In addition, the following must be considered when positioning the measuring station:

I. Avoid low lying areas with wet spots or poor drainage, steeper terrain and other anomalous or unusual features, which are not likely to be representative of the wider area.
II. Functional requirements to collect the data (e.g., distance and line of sight for radio signals, or cellular or Wi-Fi signal for internet connectivity).
III. Do not install sensors close to metal objects (i.e., irrigation equipment, over heading power cables and fences) and water carrying infrastructure (i.e., metal or PVC buried or surface pipes).
IV. Be sure to position, mark and protect soil water sensors from infield operations (weeding, burning, harvesting, and loading) and traffic (stay clear of animal paths, tractor paths, centre pivot wheel tracks and infield extraction routes).

Ideally, soil water sensors should be in close proximity to roads or cane breaks for accessibility (access requirements for manual downloading of data or for repairs, replacement of batteries, etc.).

Where to place sensors relative to the cane row and infield irrigation equipment?

The sensors should be placed about 20 cm from the edge of the stool in the interrow for all irrigation systems (centre pivot, drip, and sprinkler systems). In controlled traffic systems with dual cane rows, sensors should be placed in between the narrowly spaced cane rows and not in the interrow (traffic zone).

In fields irrigated with dripper systems, sensors must be installed so that the cane row is not between the dripper line and the sensor. Also, if the sensor is placed directly below the drip emitter, it will reflect wetter readings and result in longer irrigation intervals. As illustrated in Figure 17.2, we recommend installing the sensors a quarter of the distance away from the drip emitter and 20 cm away from the cane row for single line and tramline cane row configurations. The circular blue shaded areas reflect an aerial view of the typical wetting pattern for drip emitters in Figure 17.2 and for overhead sprinklers in Figure 17.3.

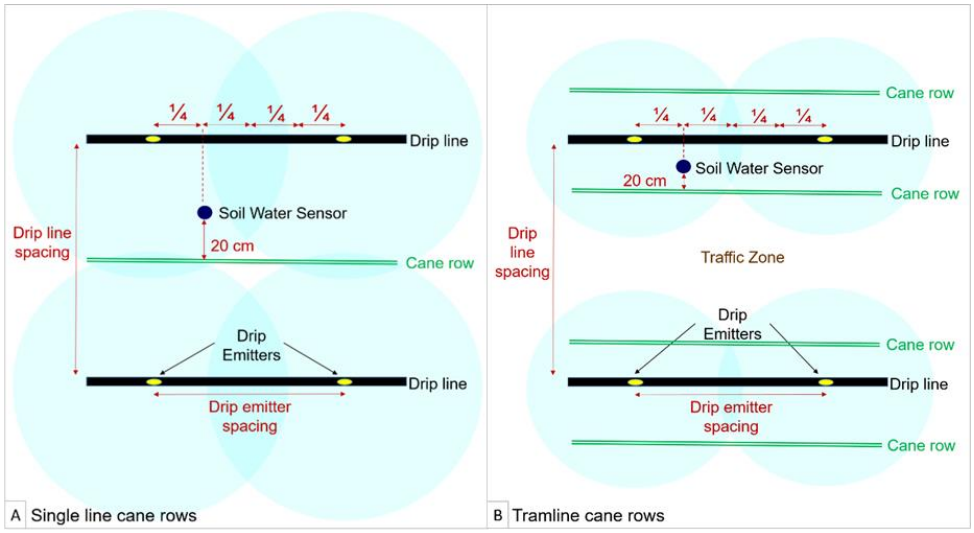

Figure 17.2

Recommended placement of soil water sensors in drip irrigation systems for: A) single line cane rows and B) Tramline cane rows

In fields irrigated with overhead systems, sensors must be placed a quarter of the distance between sprinkler risers and a third of the distance between irrigation lateral lines. This does not apply to pivot systems, but the rule of placing sensors 20 cm from the cane row must be followed.

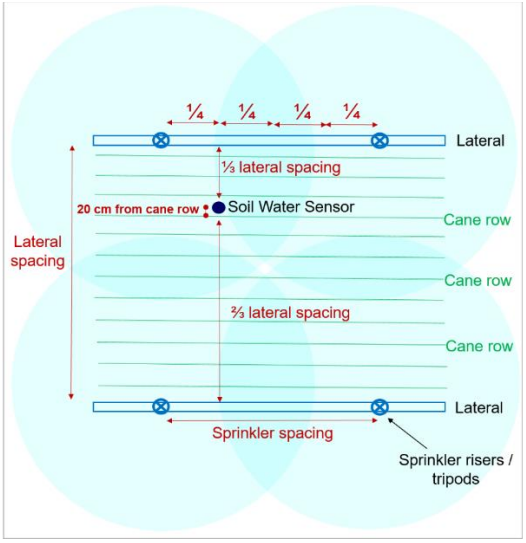

Figure 17.3

Recommended placement of soil water sensors in sprinkler irrigation systems

Sensor orientation: vertical, at an angle or horizontal?

The sensitivity to orientation of soil water sensors is greatest under drip irrigation and for longer instruments, such as the capacitance probes, which simultaneously measure soil water at multiple depths. This is because drip emitters wet the soil from a point source and distributes water in the soil in the shape of an onion bulb, i.e., depth and width of wetting zone are not always equal. The wetting pattern is dependent on soil texture and emitter flow rate, but generally, achieving wider horizontal distribution also results in deeper wetting. As shown in Figure 17.4, installing the probe at an angle can lead to drier readings from sensors at the bottom of the instrument, which can incorrectly trigger irrigation when there is still sufficient water at depth. For this reason, SASRI recommends vertical installation of capacitance probes. The sphere of soil measured by most soil water sensors is only 1 to 5 cm. It is therefore critically important to install them with no cavities and to ensure good contact between the soil and the sensor. It is also very important to prevent preferential water flow along the vertical surface of the sensor in the disturbed soil. To achieve this, the installation hole should be just big enough to install the sensor or access tube. A good practice is to make a slurry, using soil augured from the hole. The soil-water slurry is poured into the hole to cover the gap between tube or sensor and the soil. In addition, the soil at the surface should be raised slightly above the natural ground level around the access tube and sensor cable. This will settle in time, but along with the slurry will go a long way to prevent preferential flow and air pockets.

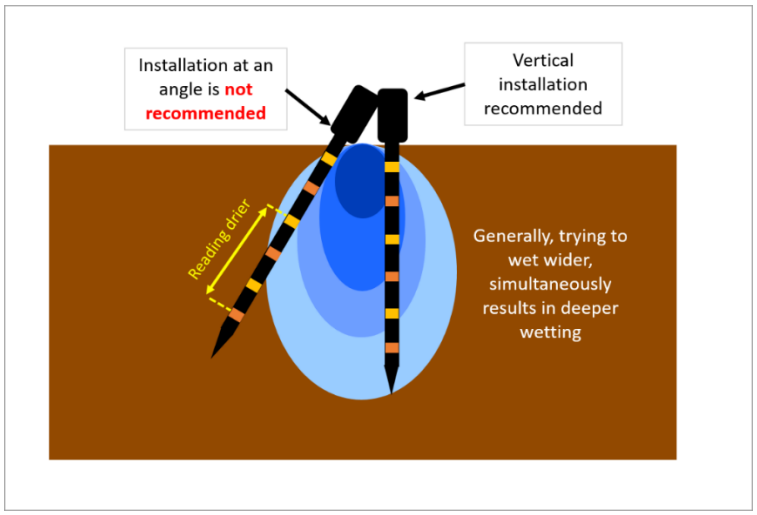

Figure 17.4

Recommended orientation of capacitance probes under drip irrigation

Crop water requirements

In this section, we aim to address the issue of whether irrigation applications are adequately meeting the crop water requirements. No new research is required. A newly developed information sheet titled Evapotranspiration (ET) Calendars provides the information requested. The text below is a summary of the information sheet and depicts how the ET calendar can be used to answer the question raised by the farmers (i.e., Is 50 mm irrigation per week enough in December, for example?).

The ET calendars are a summary of the average daily crop water requirements (ET) (mm/day) for each growth month for different harvest cycles (harvest months).

The Canesim model was used to simulate crop water use for 12-month crops for different start dates ranging from April to December, with 20 seasons of weather data from representative weather stations for each irrigated region. Irrigation was optimised in the model to minimise water stress on the crop throughout the growth period (i.e. optimal scheduling). The simulated crops were neither dried off nor mulched. The simulated ET values are applicable for both plant and ratoon crops.

The ET calendars for Zululand, Komatipoort and Malelane are provided in Tables 17.1, 17.2 and 17.3, respectively. Table 17.11 for Northern Zululand is representative of a wider region because the atmospheric evaporative demand, particularly in the peak months, were similar across the different Mill supply areas.

Table 17.1

Simulated average daily sugarcane ET (mm/day) for Pongola, Makhathini, Mkuze, Umfolozi and Heatonville.

Crop start month	Growth Month																				Annual Total (mm)
	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	
Apr	1.0	1.5	2.2	2.6	3.5	4.3	4.7	5.1	5.6	5.7	5.3	4.5									1396
May		0.6	0.8	1.5	2.6	3.9	4.5	5.1	5.6	5.6	5.3	4.5	3.6								1324
Jun			0.6	0.5	1.5	3.3	4.4	5.0	5.5	5.6	5.3	4.5	3.6	3.2							1302
Jul				0.5	0.8	2.7	4.2	4.9	5.5	5.6	5.3	4.5	3.6	3.2	3.1						1330
Aug					0.6	1.7	3.9	4.9	5.5	5.6	5.3	4.5	3.6	3.2	3.1	3.3					1371
Sep						1.0	2.6	4.6	5.4	5.6	5.3	4.5	3.6	3.2	3.1	3.3	4.0				1405
Oct							1.5	3.5	5.3	5.6	5.2	4.5	3.6	3.2	3.1	3.3	4.1	4.6			1439
Nov								2.0	4.2	5.5	5.2	4.5	3.5	3.2	3.1	3.3	4.1	4.6	4.8		1457
Dec									2.2	4.6	5.1	4.5	3.5	3.2	3.1	3.3	4.1	4.6	4.8	5.2	1458

Table 17.2

Simulated average daily sugarcane ET (mm/day) for the Komatipoort mill supply area.

Crop start month	Growth Month																				Annual Total (mm)
	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	
Apr	1.2	1.7	2.1	2.6	3.9	5.3	5.7	5.9	6.1	5.8	5.7	4.7									1546
May		0.6	0.6	1.3	2.8	4.9	5.6	5.9	6.1	5.8	5.7	4.7	3.6								1444
Jun			0.5	0.2	1.2	4.1	5.4	5.9	6.1	5.8	5.7	4.7	3.6	3.1							1401
Jul				0.4	0.5	3.3	5.3	5.8	6.1	5.8	5.7	4.7	3.6	3.1	2.8						1435
Aug					0.5	2.2	5.1	5.8	6.0	5.8	5.7	4.7	3.6	3.1	2.8	3.2					1476
Sep						0.8	3.8	5.7	6.0	5.8	5.7	4.7	3.6	3.1	2.8	3.2	4.4				1510
Oct							1.5	4.7	5.9	5.8	5.7	4.7	3.6	3.1	2.8	3.2	4.4	5.4			1543
Nov								2.2	5.3	5.7	5.7	4.7	3.6	3.1	2.8	3.2	4.4	5.4	5.6		1572
Dec									2.4	5.2	5.6	4.7	3.6	3.1	2.8	3.2	4.4	5.4	5.6	5.9	1574

Table 17.3

Simulated average daily sugarcane ET rate (mm/day) or the Malelane mill supply area.

Crop start month	Growth Month																				Annual Total (mm)
	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	
Apr	1.1	1.4	1.8	2.2	3.0	4.2	4.6	5.1	5.4	5.3	5.1	4.1									1314
May		0.5	0.6	1.2	2.2	3.9	4.6	5.0	5.4	5.3	5.1	4.1	3.1								1246
Jun			0.4	0.3	1.1	3.3	4.4	5.0	5.3	5.3	5.1	4.1	3.1	2.7							1220
Jul				0.4	0.5	2.7	4.3	5.0	5.3	5.3	5.1	4.1	3.1	2.7	2.4						1242
Aug					0.4	1.7	4.1	4.9	5.3	5.3	5.1	4.1	3.1	2.7	2.4	2.6					1270
Sep						0.6	3.1	4.8	5.3	5.3	5.1	4.1	3.1	2.7	2.4	2.6	3.3				1292
Oct							1.3	4.0	5.2	5.3	5.1	4.1	3.1	2.6	2.4	2.6	3.3	4.3			1317
Nov								2.1	4.5	5.2	5.1	4.1	3.1	2.6	2.4	2.6	3.3	4.4	4.7		1340
Dec									2.3	4.6	5.0	4.1	3.1	2.6	2.4	2.6	3.3	4.4	4.7	5.1	1344

How to read the ET calendars?

- First select the appropriate table for your region. If you are in Malelane, you will make use of Table 17.3.
- Next, one would start with the first column in Table 17.3 and select the crop start (harvest) month. Let's assume a May harvest.
- Having selected the crop start month, one would than read along that row the daily average ET values for the crop as it progresses from month 1 through to month 12. In Table 17.3 (Malelane), a crop harvested in May is expected to have an ET of:
  - 0.5 mm per day in the 1st month (M – May),
  - 0.6 mm/day in the 2nd month (J – June) and
  - 1.2 mm/day (J – July) and so on and so forth.
- To continue with the example, the peak ET for the May cut crop in Table 17.3 is 5.4 mm/day in D-December.
- Hence, the ET per day can be used to determine the:
  - ET per week (5.4 mm/day x 7 days/week = 38.7 mm/week) and/or
  - ET per month (5.4 mm/day x 30 days/month = 160 mm/month).

The ET calendars can therefore be used to assess if current irrigation applications are well matched to the crop water requirements at any time of the year, for a given crop start date.

Please note: ET is associated with the nett irrigation requirement and must still be converted to the gross irrigation requirement when comparing to irrigation application amounts. For convenience, the equations and explanations are provided below.

$$\mathrm{GIR} = \frac{\mathrm{NIR}}{\eta} \qquad \text{Eqn 1}$$

Where, GIR = Gross irrigation requirement (mm/month)
NIR = Nett irrigation requirement (mm/month)
= ET – effective rainfall (for supplementary irrigation), or ET (for full irrigation)
η = irrigation system efficiency (fraction between 0 and 1

For convenience, typical system efficiency values are listed here as Table 17.4.

Table 17.4

Typical system efficiency values

Irrigation System	Irrigation efficiency (η)
Semi-permanent sprinkler	0.83
Permanent sprinkler	0.9
Centre Pivot	0.9
Surface and sub surface drip	0.95


Dr Ashiel Jumman

For further information contact Dr Ashiel Jumman (Agricultural Engineer: Irrigation).

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18. SSGs' irrigation systems designs and modification implications: To identify the impact that a change of irrigation systems has on irrigation management. Training and education.

Priority Topic

Yes

Background

SSGs: Lots of changes are being made to infield irrigation systems (e.g., the conversion from sprinklers to drippers). What should SSGs do when converting/modifying hardware (design

implications) and thereafter to best manage the systems (management practices)? SSGs use shared infrastructure and constrained operating rules.

Desired Outcome

Guidance to SSGs on how to best manage with these dynamic system changes and repercussions of individuals/group changes on the system design (changes are made without technical design input/advice).

SASRI Response and Action

No new research is required on this topic. Several projects in the current SASRI program of work are aiming to address this issue. The first of these is Project 19TD11 entitled "*Technology development for SSGs: Irrigation Management*". This project aims to develop/design unique participatory learning resources and tools to both educate and empower SSGs to better adopt SASRI irrigation management BMPs.

The second project is Project 19KE05 entitled "*Revision of SASRI publications containing Best Management Practices*". As the project title suggests, this project is producing many new irrigation information sheets, as well as updating old ones, which will be of benefit to both small-scale and large-scale growers. One of the planned information sheets for this project (75% complete at time of writing this communique) is titled "*Harmful effects of modifying irrigation systems outside of design specifications*" and will address this issue directly. The information sheet intends to explain how the pump system, the pipe network and the operating rules of the system are locked into place by pressure and flow relationships. Modifications to the system or operating rules can result in significant crop loss from under-, over-, or non-uniform irrigation, as well as expensive damage or reduction in the life span of equipment such as pumps, valves, and pipelines. In addition, the harmful effects could also include irrigation inefficiencies leading to increased operating costs (electricity, water, and maintenance).

The third project is titled "*Soil conservation learning resources for small-scale extension*" (Project 19TD03). This project aims to develop a set of demonstration tools and a refined set of notes for a customised soils modular course for SSGs. The project also aims to upskill SSG extension specialists so that they can effectively deliver the course to their growers. While the project is focused on soil conservation, there will be a chapter within the course dedicated to the interaction of irrigation system management and soils. This chapter will aim to teach how soils influence irrigation design and management practices, and any modifications in irrigation without consideration of the soil can have a severe negative impact on crop yields, soil health and irrigation expenses.

The outcomes of the above three projects are expected to directly address the challenge raised.

For further information contact Dr Ashiel Jumman (Agricultural Engineer: Irrigation) or Dr Peter Tweddle (Agricultural Engineer: Mechanisation).


Dr Ashiel Jumman


Dr Peter Tweddle

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19. Salinity: Salt build-up in soils linked to irrigation/soils and drainage – how best to irrigate, how to ameliorate the situation and the costs thereof?

Priority Topic

No

SASRI Response and Action

SASRI has extensive knowledge on the causes and management of salts in soils. These have been shared via lectures, presentations at grower meetings, popular articles and newsletters. However,

this information has not reached a significant group of growers. Therefore, salinity and sodicity and costs to ameliorate affected soils will be addressed in a communication plan. The purpose of this plan is to structure the flow of information for maximum absorbance by the target audience.

Other aspects mentioned in the background section will also be addressed. Training material about salinity/sodicity, fertigation, crop nutrition and the recognition of soil potential are addressed in a current SASRI project (Project reference: 19TD03).

For further information contact Dr Rian van Antwerpen (Senior Scientist: Crop Nutrition and Soils; and Manager: Systems Design and Optimisation Research Programme) or Dr Thandile Mdlambuzi (Scientist: Crop Nutrition and Soils).


Dr Rian van Antwerpen


Dr Thandile Mdlambuzi

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20. Sand mining impact on irrigation abstraction: Investigate the impact of sand mining on irrigation abstraction: requirements, guidelines and the knock-on impact on water flows; pumping and lost irrigation times

Priority Topic

No

SASRI Response and Action

Conducting experiments to assess the effects of sand mining on water abstraction and develop management methods would be very difficult and complex. Possibly the most effective way of dealing with this matter is for SASRI extension and research specialists to liaise directly with growers who need to manage this challenge. The first step would be for the affected growers to contact their extension specialist who will then raise the matter with the relevant SASRI scientist or agricultural engineer. Site visits could then be arranged as required.

For further information contact Marius Adendorff (Extension Specialist: Komatipoort) or Jan Erasmus (Extension Specialist: Malelane).


Marius Adendorff


Jan Erasmus

21. Products for cleaning of drippers: various types of products – guidance on the best chemicals for different scenarios. Systems maintenance and management.

Priority Topic

No

SASRI Response and Action

No research is required as the Water Research Commission (WRC) of South Africa has recently published detailed reports on the topic. The WRC report, along with content from the updated Irrigation Design and Irrigation Users Manual was used to formulate a new SASRI information sheet "5.13: Water Quality consideration for optimal performance of irrigation equipment" (final formatting in progress). Sections of the information sheet are given below to illustrate the type of information and guidelines that is available on the topic.

Causes of blockages in drip irrigation systems

Blockages can be caused by physical (solids/sediments), chemical (deposits precipitating out of the water) or biological factors (algae, microbiological organisms). The water quality guidelines to quantify the blockage hazard of the irrigation water, especially in drip irrigation systems, are shown in Table 21.1.

Table 21.1

Water quality guidelines to quantify the blockage hazard of irrigation water

Cause	Blockage hazard rating			
	Ideal	Acceptable	Tolerable	Unacceptable
Physical:				
Suspended solids, e.g. silt, clay and organic material (mg/ℓ)	<50	50 - 75	75 - 100	>100
Chemical:				
pH	5 - 7	7 - 7.5	7.5 - 8	>8
Bicarbonate (mg/ℓ)	<100	100 - 150	150 - 200	>200
Calcium (mg/ℓ)	<10	10 - 30	30 - 50	>50
Manganese (mg/ℓ)	<0.1	0.1 - 0.5	0.5 - 1.5	>1.5
Iron (mg/ℓ)	<0.2	0.2 - 0.5	0.5 - 1.5	>1.5
Total dissolved solids (mg/ℓ)	<500	500 - 1000	1000 - 2000	>2 000
Nitrates (mg/ℓ)	<10			>10
Biological:				
Bacteria (count/mℓ)	<10 000	10 000 - 50 000		>50 000
Some suppliers of drip irrigation systems consider water with an iron content of 0.8 mg/ℓ in storage dams and borehole water with an iron content of 0.3 mg/ℓ as a high blockage hazard for emitters. Water with a manganese content of 0.3 mg/ℓ is also considered a blockage hazard. These causes are interactive with each other, e.g. the removal of organic material will reduce biological activities.				

Proactive water treatment options to address blockage hazards in drip irrigation

- *Addressing blockage risks from physical factors*

  - *Sedimentation dams*

    In cases where the irrigation water contains solid particles in suspension in excess of 100 mg/ℓ, it is advisable to have a sedimentation dam. Therefore, it is important to ensure that the water standing time in the dam is adequate to ensure all suspended solids sink to the bottom before the water is pumped through the filter and into the pipeline. The water supply outlet to the dam should be as far away from the pump inlet. Backwash water from filters should preferably not be directed back into the dam, or as far away from the pump inlet. It also helps to install the pump suction intake on a float. Measures should also be taken to clean the sedimentation dam with minimum effort.

  - *Filtration*

    Filtration systems are essential to remove suspended solids before irrigation water enters into drip systems. Irrespective of water quality, filtration system are highly recommended for all drip (or micro) irrigation systems. The *Suid Afrikaanse Besproeiings Instituut (*SABI) norms encourage the installation of primary filters at the pump station and secondary filters at block inlets. Secondary filters capture material missed by primary filters. Where secondary filters get dirty regularly, it indicates problems with filtration effectiveness at the primary filters. The filter banks are sized according to system flow rates, while the filtration efficiency is also dependent on correct pressure at filter. Insufficient flushing cycle duration, incorrect setting of flushing control valves and use of filters outside of their recommended flow range are the greatest causes of filter blockage. Sand and disc filters are usually preferred for drip irrigation, while screen (mesh) filters or disc filters are typically used for micro-sprinkler systems (typically used on tree crops). The level of filtration (measured in microns) is closely related to the dirtiness of the water.

- *Addressing blockage risks from chemical and biological factors*

  - *Aeration*

    Iron-rich water (> 1.5 mg/l) should be aerated to promote formation of Fe-oxide that can settle in the holding dam. This must be done before abstracting water to prevent Fe-rich water from causing blockages in the irrigation system.

  - *Acid application*

Dilute acid solutions (typically hydrochloric but can include phosphoric and sulphuric) are periodically used to lower water pH to primarily dissolve scales and prevent precipitates of carbonates and oxides forming. A routine water quality analysis will indicate the need for flushing with acid solutions.

Introduction of acid into the irrigation system must consider resistance of the irrigation hardware to acids and ensure proper mixing in the system. Excessive use of acid can promote chemical corrosion, where metallic components tend to dissolve. uPVC and polyethylene fittings are recommended in these cases. The injection points should apply the acid solution in the centre of the pipeline for proper mixing, preferably after the filter. After acid treatment, the system should be flushed with clean water to reduce unnecessary corrosion of equipment.

- *Chlorine application (Oxidising Agents)*

Strong oxidising agents, such as chlorine, can be used to precipitate iron and manganese out of the irrigation water. The chlorine should be administered before the filters to prevent the precipitate/sediments from entering the system and blocking emitters.

Chlorine will also remove organic materials such as bacteria, bacterial slimes, algae, pathogens, etc. Due to low persistence of free chlorine, the application point must be close to the area of concern to improve effectiveness and reduce losses. Stabilised chlorine products can improve residence time. Laterals of drip lines must be flushed clean to remove dirt before the application of chlorine.

Chlorine can be added continuously or periodically, depending on the prevailing quality of water and the resultant water treatment needs. Chlorine is most effective at a pH of ± 6.5 and irrigation water must be acidified if necessary. The acid is applied to reduce the pH of the water for 10-20 minutes and the chlorine is applied thereafter. Recommended concentrations are provided in Table 21.2 for both options. In Table 21.2, the concentration of chlorine at the end points are also provided for monitoring the effectiveness of the process. For example, the free residual chlorine at the end of the system is an indication that the oxidation process is completed and should be 1-3 mg/ℓ. Periodic application of chlorine usually takes place during the last 30 to 60 minutes of irrigation. Avoid chlorine concentration of more than 100 mg/ℓ since this can possibly damage dripper diaphragms. After irrigation, the free residual chlorine in the water that remains in the pipes will suppress undesirable microbiological activities. The laterals must then be flushed thoroughly before the next irrigation cycle.

Table 21.2

Recommended chlorine concentrations

Purpose of chlorination	Chlorination method	Recommended concentration (mg/ℓ):	
		Injection point	End point
Prevention of sedimentation	Continuous	3-5	>1
	Periodically	10	>3
Cleansing of system of bacterial slimes	Continuous	5-10	>3
	Periodically	15	>5

Chlorine is available as chlorine gas (50 kg gas bottles), liquid sodium hypochlorite (20 litre plastic canisters) and granular calcium hypochlorite (HTH). Chlorine gas is relatively cheap, although the gas form is extremely dangerous and requires that prescribed safety precautions are used. Other oxidizing agents include bromine, ozone and activated peroxygen.

- *Hydrogen Peroxide*

Hydrogen peroxide (H_2O_2) reduces the growth of algae and slime in irrigation systems as well as the occurrence of fungi in soils and growth mediums. It is more aggressive than chlorine in loosening

residues in pipes and is not sensitive to high pH like chlorine. The point of injection should be at the block valves. Injection should be continued for an hour or for the time it takes for one drop to travel from the point of injection to the last dripper. The system is required to stand for 12 to 36 hours after the injection and the lifespan of the peroxide is a few days after which the system needs to be flushed. Hydrogen peroxide is environmentally friendly, it doesn't cause dangerous residue and it is very effective, though it must still be handled with care due to strong oxidative effects on biological tissues.

Dealing with blockages in drip systems after they occur (reactive)

Blockage material can often be identified by the colour of the deposit in the blocked dripper. Typically, salt deposits are white, iron oxides are a rusty colour, and blockage material resulting from microbiological activities is dark brown to black. Each type of blockage has a unique solution and usually a water analysis is required to indicate the likely cause of the blockage. Generalised solutions for different blockage problems are shown in Table 21.3, though manufacturer guidelines will take precedence over these.

Table 21.3

Solutions for specific clogging problems (drip irrigation systems)

Problem	Solution
Carbonate deposit (whitish colour) HCO3>100 mg/l pH >7,5	• In extreme cases, where costs allow, continuous acid application – Maintain pH of 5 to 7. • Shock acid application at end of irrigation cycle. Maintain pH of 4 for 30 to 60 minutes. • Flush with clean water after to prevent corrosion of metal pipes and fittings.
Iron deposits (reddish colour) Iron concentration >0,2 mg/l Manganese deposit (black colour) Manganese concentration >0,1 mg/l	• Aeration and sedimentation of water at source to oxidise iron (especially suited to high iron concentration of 10 mg/l or more). • Two step acid and hydrogen peroxide application to treat iron deposits, applied at block level: - Pressurise and flush system. Irrigate for one hour, inject acid (0.6% concentration) for 10 minutes, then flush injection equipment with clean water - Thereafter, complete the hydrogen peroxide treatment (500 mg/l concentration initially, 250 mg/l follow up treatments) for one hour. - Wait for 12-36 hours and flush dripper lines. Do one combination treatment per month; do not exceed one combination treatment per week.
Iron bacteria (reddish slime) Iron concentration >0,1 mg/l	• Application of 1 mg/l chlorine (free chlorine available) continuously or 10 to 20 mg/l for up to 0-60 minutes as required.
Sulphur bacteria (white cotton-like slime) Sulphide concentration >0,1 mg/l	• Continuous application of chlorine at 1 mg/l per 4 to 8 mg/l sulphur hydroxide. • Application of chlorine as required until 1 mg/l free chlorine is available for 30 to 60 minutes.
Algae (greenish slime)	• Application of chlorine at a continuous rate of 0.5 - 1 mg/l or 20 mg/l for 20 minutes at the end of each irrigation cycle.
Iron sulphide (black, sandy material) Iron and sulphide concentration >0,1 mg/l	• Dissolve iron by continuous acid application to reduce pH to between 5 and 7.

In conclusion, it must be emphasised that it is critical for growers with drip irrigation systems to develop a customised maintenance program (including treatment with chemicals) with a specialist service provider for their system and context, as it is next to impossible to provide exact guidelines for the multitude of scenarios.

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Dr Ashiel Jumman

For further information contact Dr Ashiel Jumman (Agricultural Engineer: Irrigation).

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22. Automation within irrigation systems – availability and comparison of automation or control systems.

Priority Topic

No

SASRI Response and Action

No new is required to address this issue. The South African Irrigation Institute (Suid Afrikaanse Besproeiings Instituut – SABI) will be hosting an advanced irrigation designer course on automation and fertigation in August 2022. The specific dates and venues are as follows.

Automation/Fertigation: Western Cape on 10 and 11 August 2022; Gauteng on 23 and 24 August 2022.

For more information about this course, contact SABI directly:

Website: www.sabi.co.za;
Email: Rene van der Merwe - admin@sabi.co.za;
Phone: 021 850 8220

The SA irrigation industry is filled with several service providers (manufactures, suppliers, consultants, designers, and contractors) and information is normally readily available from their staff or product brochures and internet web pages. In addition, the costs of instruments tend to change rapidly, and will render any published library of control instruments with associated costs outdated within a short period of time. Hence, farmers are advised to contact the relevant service providers and obtain advice and costs for their specific context and circumstances. It is also recommended that several quotations from different service providers is obtained, to ensure that the proposed instruments and associated costs are comparable (within a reasonable ballpark) and competitive. A list of SABI approved designers and SABI member companies can be found on the SABI website and the SABI magazine.

Over and above the costs, a key consideration is reliability of the equipment and aftersales service. For this reason, we also advise farmers to do some homework to ascertain the following when selecting service providers and/or equipment:

Primary considerations: Costs and after sales service

- Cost

  - What is the cost of equipment, software, transmission costs (airtime or radio licence), cost of repairs, maintenance costs, data costs, annual licence fee, etc.
  - Is there a warranty for the system (or for specific items)?
- After sale service
  - What is the agreement regarding maintenance and repairs?
  - How long to respond to a query and what are the call out fees involved?

Is the company reputable?

- Local or International:
  - Who and where is the owner/manufacturer of the equipment, data transmitters, software, etc.?
- Address
  - Do they have a web presence?
  - How long have they been in existence?
  - Do they have local representatives?
  - Are they registered with SABI?
- References from other users
  - Any feedback from current users?
- Consultants
  - Are there local consultants for the company or does someone have to travel far from head office?
  - What is the training and knowledge of the local rep/agent and company staff?
  - How easily contactable are they?
- Sugarcane knowledge
  - Does the company have knowledge/done previous work in sugarcane?

Other considerations

- Theft or vandalism:
  - How conspicuous is the equipment (e.g., electric cables, solar panels) in the field?
- Protection during burning and harvesting:
  - What measures are taken to protect the equipment from damage during cane burning and harvesting operations?
- Communication:
  - Is there good coverage by one or more cell phone provider across the farm?
  - Are there any obstructions such as small hills or large trees between fields and the office that could limit telemetry-based systems?


Dr Ashiel Jumman

A communication plan has been developed to improve knowledge exchange on this topic.

For further information contact Dr Ashiel Jumman (Agricultural Engineer: Irrigation).

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23. The use of remote sensing (NDVI) for irrigation scheduling; Drone usage to monitor crop for crop health and identify risks (e.g., weed – problem fields, P&D) e.g., Aerobotics. Investigating how such can be of benefit to farmers.

Priority Topic

No

SASRI Response and Action

Researchers have established a strong correlation between crop coefficient (K_c) and the NDVI for crops such as wheat, cotton, citrus, and almonds. Several studies have demonstrated the utility of the NDVI for irrigation scheduling. Within the sugarcane industry, several studies have established

the link between K_c and the NDVI and the potential for using the NDVI for irrigation scheduling. There is thus an opportunity to investigate the potential for real time irrigation water management for the South African sugar industry.

Drones are increasingly being used for crop monitoring. Several companies in KZN and SA offer drone services to the agricultural industry. Ideally, drones should be used to complement satellite monitoring where higher spatial resolution and/or cadence is required. Drone-based monitoring may be significantly costlier compared with satellite monitoring.


Dr Nitesh Poona

For further information contact Dr Nitesh Poona (Scientist: Digital Agriculture).

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24. Solar systems on pump houses. When is it cost effective to invest in solar pumping? What are the pay back periods?

Priority Topic

No

SASRI Response and Action

A current SASRI project is addressing this topic (SASRI project reference 20SD01). In the project, the impact of load-shedding on irrigation operations is under investigation. Alternative energy sources are also being investigated to help identify when such systems would be feasible. Solar power is one of the alternative energy sources that are being investigated.


Dr Peter Tweddle

For further information contact Dr Peter Tweddle (Agricultural Engineer: Mechanisation).

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25. Harvesting systems – Mechanical harvesting and planting: What is happening in other industries (strategic perspective)? Guiding the adopting of new systems. A systems perspective on the topic is required and break-even analyses to determine when the adoption of systems become feasible.

Priority Topic

Yes

Background

Strategic perspective: Growers are conducting their own mechanical harvesting and planting system research on their farms with respect to mechanical systems. Would like SASRI input on what information already exists locally and internationally – raise red flags on challenges that others have experienced. Guiding the adoption of new systems. Yield implications, soil prep, row configurations, field layouts, controlled traffic, varieties suited for mech harvesting, ratoonability issues, germination, gap filling, field maintenance operations, trash blanket, P&D issues eg. RSD, trash worms, eldana; BHTCD implications, gapping, replant cycles. Systems perspective on the topic and break-evens.

Desired Outcome

What systems and interventions are viable locally? What changes (compatibility of existing operations and systems) are necessary to get implementation? Guidelines on when such interventions would be/become feasible given the resources that farmers have (costings). What influence do soils have on mechanical harvesting systems and/or operations? What varieties are most suited for mechanical harvesting and planting operations?

SASRI Response and Action

This is a reoccurring topic. In costings that were conducted (refer to past RD&E communiques 2020: Topic 41), the mechanical harvesting systems were generally not cost competitive compared to the whole stalk cutting operations traditionally used in the industry even for larger scale farming operations. There are many other implications (red flags) that one needs to consider if one wants to investigate chopper harvesting operations. These include elevated levels of high impact field traffic. Controlled traffic is thus essential to constrain the high impact traffic to dedicated traffic lanes away from the cropping areas. Mechanical harvesting best management practices need to be practiced to minimize stool damage by targeting harvesting rates for crop sustainability (not necessarily for productivity). Residue management is another issue to consider. Mechanically harvested cane billets are subject to elevated rates of deterioration, although the billets tend to offer higher payloads but advantages may be offset against the need for specialized transport systems for loading and offloading of the billets.

Most harvesters currently being used are on a narrower row spacing. Latest trends are for wider tracked harvesters (2.4m wheel tracks) where 2 rows (maximum of 0.9m dual rows) are harvested simultaneously per pass. This reduces the amount of heavy infield traffic as infield traffic is constrained to wider wheel tracks and fewer swaths through the field.

Gaps in knowledge include variety responses to mechanical planting and harvesting operations.


Dr Peter Tweddle

For further information contact Dr Peter Tweddle (Agricultural Engineer: Mechanisation).

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26. Mechanical system comparisons: Investigating alternative planting systems (eg. whole stalk versus billet planters).

Priority Topic

No

SASRI Response and Action

Mechanical harvesting has been a recurring topic raised during RD&E Committees' workshops held in the Northern Irrigated region.

Past communiqués have provided a broad range of information on the subject. These are listed below and are available through the extension specialists, Marius Adendorff, Jan Erasmus, Etienne de Beer, Jeffrey Foxon, Mboniseni Buthelezi and Norman Mkhabela.

- 2020
  - Topic 41: Quantification of damage and production losses caused by compaction and stool damage. This communiqué provides an overview of past responses relating to compaction and stool damage and a relative costing of various systems including a mechanical harvesting system
  - Topic 40a: Information needed on the interactions between varieties, mechanisation and ratoonability. The communiqué provides information on mechanical harvesting reducing crop cycle lengths and causing crop damage, and the management and maintenance of mechanical harvesters. In addition, it provides an overview of many of the issues faced by other industries when migrating towards mechanical harvesting, the advantages and disadvantages of manual versus mechanical harvesting operations and best practices when adopting mechanical harvesting operations on a larger scale.

- 2018
  - Topic 11: Stool damage and reduced ratoonability from mech harvesting.
  - Topic 15: Long term effects of mechanised systems.
  - Topic 34: Suitable varieties for mechanical harvesting.
  - Topic 38: Holistic costs of mechanical compared with manual harvesting.
- 2016
  - Topic 20: Mechanical harvesting considerations.
  - Topic 34: Mechanical harvesting - Problems and value of residue.
- 2015
  - Topic 5: Residue handling options.
- 2014
  - Topic 22: Overview of various planting options.
  - Topic: VI response to the agronomics associated to RD&E 2014 issue.
- 2013
  - Topic 73: Mechanical planting. Overview of historically available planters.
  - Topic 24: Cutter productivity, harvesters developed, harvesting aids, harvesters available.


Dr Peter Tweddle

For further information contact Dr Peter Tweddle (Agricultural Engineer: Mechanisation).

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27. Alternative harvesters (or harvesting aids) or partial or semi-mechanization options – What is available?

Priority Topic

No

SASRI Response and Action

A comprehensive overview of harvesting systems was provided for Topic 24 in the communiqués arising from the 2013 RD&E Committees' workshop. The communiqué provided a historic overview of harvesting aids and harvesters that were developed at SASRI. The only commercially available harvesting aids (besides chopper harvesters) are the walk behind Cane Thumper or the tractor mounted Sickle Sword type harvesters.


Dr Peter Tweddle

For further information contact Dr Peter Tweddle (Agricultural Engineer: Mechanisation).

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28. SSGs: Training for new entrant growers on mechanization; workshops or field days e.g., landprep operations and standards.

Priority Topic

No

SASRI Response and Action

No additional SASRI project is required. 19TD03 is a current SASRI project for the development of a soils modular course for small scale growers. In the course, a section on tillage operations covers many of the primary and secondary tillage operations that are required to create a friable tilth for the establishment of sugarcane crop.

In addition to this project, the junior and senior certificate courses cover general mechanization and costing of systems in detail. Regional modular courses are also available by theme-based topics. For example, row spacing options, planting, or ratoon management operations. These provide practical overview of farming operations and cane farming guidelines. The SASRI information sheets also provide additional mechanization themes.

To summarise, there are a range of training materials and various resources that are available. SSG extension would need to confirm that the SSG sector training needs would be covered by these various resources.


Dr Peter Tweddle

For further information contact Dr Peter Tweddle (Agricultural Engineer: Mechanisation).

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29. Carbon foot-print profile for irrigation systems and for mechanization, with respect to the sugarcane value chain master plan.

Priority Topic

No

SASRI Response and Action

Refer to Topic 11 (click here).

PEST AND DISEASE MANAGEMENT

30. YSA management.

Priority Topic

Yes

Background

(a) Erratic behaviour, huge damage, lack of understanding on how to deal with YSA; (b) Financial issue due to spraying – long term that seems to affect next ratoon. When does it affect the crop most? When should spray be applied in order to maximise effects on YSA. (c) Different varietal experience on ground vs what SASRI has provided. (d) Alternative chemicals and trials in LV? Can SASRI approach chemical companies with growers to run trials. (e) Expansion of YSA management into something like Smut? Growers cannot afford to each have their own P&D team.

Desired Outcome

(a and b) Structured program for YSA management coordinated by P&D committee – get all neighbours to implement management. Chemicals that can be applied in drip and overhead as different mechanisms involved. Drones. (c) Varietal information - more detailed information on variety tolerance that is more ground truthed. (d) Research trials to test chemicals in Lowveld under these conditions. Growers willing to engage in research trials. Grower led trials. (e) SASRI P&D to assist in scouting and reporting of incidence. Also, irrigators that are on farm every day. A “rule system” like what is being implemented with smut to manage infestations – e.g., moderate infestation means you must spray?

SASRI Response and Action

Lack of understanding on how to deal with yellow sugarcane aphid in terms of biology and infestation management. Point 1 was coupled with Point 2: Financial implications of insecticide applications (long-term solutions), and timing of insecticide applications to maximise effects on YSA.

A structured dissemination of information has been planned to address the knowledge gap associated with YSA as a pest on sugarcane. Focus areas to be covered in sequential order include:

- Pest life cycle and biology, and associated plant physiological effects
- Potential drivers of infestation: soil health, climatic change
- Field scouting (plus methodology) as a key driver for either reactive or preventative action
- Chemical management: timing, choice of chemistry, window periods, chemical registrations, application methods (via irrigation, drones, soil)
- Varietal reaction to YSA
- Integrated management and biological control
- In-field monitoring applications that will soon be available to growers: reporting, monitoring, planning spray applications, categorising infestation
- SASRI's research initiatives that are underway: variety, control, risk indices, predictive modelling.

It is envisaged that this information will be relayed to growers via Link publications, information sheets, grower days and demonstrations, study groups, and Extension newsletters.

Current initiatives underway at SASRI for YSA management are focused across several projects that aim to provide growers with the tools to implement area-wide integrated pest management.

- An investigation of the biodiversity of YSA natural enemies (Project 19CP03).
- YSA Risk Index (Project 16TD04).
- On-farm biodiversity management for biological control (Project 21KE01; a grower-led initiative).
- Silicon amendments and their effects on YSA infestation (Project 21KE02, grower-led trials).
- Hyper- and multi-spectral remote sensing for modelling YSA infestations (Project 19TD01).
- Spectroscopic determination of YSA-induced stress in sugarcane (Project 21CP01).
- Testing alternative chemistries against YSA (Project 00CP04).
- YSA variety susceptibility (Project 19TD02).

Different varietal experience in response to YSA severity on ground in comparison to the information provided by SASRI.

Growers raised concerns over varietal performance in terms of YSA severity on-site (at farms) versus the reported performance provided by SASRI. The request was for more detailed information that was more ground-truthed. Variety information includes the best and the most limiting features, yield and quality information, reaction to diseases and pests, as well as agronomic and milling characteristics, and is generally an end-product of analyses of data collected throughout the lengthy eleven-to-15-year plant breeding and selection process. YSA appeared in 2013, with variety evaluation to assess YSA severity in released varieties starting from 2015 and with the current project set to continue until March 2023. These commercial varieties have been tested in different agro-climatic regions across the industry within a variety evaluation programme (VEP) which is a network of variety trials across different regions. Furthermore, assessments have also been carried out on Variety x Ripener trials, Variety x Nematicide trials, and Variety x Mosaic trials.

The behavioural patterns of YSA are erratic, and infestation is not always a certainty in each trial. Hence, while evaluations released to growers represent at least three to five years' worth of assessments, under commercial conditions across sugarcane growing regions, it remains a dynamic assessment, and is likely to differ from large-scale growing operations as both environment and pest behaviour (often a function of environmental change) are different in each microclimate.

While trial data exist for YSA damage to all commercial varieties, including irrigated varieties, the published ratings have been produced only for varieties for which there was sufficient data to enable

a statistically reliable result (specifically, where there was data from eight or more plots across all trials assessed) and where the damage was great enough to show differences between varieties. Because the irrigated varieties, especially more recently released ones, had a limited amount of data compared with rainfed varieties, this largely excluded most of the irrigated varieties from the recent analysis. Nonetheless, YSA data from over 4000 plots in 27 variety trials across the industry have been gathered to date. Going forward, efforts will be made to include as many irrigated varieties as possible in the assessments, where the trials are of a suitable age (4-5 months) and at a suitable time of the year (spring to late summer, when YSA outbreaks are expected), in order to increase the sample size and allow reliable assessments to be made.

The updated information will be shared with growers in the form of updated information sheets, Link publications, grower days, and extension newsletters.

Trials in the Lowveld to test alternative chemicals against YSA. Can SASRI approach chemical companies with growers to run trials?

Current chemicals registered for use against YSA on sugarcane in South Africa are reflected in Table 30.1.

Table 30.1

Current chemicals registered for use against YSA on sugarcane in South Africa.

Tradename	Active Ingredient	Registration Holder
Allice 20 SP	Acetamiprid	UPL Group (Pty) Ltd
Wonderland 200 SP	Acetamiprid	Cedar Fall Properties 130 (Pty) Ltd
Ampligo	Chlorantraniliprole + lambda-cyhalothrin	Syngenta South Africa (Pty) Ltd
Bandito GR	Imidacloprid + oxamyl	UPL Group (Pty) Ltd
Actara SC	thiamethoxam	Syngenta South Africa (Pty) Ltd

This area of investigation relies heavily on grower participation. SASRI can engage with chemical representatives who may offer alternative products, assist in trial design and some degree of assessment. However, the primary responsibility of such trials will lie with the company and the grower. It must be emphasized that SASRI's role within agrochemical research is limited to exploratory work due to SASRI being unable to apply for registration of a product. The company that owns the product must be willing to invest in the research required to get it registered before it can be brought to the market. Should a company not be interested, growers can fund the research required for registration, but it still must be handed over to the chemical company for registration.

SASRI, through its agrochemicals project (00CP04), its interactions with the Registrar's office and its Specialist Advisory Request (SAR) system have engaged with chemical companies to raise the needs profile of the sugar industry and this approach to date has resulted in several new products being registered within the industry (with products currently being tested in research trials). SASRI however must operate within the confines of Act 36 of 1947 and as such its options are limited. SASRI also cannot recommend the products of one company over another. It must also be emphasised that growers play a key role in attracting new active ingredients and methods to the industry by only using registered chemicals.

Is it feasible to explore expansion of a YSA management system to what is currently being implemented for smut? Growers cannot afford to each have their own P&D team and would prefer central governing legislature for YSA management.

Currently, SASRI's Biosecurity Inspectorate assists in scouting for and reporting YSA incidence. This is carried out in an adjunctive manner during both disease and Eldana surveys. These reports are purely indicative of presence or absence, and in some instances where the P&D inspector has the capacity to, also indicative of severity (mild, moderate, severe). However, the Inspectorate cannot assume complete responsibility for either identifying or reporting YSA incidence in

commercial fields since scouting should be carried out at 2-week intervals. This responsibility lies largely with the growers concerned, and in-house scouting is crucial to either pre-emptively or reactively, manage infestations.

Implementation of a “rule” system for YSA management, as is in place for smut, e.g., where smut infestation above a particular threshold requires mandatory remedial action (amongst other rules), will require some modification of the Sugar Act. This will be further scrutinized for feasibility in terms of any/all administrative legislature (legalities, timelines, costs) that may be required for implementation. One of the challenges with introducing a mandatory spray system when a set threshold is exceeded is that YSA, unlike smut, is often transient and has been observed to “disappear overnight”. The grower may be legally bound to apply a pesticide despite the drop in YSA numbers.

A communication plan has been developed to improve knowledge exchange on this topic.


Dr Iona Basdew Dr Malcolm Keeping

For further information contact Dr Iona Basdew (Scientist: Biosecurity) or Dr Malcolm Keeping (Senior Scientist: Entomology).

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31. Eldana management.

Priority Topic

Yes

Background

Varietal difference on ground vs what SASRI recommends in terms of Eldana tolerance. Why are these differences prevalent from region to region?

Desired Outcome

More precise/detailed varietal information on Eldana tolerance/resistance more relevant to the Lowveld.

SASRI Response and Action

Varietal resistance or susceptibility to eldana (or to any pest or disease) is a genetically determined and fixed trait and will not change over time. A variety will not change slowly from being resistant to susceptible (or vice versa) while exposed to a pest or disease. This is especially true in sugarcane, as a vegetatively propagated crop. There are factors, such as water stress or excessive nitrogen supply, that can increase susceptibility of any variety to eldana, but this is as a direct result of the action of those factors on the physiology and nutritional status of the variety. If a variety is intolerant of water stress for example, this may compromise its resistance to eldana when water stress increases during periods of inadequate water supply. Such external stress factors do not have any effect on the genetic make-up of the variety or change the innate characteristics of a variety over time.

The varieties that SASRI releases to the industry have been tested rigorously for their level of genetic resistance to various pests and diseases in different stages of the selection programme, over several crops, and in different environments. For eldana, this includes screening varieties in trials with potted sugarcane in which external factors such as level of exposure to eldana, temperature, soil characteristics, nutrition, and water supply are uniform across the trial, ensuring that measured differences in resistance (i.e., eldana infestation and stalk damage) reflect differences in the genetic make-up of tested varieties. Furthermore, a uniform level of water stress is imposed across the trials during the period when the plants are artificially infested with equal numbers of eldana larvae, which are then allowed to bore into the cane for a specific length of time

before sampling the trial. Therefore, the resistance of the varieties is measured under conditions of mild water stress, which varieties may well encounter in the field if released for commercial production. Six standard varieties with known eldana ratings are included in each trial. The success of each trial is determined using statistical methods and the eldana ratings of the pre-release varieties are calculated based on eldana damage in the standard varieties. Differences between regions in water supply, temperature, soil characteristics and crop nutrition can all influence the severity of eldana infestations, no matter what the genetically determined level of resistance (as measured in screening and plant breeding trials) of varieties grown in different regions may be. These are environmental or agronomic factors that can directly or indirectly affect the pest and consequently the crop damage it can cause.

Age is another factor that can affect the level of eldana damage and can become a factor of major concern if crops of more susceptible varieties are aged to over 12 months. All varieties gazetted for cultivation in regions where they are likely to be aged to more than 12 months are required to have at least a moderate level of resistance to eldana, to ensure they can be aged more safely. As sugarcane grown in the Irrigated North is grown on a 12-month cycle, susceptibility to eldana has been accepted by the PD&VC Committees as a risk that can be managed under the shorter growing cycle and with irrigation (and consequent lower likelihood of water stress). Variety selection and evaluation trials are also grown on a 12-month cycle in this region; consequently, eldana damage will usually not be severe enough in these trials to allow clear discrimination of varietal differences in eldana resistance. However, the variety evaluation trials conducted in Pongola and Mpumalanga will be surveyed for eldana damage in order to gather further data on potential varietal differences in resistance. It should also be noted that pre-release varieties from the SASRI Pongola selection programme are screened in the pot trials at Mt Edgecombe for eldana resistance, where, as previously mentioned, they are exposed to moderate water stress and a pronounced eldana infestation. Therefore, information on relative resistance and susceptibility of varieties released to the Irrigated North is always generated by these trials and considered before release.

An additional factor to be considered in releasing more susceptible varieties in the Irrigated North is the commonly inverse relationship between smut and eldana resistance. Because smut is of particular concern in this region, a strict adherence to eldana resistance cannot be imposed during release, as it would frequently compromise smut resistance. If eldana resistance is to become an important factor in the release of varieties in the Irrigated North, then growers would need to understand that eldana resistance may bring with it other compromises, such as in RV yield, which would have to be considered in the selection process.


Dr Malcolm Keeping

For further information contact Dr Malcolm Keeping (Senior Scientist: Entomology).

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32. Seedcane management.

Priority Topic

Yes

Background

(a) Seedcane programme requires input from Marius Adendorff and Jan Erasmus. Resistance to P&D. Need detailed/accurate P&D info on varieties in order to put down good seedcane. Followed protocol for seedcane. Extension to be involved in the roll-out of the varieties. (b) Growers are generally not planning ahead in terms of their seedcane requirements. (c) Water sources at the mother block. Poor mother block – rife with Eldana. Contaminated water at the mother block that results in diseased mother block material.

Desired Outcome

(a) Extension to be an active part of the seedcane programme from a P&D perspective. Farmer fully updated on what is going on with the seedcane with the assistance of P&D. (b) Added to Online

Estimation where grower can place their requirements in advance. Ongoing system going forward. (c) Want a source where growers can load their material away from the mother block and take back to their fallowed lands which are ready for planting.

SASRI Response and Action


Marius Adendorff

A strategy document is to be developed by Marius Adendorff and Jan Erasmus.

For further information contact Marius Adendorff (Extension Specialist).

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33. P&D data and early warning.

Priority Topic

Yes

Background

MIS (previously GIS) system that captures variety, agronomic information – can this not be used to also capture P&D data too. This system was used to advise growers for a replant – varietal, P&D, soil, irrigation etc. To identify hotspots – early warning. YSA early warning.

Desired Outcome

Can SASRI not have access to this system to implement as an early warning system – use the information on database to guide replant/varietal choice/irrigation planning based on prior datasets?

SASRI Response and Action

A formal request for access will be made to the Mpumalanga MIS Committee via the committee chairperson.

A project pre-proposal is being drafted to address the development of an early warning system (EWS). Should the proposal be successful, the project will commence in 2023. The EWS will employ satellite remotely sensed data, indices (such as the popular NDVI), and in-field P&D data for model development. The EWS will serve both the large- and small-scale grower sectors of our industry.


Dr Nitesh Poona


Ingrid Thompson

For further information contact Ingrid Thompson (Scientist: GIS and Remote Sensing) or Dr Nitesh Poona (Scientist: Digital Agriculture).

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34. Alternative measures from Smut management.

Priority Topic

Yes

Background

Preventative sprays/additional chemistries. Current recommendation is roguing and plough-out. Alternative control.

Desired Outcome

Alternative to roguing for smut management.

SASRI Response and Action

Fungicides

Seedcane health is an important factor in the integrated management of smut. Fungicides can be effective in reducing the risk of infection at planting, particularly after hot water treatment to produce Certified Seedcane. Bayleton 25% WP is the only fungicide that is currently registered against smut on sugarcane in South Africa, but it is no longer available. A replacement fungicide is required.

Two fungicides (a.i. Flutriafol : Fluoxastrobin and Azoxystrobin : Tebuconazole : Prochloraz) have been shown to be effective against smut at planting when applied to setts as a 10-minute soak or in-furrow spray. No smut was observed 6 months after planting in the soak treatments. Smut incidence (shoots infected) was up to 98% lower than the untreated control in the soak treatments and 92% lower in the in-furrow treatments 8 months after planting. In the 1R crop, incidence was up to 40% lower in the treated plots. Further efficacy data are required from trials with sufficient infection to allow a comparison between treatments before the chemical companies can submit a request for registration. This research is ongoing.

Protection of NovaCane® plantlets against smut (project pre-proposal submitted)

In order to protect young NovaCane® plantlets from rust in bulking plots, a routine foliar application of a registered strobilurin : triazole fungicide has recently been introduced before releasing the plantlets from the hardening off facility. Fungicide application at this early stage of growth may offer protection against other fungal pathogens including smut. This is likely to improve the overall health of Certified Seedcane produced in the bulking plots.

Chemical roguing

Time and motion studies indicated that applying glyphosate (10% v/v) to smut-infected stools was fourfold quicker than physical stool removal (manual roguing) (Project 18TD02). The amount of soil and plant material removed from the field during the chemical roguing operation was substantially lower than physically removing stools, saving time, and reducing costs associated with the disposal of the infected material. Based on grower surveys, chemical roguing is less popular than manual roguing. Chemical roguing has been selected as a case study in project 17KE01 (Refining SASRI's Knowledge Exchange Platform). A detailed communication plan will be developed during this phase of the project.


Sharon McFarlane

For further information contact Sharon McFarlane (Senior Scientist: Pathology).

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35. Pest and disease resistance development in varieties

Priority Topic

Yes

Background

New varieties picking up pests and disease – described as resistant but turn susceptible in field.

Desired Outcome

Re-evaluate varieties in field for resistance to pest and disease – based in the Lowveld.

SASRI Response and Action

Pest and disease susceptibility developing in varieties

The relationship between a plant and a pest or pathogen is complex. The ability of a pest or pathogen to damage a plant or cause disease depends on characteristics of the organism, the capacity of the plant to defend itself and environmental conditions.

Varieties differ in their ability to defend themselves against pest and pathogen attack. Varietal resistance or susceptibility to pests and diseases is a genetically determined and fixed trait and will not change over time. A variety will not change slowly from being resistant to susceptible (or vice versa) while exposed to a pest or disease. This is especially true in sugarcane, as a vegetatively propagated crop. However, the interaction between the same variety and pest or pathogen may have different outcomes depending on the level of pest or pathogen pressure, the age of the crop, and the environmental conditions under which the crop is being grown.

For instance, factors such as water stress or excessive nitrogen supply can increase the susceptibility of any variety to eldana, but this is as a direct result of the action of those factors on the physiology and nutritional status of the variety. If a variety is intolerant of water stress for example, this may compromise its resistance to eldana when water stress increases during periods of inadequate water supply. Such external stress factors do not have any effect on the genetic make-up of the variety or change the innate characteristics of a variety over time. Age is another factor that can affect the level of eldana damage and can become a factor of major concern if crops of more susceptible varieties are aged to over 12 months, especially in the irrigated north. All varieties gazetted for cultivation in regions where they are likely to be aged to more than 12 months are required to have at least a moderate level of resistance to eldana, to ensure they can be aged more safely. As sugarcane grown in the Irrigated North is grown on a 12-month cycle, susceptibility to eldana has been accepted by the PD&VC Committees as a risk that can be managed under the shorter growing cycle and with irrigation (and consequent lower likelihood of water stress).

Smut incidence is strongly influenced by environmental conditions, with warm dry winters and periods of water stress favouring outbreaks. The conditions in the irrigated north are highly favourable for smut. No released variety is immune to the disease which means that all varieties can become infected under favourable conditions when inoculum levels are high. The inherent resistance of each variety will however influence the rate of increase of the disease. Smut is also spread in infected seedcane, so one favourable season could result in a substantial, persistent increase in smut when infection in seed sources is not detected.

The varieties that SASRI releases to the industry have been tested rigorously for their level of genetic resistance to various pests and diseases at different stages of the selection programme, over several crops, and in different environments. For eldana, this includes screening varieties in trials with potted sugarcane in which external factors such as level of exposure to eldana, temperature, soil characteristics, nutrition, and water supply are uniform across the trial, ensuring that measured differences in resistance (i.e. eldana infestation and stalk damage) reflect differences in the genetic make-up of tested varieties. Furthermore, a uniform level of water stress is imposed across the trials during the period when the plants are artificially infested with equal numbers of eldana larvae, which are then allowed to bore into the cane for a specific length of time before sampling the trial. Therefore, the resistance of the varieties is measured under conditions of mild water stress, which varieties may well encounter in the field if released for commercial production. Six standard varieties with known eldana ratings are included in each trial. The success of each trial is determined using statistical methods and the eldana ratings of the pre-release varieties are calculated based on eldana damage in the standard varieties. Differences between regions in water supply, temperature, soil characteristics and crop nutrition can all influence the severity of eldana infestations, no matter what the genetically determined level of resistance (as measured in screening and plant breeding trials) of varieties grown in different regions may be. These are environmental or agronomic factors that can directly or indirectly affect the pest and consequently the crop damage it can cause. Information on relative resistance and susceptibility of varieties released to the Irrigated North is always generated by these trials and considered before release.

Smut screening trials are currently conducted in Pongola. At least three trials are planted annually. Two trials are inoculated by dipping setts of the varieties under test in a suspension of smut spores. The rate of infection using this method is fairly quick so these trials are assessed over two crops. The third trial is not inoculated but smut-infected spreader sections are planted between the rows of varieties under test to increase smut pressure. Smut infection is generally low in the plant crop in

this trial, so assessments are conducted over three crops. All trials are assessed three to four times between January and April each year. Nine standard varieties with known smut ratings are included in each trial. The success of each trial is determined using statistical methods. Provided there is sufficient infection in the trial and the standard varieties react as expected, smut ratings are assigned using statistical methods.

An important factor to be considered in the release of varieties in the north is the inverse relationship that commonly exists between smut and eldana resistance. In the past, varieties with resistant to intermediate ratings for both smut and eldana were accepted for release in the region. A change in strategy lead to the selection of varieties with a resistant to intermediate-resistant smut rating and excluding varieties with an intermediate rating. This necessitated a relaxation in the requirements for eldana resistance and resulted in two eldana susceptible varieties (N71 and N73) being released recently. If eldana resistance is to become an important factor in the release of varieties in the irrigated north again then growers would need to understand that eldana resistance may bring with it other compromises, such as in RV yield, which would have to be considered in the selection process.

Future plans

- *Eldana data from variety trials in the irrigated north*

Variety selection and evaluation trials are grown on a 12-month cycle in the irrigated north; consequently, eldana damage will usually not be severe enough in these trials to allow clear discrimination of varietal differences in eldana resistance. However, the variety evaluation trials conducted in Pongola and Mpumalanga will be surveyed for eldana damage to gather further data on potential varietal differences in resistance. The results will be communicated through Extension and at grower events.

- *Smut screening trials*

Plans are underway to inspect the late-stage Plant Breeding trials at the Komati Research Station more frequently for smut after Zhou (2018) reported that smut incidence in the late season Plant Breeding trials in Mpumlalanga was significantly higher than at Pongola. The control varieties selected for these trials have a range of smut ratings which will allow ratings to be assigned to the pre-release varieties in a similar way to the smut screening trials at Pongola. All these trials are taken through to the third ratoon, providing sufficient time for smut to develop under natural conditions. The additional information from these trials will improve screening efficiency for smut resistance breeding and would validate the ratings obtained from the Pongola trials.

An additional inoculated trial with late-stage selections for the irrigated region will be planted at Pongola. This trial will have bigger plots to reduce variability and improve the accuracy of the analysis.

Reference

Zhou MM (2018). Location and seasonal effects on genotype smut (*Sporisorium scitamineum)* infection levels among irrigated sugarcane breeding trials in South Africa. *Proc S Afr Sug Technol Ass (2018) 91: 181-184*

A communication plan has been developed to improve knowledge exchange on this topic.


Sharon McFarlane


Dr Malcolm Keeping

For further information contact Sharon McFarlane (Senior Scientist: Pathology) and Dr Malcolm Keeping (Senior Scientist: Entomology).

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36. Estimate technology

Priority Topic

Yes

Background

Using drones etc? NDVI applications for early warning?

SASRI Response and Action

The SASRI Director, Dr Terry Stanger, has sent a request to the Chairperson of the MIS Committee for advice on how best to enter into a data sharing agreement with the Mill Group Boards.

A pre-proposal has been submitted for a project aimed at developing an early warning system (EWS). Should the proposal be accepted for funding by the Industry, the project will commence in April 2023. The EWS will employ satellite remotely sensed data, indices (such as the popular NDVI), and in-field P&D data for model development. The EWS will serve both LSG and SSG sectors of our industry.


Dr Nitesh Poona


Ingrid Thompson

For further information contact Ingrid Thompson (Scientist: GIS and Remote Sensing) or Dr Nitesh Poona (Scientist: Digital Agriculture).

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CROP NUTRITION AND SOIL HEALTH

37. Salinity and sodicity in soils

Priority Topic

Yes

Background

Salinity problems caused by poor drainage and the absence of a subsurface drainage systems. Abnormal rainfalls on poorly drained soils. Illegal planting sugarcane by growers on wetlands. Poor maintenance of irrigation systems. An application of nutrients through fertigation can help minimize nutrient losses and improve nutrient use efficiency. SSGs require fertigation guidelines. SSGs require guidelines in the application and timing of chemigation (e.g., aphid control).

Desired Outcome

Intensive training in soil nutrition and financial management (teaching the basics to SSGs). Training SSG growers in soil sampling and soil classification (the identification of soil potential in the production of sugarcane). Training and planning of fertigation.

SASRI Response and Action

SASRI has extensive knowledge on the causes and management of salts in soils. These have been shared via lectures, presentations at grower meetings, popular articles and newsletters. However, this information has not reached a significant group of growers. Therefore, salinity and sodicity and costs to ameliorate affected soils will be addressed in a communication plan. The purpose of this plan is to structure the flow of information for maximum absorbance by the target audience.

Other aspects mentioned in the background section will also be addressed. Training material about salinity/sodicity, fertigation, crop nutrition and the recognition of soil potential are addressed in a current SASRI project (19TD03).

A communication plan has been developed to improve knowledge exchange on this topic.


Dr Rian van Antwerpen Dr Thandile Mdlambuzi

For further information contact Dr Rian van Antwerpen (Senior Scientist: Crop Nutrition and Soils; and Manager: Systems Design and Optimisation Research Programme) or Dr Thandile Mdlambuzi (Scientist: Crop Nutrition and Soils).

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38. Water logging and leaching

Priority Topic

No

SASRI Response and Action

Waterlogging

The soil serves as a reservoir for storing water and nutrients. In its natural state, the soil must absorb water on the surface (infiltration) and regain its natural state. However, at times the soil is unable to do that, it becomes difficult for water to go anywhere because of human activities. This then leads to condition referred to as waterlogging. Waterlogging occurs when water cannot drain from field leading to a saturated soil and puddling on the soil surface. It is often associated with over irrigation of poorly drained soils but can also be caused by poor surface water management of the surrounding fields (Figure 1). Inadequate drainage of the subsoil linked to excessive supply of water to the porous topsoil will lead to the development of a water table. The main consequence mostly cause by waterlogging is that, it could create anoxic or anaerobic (i.e. low air, stagnant) soil conditions. This promotes loss of nitrogen as gas (volatilisation of nitrous gases) and stunts root growth.

Figure 38.1

Different forms of field surface waterlogging

- *Causes of waterlogging*

  There are various types of waterlogging and these can be categorized based on certain factors which include the following.

- Ponding and runoff due to crusting: If irrigation or rainfall exceeds infiltration rate (or soil is sealed) and land is flat/shallow (limited surface run off), ponding may occur (effectively surface waterlogging).
- Compaction, shallow soils and impermeable soil layers that prevent excess water from draining.
- Intensive and/or over irrigation: This can cause a rise of groundwater table because water percolates deeply and the soil becomes waterlogged (Good drainage is essential to avoid waterlogging).
- Heavy rainfall: Heavy rainfall could result in a waterlogged condition. Waterlogging cause by rain could last for a short while or days depending on the amount of rain.
- Natural drainage: High clayey soils are less permeable than sandier soils.
- Seepage of water from earthen canals which could add significant quantity of water to the underground reservoir continuously.

- *Effects of waterlogging*

Soils can be affected by waterlogging in various ways which include the following.

- Anaerobic conditions could be created in the root zone (poor soil aeration).
- Growth of water loving plants can be abundant (growth of wild plants like sedges (watergrass) and some types of grass species).
- Impossibility of tillage operations.
- Accumulation of salts.
- Reduction in time for crop maturity.
- Lowering of soil temperature.
- Soil nutrients could be affected (mainly increased denitrification leading to gaseous loss of nitrogen from the soil).

- *Preventive measure and management for waterlogging*

  - Prevent the development of crusts by protecting the surface with a mulch or crop. Alleviate crusts with shallow tillage operation.
  - Prevent and ameliorate the development of compacted or impermeable layers by adopting controlled traffic. Alleviate compacted layers if present by ripping.
  - Know the water infiltration rates and water storage capacity of soils and irrigate accordingly.
  - Control the loss of water due to seepage from the irrigation canals.
  - Identify soils with poor drainage properties and install professionally designed subsurface drainage systems.
  - Augmenting outflow and preventing inflows (waterflow control structures onto and off fields). Systems to consider are contour banks, mulching, ridging/raised beds, strip cropping and terracing.
  - Do not irrigate with water of a poor quality (i.e., water classified as either sodic or saline).

  For further information on strategies to manage poor drainage and reduce waterlogging see information sheets as follows.

  1.2 Gully stabilisation and repairs
  3.1 Ridging
  3.2 Mole drainage
  3.3 Drainage in irrigated fields
  4.3 Subsoiling and ripping in ratoons
  4.7 Burning vs mulching
  4.10 Minimum tillage
  5.11 Properties of saline/sodic soils and their reclamation
  5.12 Irrigation water quality
  5.13 Water quality considerations
  6.2 Compaction of sugarcane
  14.4 Infield traffic management

Leaching

Leaching can be defined as the process when the soil loses essential water-soluble nutrients needed for crop growth due to excessive irrigation or rainfall. The rate of losses is highest in sandy soils and the rate of leaching increases due to the amount of irrigation, rainfall and high temperatures and also by the removal of protective vegetation. It is essential to understand the process of leaching and how it affects the environment and its effects on crops. In an instant were leaching occurs on a grower's field, the water-soluble nutrients leached need to go somewhere, often these flow into rivers, streams, lakes, or absorbed into ground water. Leaching also removes nutrients and micronutrients from the soil causing potential deficient for crops. Sometimes when leaching occurs, nutrients leave the soil creating a toxic environment that could cause damage to crops. When the soil becomes toxic, it means that soil health is affect (e.g. the number of earthworms found in the soil could decrease). Soils that have high infiltration rates and low nutrient retention capacity like sandy soils are most susceptible to leaching.

It is worth noting that SASRI project 19TD11 (Technology development for Small Scale Growers: Irrigation management) is aiming to design unique participatory learning resources to empower Small Scale Growers to adopt SASRI Best Management Practices associated with irrigation.

For further information contact Dr Rian van Antwerpen (Senior Scientist: Crop Nutrition and Soils; and Manager: Systems Design and Optimisation Research Programme), Dr Louis Titshall (Senior Scientist: Crop Nutrition and Soils) or Dr Thandile Mdlambuzi (Scientist: Crop Nutrition and Soils).


Dr Rian van Antwerpen


Dr Louis Titshall


Dr Thandile Mdlambuzi

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39. Fertiliser price

Priority Topic

Yes

Background

Very expensive for SSGs (the high fertilizer prices leads to low application of fertilizer. This compromises nutrient status of the soil leading to low/reduced yields). Fertilizer not being produced locally and affects its availability to SSGs during a time of need - sometimes with a two-week delay. This causes the demand to be high resulting in an inflation of the prize. This also means that fertilizer is not available when needed leading to a delay in application.

Desired Outcome

Subsidizing fertilizer to SSG might help in reducing the load of SSGs having to buy fertilizer. The establishment of a local fertilizer blender. This is hoped to stabilize the cost of fertiliser or even to reduce prices. The SSG community is in need of financial management training. The SSG community is also in need of Intensive soil nutrition training in order to understand the need of soil sampling and analyses.

SASRI Response and Action

For further information contact Thulani Masondo (Manager: Small-scale and Land Reform Grower Extension) or Mboniseni Buthelezi (Small-scale Grower Extension Specialist: Lowveld).

Thulani Masondo Mboniseni Buthelezi

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40. Nutrient deficiency

Priority Topic

Yes

Background

Timing of application of fertilizers (SSGs do not know when and how much fertilizer needs to be applied after harvesting. Can use of drones help in detecting nutrient deficiencies in fields? What nutrients can be applied through foliar application? Is there room for growth stimulants / growth hormones to help with nutrient deficiencies in soils? Can drones be used to solve nutrient deficiencies? Can application of NPK and micro-nutrients for uptake by leaves be done through drone technology? Can aerial application of nutrients help in solving nutrient deficient problems? SSGs may use the money intended to by fertilizer for household items. The problem with this is that growth will be restricted by the application of deficient amounts of fertilizer. Many SSGs still do blanket application of fertilizers. There should be a buy-and-apply strategy for SSG when it comes to fertilizer. They do not have storage facilities therefore they should buy fertilizer and apply immediately. What is the turnaround time for samples sent to FAS from Mpumalanga? If all growers would buy into sampling and testing, will FAS be in a position to handle the additional samples? There is currently a poor relationship between growers and extension personnel.

Desired Outcome

Training of contractors in fertilizer application as they are the ones that do fertilizer application in their fields. Intensive training in soil sampling and nutrient management. SASRI should look into the use of drones for the application of mixed products (Fertiliser / hormones / stimulants). Establish a FAS soil laboratory in the Mpumalanga region by SASRI will be advantageous for SSGs. SSGs trust recommendations by FAS as FAS is regarded as neutral. Some fertilizer companies give recommendations based on the stock that they need to sell. SASRI should adopt 3 or 4 contractors and train them so that the buy-and-apply strategy could work efficiently.

SASRI Response and Action

Engagement with contractors operating in the region regarding training needs form part of the programme of work of Mboniseni Buthelezi and is to be planned and undertaken in conjunction with other regional stakeholders.

For further information contact Thulani Masondo (Manager: Small-scale and Land Reform Grower Extension) or Mboniseni Buthelezi (Small-scale Grower Extension Specialist: Lowveld).

Thulani Masondo Mboniseni Buthelezi

Discussion of the other elements of this topic discussion is undertaken under sections:

- Provision of regional analytical services (Northern FAS laboratory)
- Foliar application of fertilisers and biostimulants
- Remote sensing for nutrient management in sugarcane
- Drones for fertiliser application

Provision of regional analytical services (Northern FAS laboratory)

The cost of establishing a new laboratory is exceptionally high, running into millions of rands of capital investment for infrastructure development and equipment acquisition. Operational running costs are also high, due to the high cost of consumables, the need for skilled, technical staff and continued servicing requirements of the instruments used in a modern laboratory. Furthermore, laboratory accreditation (e.g., ISO 9001 and ISO 17025) requirements have become necessary for many laboratory services, which add further running costs. To ensure that such as service is economically viable while keeping the unit cost per analysis affordable requires a large sample throughput (20 000+ samples per year).

If the current sample numbers from the region (Komatipoort, Malelane, Pongola, Eswatini and Mozambique) that are submitted to FAS are considered, it is unlikely that a viable economy of scale will be achieved for the region. Based on FAS records the average annual sample numbers (over the last 10 years) received from the Komatipoort, Malelane and Pongola regions has been about 400, 300 and 600, respectively. A further 800 and 600 samples per year are received from Swaziland and Mozambique, respectively. While the actuals fluctuate widely from year to year, the overall total remains well below what would be considered feasible to establish and maintain a laboratory service. While it can be reasonably expected that sample numbers would increase if a regional laboratory service were available, it still seems unlikely this increase would achieve the required economy of scale to support such a service. The FAS laboratory at Mt Edgecombe has capacity to service a far greater number of samples than this and will expand resources should sample numbers reach economic thresholds.

To assist growers with sample submission from all regions, the FAS provides a free courier service from all extension regions. Due to the long period where there was a lack of extension services in the NIA region, awareness of this courier service has been low. However, with the recent appointment of new extension officers in the region, this service will be highlighted as part of crop nutrition and soil health management training and support.

Samples are collected weekly at the indicated drop-off points and couriered to the FAS at SASRI. The drop-off points are indicated on the FAS website - https://www.fasagrilab.co.za/drop-off-points/.

It is worth noting that samples dropped-off after the weekly collection time slot will only be collected the following week. This is done to keep costs of this free, value-added service within reasonable limits. However, in cases where large numbers of samples are submitted well before the collection day, then an additional courier run will be arranged. This option can be discussed with your regional Extension Specialist or by contacting FAS directly. Once samples arrive at the FAS turnaround time is on average 8 working days for soil samples and 5 days for leaf analysis. It is thus important that these time periods are kept in mind when planning sampling and nutrient management planning.

The following strategies will be used to improve awareness of the sample delivery service:

- Improve awareness among extension staff (particularly new staff members) of the service.
- Create awareness among growers through the extension officers (e.g. grower days, newsletters and magazine articles, advisory interactions).
- Newsletters and Link articles advertising FAS services, including sample delivery options (ongoing)
- FAS is developing a Grower Portal that will give growers easier access to their reports as well as additional features such as sample payment.

- ***Foliar application of fertilisers and biostimulants***

Foliar fertilisation refers to the application of nutrient containing solutions to the leaf area of a growing crop, where many nutrients can be taken-up or absorbed into the crop directly from the leaves treated. Absorption of nutrients through plant leaves is a well-recognised in many crops (Fernandez et al. 2013). Foliar treatment is often suggested as a mechanism whereby nutrients that are not readily taken-up from the soil can be introduced to the crop, or in some instances to remedy deficiencies that have appeared in later crop growth where soil treatment may be too late or ineffective (Fernandez et al. 2013). Gopalasundaram et al. 2012 report that foliar uptake efficiencies can be as high as 90 to 95%, suggesting most of the applied nutrient can be taken up by the crop.

Fernandez et al. (2013) discusses the many factors that influence the effectiveness of foliar nutrient application. Key aspects found to affect the uptake and translocation of foliarly applied nutrients include:

- Leaf morphology, notably epidermal features (leaf area, hairs, coatings, stomatal openings)
- Ability of plant to translocate elements absorbed by leaf structures to other parts of the plant (genetics of plant influencing physiology and biochemistry)
- Environmental factors (temperature, wind, moisture) that affect both growth rate and application conditions.
- Properties of elements, fertiliser compounds and spray solutions, and
- Concentrations and frequency of application.

Specific concerns relate to toxicity effects where excessive amounts of some elements or compounds lead to toxic effects in the plant, salt effects caused by high salt concentrations leading to leaf scorch and damage due to excessive osmotic stress or excess alkalinity or acidity that can damage leaves. These factors can also greatly reduce the efficacy of uptake, thus compromising this approach in nutrient management.

In the case of sugarcane, research on foliar application of nutrients has not been extensive, though there are some studies that have investigated this approach mainly as a complimentary strategy to support and enhance crop responses from soil-based fertiliser applications. Possible reasons for lack of research on foliar applications include:

For macro-nutrients where crop requirements are typically high, achieving the target rates can be difficult by foliar application.

- While foliar treatment of micro-nutrient deficiencies has been found to be effective in many cases (particularly iron (Fe) and zinc (Zn)), the occurrence of deficiencies seems relatively low and many bulk fertilisers can be ordered to contain these elements so ensuring supply from the soil.
- Often deficiencies are due to an underlying soil constraint which may be related to low soil levels of the nutrients or due to factors reducing availability. Remedying these factors tends to provide longer term benefit to avoid deficiencies in the future.
- Some deficiencies are often temporary (such as ratoon chlorosis, an Fe deficiency, mainly found in young cane grown in alkaline soils) and often crop outgrows the condition where symptoms are mild.
- Where nutrient application is required to more established or mature cane, access to the fields with spraying equipment may be restricted and treatment is often deferred to soil-based treatments after harvest (though treatment may be more easily achieved in the case of overhead irrigation systems or aerial/drone-based application methods).

Studies that have examined foliar application of nutrients in sugarcane fall into two main categories:

- Supplementary or complete replacement nutrient application, mainly for macro-nutrients (mainly N, but also P and K).
- Treatment of suboptimal or deficient levels of nutrients (usually micronutrients).

Supplementary or replacement nutrient application

Ali et al. (1997) reported on basal N applications (at planting and topdressing) with supplemental spraying of N (5% urea solution sprayed at 250L/ha or 5.75 kg N/ha) across a range of rates and spraying rates and frequencies. Overall, they found no significant advantage to yield parameters due to application method, though leaf N was found to be greater in foliar treatments compared to soil only treatments. Stacciarini et al. (2021) investigated the application of supplemental foliar applied amidic N polymer (applied at 0, 1, 2, 3 and 4 kg N/ha by knapsack sprayer in 333 L water/ha,) to basal applications of ammonium nitrate (0, 50, 100, 150 and 200 kg N/ha) in Brazil. They reported no significant effects of either soil or foliar treatments, suggesting that soil supply was adequate at this site and may have masked in treatment responses. Raposo Junior et al. (2013) examined various foliar treatments (distilled water (control), potassium phosphate (K_2HPO_3), micronutrients, humic/amino acids (HAA), K_2HPO_3 +

micronutrients (Cu, Mo and Fe), K_2HPO_3 + HAA, micronutrients + HAA and K_2HPO_3 + micronutrients + HAA) on yield of sugarcane after application of fertiliser solutions at 30, 90 and 150 days after harvesting two-year-old crop in Brazil. The basal fertiliser treatment was not reported. They found no significant treatment effects of the foliar nutrient treatments on yield or quality parameters at any of the treatment times. However, it was noted that generally all parameters were higher in the foliar treatments than the control, suggesting some improvement.

Ranga et al. (2021) investigated supplementary foliar application of N, P and K over basal soil applied fertiliser in India. The basal treatment consisted of a regional recommended fertiliser treatment consisting of 150 kg N/ha, 22 kg P/ha and 42 kg K/ha and a basal only treatment served as the control treatment. Foliar treatments consisted of factorial combinations of 2 or 3 % urea, diammonium phosphate (DAP) and KCl applied in three applications 15 days apart (though actual spray rates are not reported). They reported an approximate 10 t/ha increase in sugarcane yield where foliar applications of 2 and 3 % combinations of urea, DAP and KCl were applied in addition to the basal fertiliser, while 3% solutions of urea and DAP or 3% urea and KCl yielded approximately 8 t/ha more than the basal treatment alone. All other foliar treatments also improved sugarcane yield, though not to this magnitude. However, the benefit to crop quality parameters or sucrose yield are not known as these were not reported.

Khokar et al. (2021) also investigated supplementary foliar application of N, P, K and micronutrients over a basal soil applied fertiliser treatment in India. The basal treatment consisted of a regional recommended fertiliser treatment consisting of 150 kg N/ha, 22 kg P/ha and 42 kg K/ha and a basal only treatment served as the control treatment. Foliar treatments consisted of various combinations of N, P, K (2 to 2.5%), Fe (1%) and Zn (0.5%) foliar sprays, applied in three applications 15 days apart. Like Ranga et al. (2021) they also found that foliar treatments increase sugarcane yield, where the best treatment consisted of a 2% NPK solution with Fe and Zn included (about 8 t/ha increase over the basal treatment). Sugarcane quality and sucrose yield also improved highest with this treatment (sucrose yield increasing by 2 t/ha).

Soudi (2012) examined the potential of additional K foliar fertiliser application when combined with a soil applied basal treatment in Egypt. Basal K was applied at 50 kg K/ha (along with 22 kg P/ha and 230kg N/ha) and foliar K was applied 2 and 3% K solutions (+ a zero control) applied in 950 L water/ha (about 20 and 30 kg K/ha). They reported that the foliar K significantly increased yield parameters, with the best performance found at the 3% solution application. Pawar et al. (2003) reported on the effects of supplemental foliarly applied P, (as well as foliar treatments that included B, Fe+Zn or Si) in combination with a basal fertiliser application (250 kg N/ha, 50 kg P/ha and 95 kg K/ha). Foliar P was applied either 8 or 12 kg P/ha, while B was applied as a 1%, Fe+Zn as a 0.5% and Si as 2% solution (though spray rates were not provided). They did not measure sugarcane yield, but reported the average plant and first ratoon, sucrose content increase significantly with foliar P at 8 and 12 kg/ha and Fe+Zn treatments (0.7, 0.9 and 0.6 % increase, respectively) over the basal fertiliser treatment.

Micronutrient application

Studies on micronutrient foliar sprays are more common that macronutrient application. In South Africa it does not appear that much work has been carried-out on foliar treatment, but the information available reported focussed on alleviating deficiencies observed under field conditions. Du Toit (1956) reported on Cu deficiency found on granitic soils of the KwaZulu-Natal (KZN) South Coast caused by high pH due to the excessive use of filtercake. The application of $CuSO_4$ either to the soil or as a foliar spray, alleviated deficiency symptoms, though the response to foliar treatment was much quicker. Du Toit (1962) also reported on Zn deficiencies on the KZN North Coast and remarked that soil applications of Zn tended to provide better responses than foliar applications. However, like for foliar Cu spray the response to foliar Zn was evident sooner after foliar application than soil treatment.

Mangrio et al. (2020) reported that in alkaline soils in Pakistan, 0.1% B solutions applied foliarly significantly improved sugarcane yield over an untreated control and soil application (1 kg/ha), while foliar Zn had no benefit over the soil applied treatment (though Zn application did significantly increase yield over the untreated control). Wang et al. (2005) compared soil applications of Zn as granular $ZnSO_4$ (0, 4.4, 8.9, 17.9, and 33.8 kg Zn/ha) and one foliar

application rate (1.3 kg/ha Zn). Soil applications of 4.4 and 8.9 kg Zn /ha significantly increased sugarcane and sucrose yields in both acidic and calcareous soils, but foliar application were only significantly better than the control on the calcareous soil. They advised soil applications of $ZnSO_4$ for lasting benefit. Rakkiyappan et al. (2002) reported that three applications of $FeSO_4$ (2%) provide the same yield response as soil applications of 150 and 225 kg/ha on a calcareous soil in India. This was attributed to the effect of high soil pH on Fe availability in the soil treatments, requiring very high rates to overcome fixation processes. Naga Madhuri et al. (2013) also reported significant cane quality improvements after foliar treatments of Zn or Fe over a control treatment, but not over soil applied treatments. Foliar B application did not provide any advantage, but soil applied B did. Mishra et al. (2014) reported significant yield and quality gains after applications of 1% MnSO4 or FeSO4 in an alkaline soil in India. Chen et al. (2016) reported on Fe deficiency (caused by excess Mn, commonly called acid chlorosis) in acidic soils in China. While crop yield parameters were not reported they demonstrated that the Fe foliar applications (0.2 and 0.3%) improved visual symptoms (Figure 1).

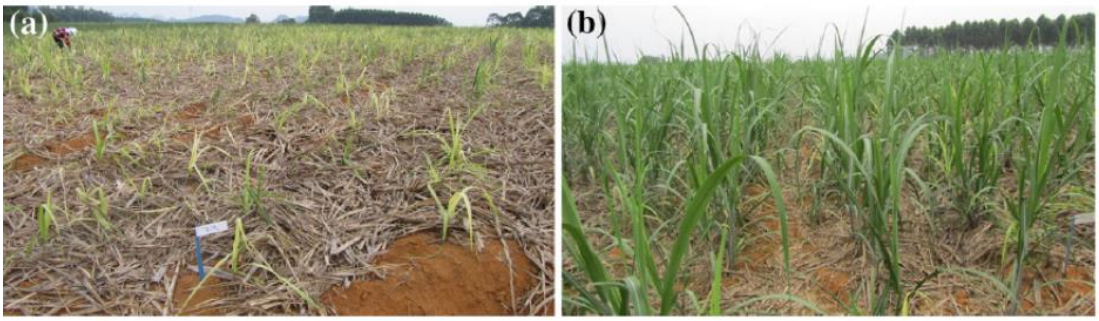

Figure 40.1

Effect of Fe foliar treatment of Fe deficient crop in an acid soil in China (from Chen et al. 2016), where a) is a field prior to foliar Fe spray, and b) several weeks after Fe treatments.

Abd El-Hadi (2015) investigated foliar micronutrient applications to sugarcane grown in micronutrient deficient soils in Egypt. They tested Zn-chelate, WuxalSuB Micro (N, Zn, Fe and Mn), FetrilonCombiWady (Zn, Mn, Fe), Algifert (N, P, K, Zn, Fe) and MetalosateMulti (Zn, Fe, Mn) against an untreated control on sugarcane and sucrose yield in the plant, and first two ratoons. Sugarcane and sucrose yield were generally significantly increased by applying the compounds (except the Algifert treatment), with average response in sugarcane yield ranging from -2 to 20 % and sucrose yield ranging from 4 to 30%.

Biostimulant spraying

Biostimulants are receiving increasing world-wide attention and are promoted as products that can improve nutrient uptake and use efficiency, increase tolerance to stresses (drought, disease) and stimulate crop growth. Rouphael and Colla (2020) indicate that biostimulants are broadly classed as being microbial and non-microbial depending on formulation procedures and define them as:

"…Substances and materials, with the exception of nutrients and pesticides, which, when applied to plant, seeds or growing substrates in specific formulations, have the capacity to modify physiological processes of plants in a way that provides potential benefits to growth, development and/or stress responses".

Sible et al. (2021) and de Moraes et al. (2018) both provide recent reviews of the different types of biostimulants and their use across several other crop types and sugarcane. While the number of studies investigating biostimulant products in sugarcane is increasing, comprehensive and independent research into their effectiveness is still lacking. SASRI has not conducted extensive research evaluating the potential of foliar biostimulant application. Providing clear guidance is thus difficult. While many of the products may have beneficial properties, there is also a

preponderance of unproven products (so-called Wonder-Products), often sold with exaggerated marketing claims. It is thus very difficult to clearly identify and advise on products that may provide actual and cost-effective improvements in sugarcane production. Current regulatory guidelines in South Africa require that these products be registered as Group 3 fertilisers where the key requirement for registration is they are demonstrated not to have any phytotoxic or deleterious effects (DAFF, 2016).

- *Sugarcane responses to foliar applied biostimulants*

Some studies that have reported on foliar treatments of biostimulants reported mixed results. For instance, Raposo Junior et al. (2013), found no significant benefits of humic or amino acids applied with or without nutrients. Abd El-Hadi (2015) investigated micro-nutrient treatments which include some biostimulatory products derived from organic materials and found this product did not enhance crop growth compared to micronutrient treatments. Anggraeni et al. (2022) combined soil applied silica with foliar biostimulant foliar sprays (unnamed product, applied at 3 and 6 L/ha)) and reported no benefit of either the biostimulant or Si on sugarcane growth parameters in Indonesia. They did find smaller but significantly better Brix and Pol responses in the 3L/ha + 100kg silica/ha treatment, but not in any other treatments. Ferreira et al. (2020) compared the use of an organic fertiliser and sewage sludge with or without biostimulants in the production of sugarcane and found that the biostimulants did not result in any significant improvements. Similarly, Sousa and Korndörfer (2010), Silva et al. (2007) and Oliveira et al. (2013) also did not find significant effects of biostimulants on sugarcane and sugar yield.

By contrast, Jacomassi et al. (2022) reported on the foliar application of seaweed extract (SWE) and found that the product enhanced tolerance against drought stress while increasing sugar yield by 2.8% in sugarcane grown in Brazil. Similarly, Karthikeyan and Shanmugam (2017) also reported improved crop growth in plant and ratoon crops when treated with a K-rich SWE at 1% in India. Chen et al (2021), also testing SWE, reported that foliar treatment improved sugarcane yield, but that it was dependent on crop age for best response. They found that application at the seedling and early stalk elongation phases gave the best yield response (about 9% increase). Spraying at the mature stages improved sucrose accumulation by 5%. The effect was greatest in drier years and attributed to stimulation of better crop enzyme and nutrient use efficiency. Silva et al. (2010) tested the application of a biostimulant with or without liquid fertilisers in five varieties. They reported an increase in yield of sugar and sugar (with or without the use of liquid fertiliser). Dias et al. (2015) also observed positive responses in the first and second ratoon with use of biostimulant. da Silva et al (2017) evaluated a mixed diazotrophic bacteria and humic acid derived from vermicompost blend as a furrow and foliar spray. They reported that foliar sprays performed better than soil treatments and increased stalk yield by 37, 5 and 24% in the plant and first and second ratoon crops, respectively.

These findings highlight the inconsistent responses, though do suggest potential benefits under some conditions. Sible et al. (2021) highlight that often the empirical responses are observed, but the mechanisms for these are not well understood or investigated, which limits their more widespread use in targeted applications. Further research is required to better understand and advise on these products.

- *General remarks*

While crop responses are varied, many studies suggest that foliar application of nutrients have positive benefits to yield and quality. In the case of supplemental macro-nutrient application there are few studies and results are varied. In none of these studies examining macro-nutrients were clear deficiencies identified, thus it remains unclear whether positive (or no responses) were linked to plant deficiency or due to some other stimulatory effect. Furthermore, most studies examined foliar treatment in addition to a basal fertiliser regime, thus assessing benefits over higher soil treatments cannot be examined. Furthermore, because most of the studies also applied basal fertiliser treatments, this indicates that full replacement of macro-nutrients is not a feasible option either. This might be expected as it is unlikely that the full crop requirement would be met with foliar treatments alone (or at the very least would require very regular foliar applications). These factors thus do not permit proper guidelines to be developed at this time.

At this time SASRI would not advise replacing more conventional macro-nutrient management strategies in favour of foliar only applications.

In the case of micronutrients, the benefit of foliar treatment is better demonstrated for Cu, Fe and Zn, but are less clear for Mn, B and Mo. Foliar application of Fe appears particularly effective in soils where deficiency is pronounced (alkaline or very acid soils) due to immobilisation or Mn-antagonistic effects in those soils. The advantages of foliar application of Cu and Zn do not seem to surpass that of soil-based treatments, though crop responses tend to be far quicker. Soil-based treatments are likely to have more persistent benefit in several crop cycles, where foliar application may be suitable to remedy severe symptoms during early crop growth to avoid harvest yield losses. Soil-based Fe treatments are found to be ineffective due immobilisation in soils and foliar treatments are likely to have greater success in alleviating a deficiency. However, as Fe deficiency is often a transient condition that the crop can outgrow, treatment is often not required except in severe crop limiting conditions. Remedying soil conditions that lead to low Fe availability tend to provide longer term benefits.

In the case of biostimulants, the lack of clear information for advisory purposes does not permit guidelines to be established. Where growers wish to investigate the potential responses of a product, SASRI has previously provide guidelines and recommendation on undertaking on-farm testing (see Further Reading below). It is important that where such tests are conducted that suitable comparative control treatment be included.

– *Further reading*

For guidelines on treating micronutrient deficiency in sugarcane using foliar spray treatments consult Information Sheets 7.8 to 7.12 and the SASRI soils handbook (available from https://sasri.org.za/crop-nutrition/).

For a compressive guide to foliar fertilisation, the book by Fernández et al. (2013) is available for free and can be downloaded from https://www.fertilizer.org/images/Library_Downloads/2013_foliar_fertilization_HR.pdf.

For details on conducting on-farm trials or to request Specialist Advisory Services from SASRI see RD&E Communique issue RD2018/13 and the following articles:

- Baker, C. Message from the Director. The Link, May 2016, pg. 3.
- Management of Specialist Advisory Requests (SARs) submitted by commercial companies. *The South African Sugar Journal*, September 2009, pp. 137-138.
- Miles, N. & van Antwerpen, R. Miracle plant growth products: Too good to be true? The Link, September 2009, pp. 6-7.
- Redshaw, K. Specialist Advisory Requests. The Link, September 2011, pg. 11.
- Redshaw, K. SASRI's role in assessing new products. The Link, May 2016, pg. 17.
- Keeping, M 2020 On-farm product testing. The Link, January 2020, Pg 14.

A newsletter article (*The Link*) is proposed to capture the main findings of this mini review.

- **Remote sensing for nutrient management in sugarcane**

In sugarcane, fertility recommendations are mainly based on soil testing. Subsequent nutrient uptake is assessed by leaf sampling and nutrient analysis, undertaken at predefined periods to permit diagnostic interpretation. Leaf analysis allows verification of the success of the nutrient management plan and guides a grower regarding potential nutrient uptake issues in their fields. This approach is reactive in nature, where generally little can be done within that season to rectify any problems, particularly where sampling was done toward the end of the ideal sampling period. In the South African sugar industry leaf sampling has not been extensively used as a crop response monitoring tool to guide nutrient management programmes. Reasons for this include difficulties or the effort required to collect samples, cost and time of analysis and a poor understanding of the value of leaf analysis. Furthermore, in the case of some nutrients (such as P) or where samples were collected late in the growth cycle, there is limited opportunity to rectify a deficiency within the

growing season sampled. In cases where samples are collected to determine a cause of a visual symptom, it is also likely that the crop production and quality has already been negatively affected. Given these constraints, many growers do not view leaf assessment as a valuable crop monitoring tool. Alternative methods that are rapid, near real-time and cost-efficient are thus desired to reduce analytical costs and encourage the more regular use of leaf sampling as a valuable crop monitoring and nutrient management tool.

The advances in remote sensing (RS) technologies, specifically hyperspectral remote sensing (spectroscopy), have presented opportunities for in-field, near real-time, non-destructive quantification of leaf nutrients. Remotely sensed visible and near-infrared (VNIR) spectroscopy has shown promise as a near real-time, non-destructive, and accurate methodology for estimating leaf nutrient concentrations in standing crops, most notably N. Optical sensors sensitive to the target wavelengths can be handheld or be aerially deployed (sensors mounted to overhead booms, drones, aircraft, and satellites). These spectral signatures, using various spectral modelling techniques, can be used to develop predictive models for estimating leaf nutrient concentrations in standing crops.

These benefits would encourage growers to undertake more frequent and intensive leaf surveys to establish the effectiveness of their current nutrient management practices. In some instances, it would permit a grower to evaluate the consequence of a remedial action (e.g., a N or K top-up application, monitor test plots and on-farm trials) within a few days to weeks of treatment with minimal additional sampling and analysis cost. Identification of causes of nutrient induced poor crop growth may also be possible (e.g., identifying deficiencies in standing crops, poor growth patches).

Of value within a given growing season is the optimisation of the application of N fertiliser, which translates directly to avoiding excessive N application that could lead to delayed maturation and reduced sucrose content. Opportunity also exists to evaluate potential problems due to unforeseen events leading to large nutrient losses (e.g., high rainfall causing excessive leaching on sandy soils or volatilisation losses on waterlogged clay soils). Where drone-based RS diagnostics are combined with drone-based fertiliser application methods, targeted N application may be feasible (within drone payload constraints) (Veroustraete 2015)

For nutrients that are more difficult to deal with after crop establishment (e.g. P, K, micro-nutrients), the diagnostics will guide remedial actions to improve conditions after crop harvest. In cases of severe deficiency, options such as foliar nutrient applications can be considered for interim remediation of the deficiency (see sections on foliar application of fertilisers and drone fertiliser application).

Robson et al. (2014), who reviewed the use of remote sensing to improve N management of sugarcane in Australia, proposed that remotely sensed leaf nutrient data could be used in three main ways:

- To directly measure leaf nutrient content of live plants and effectively replace more conventional and destructive leaf sampling and analysis where predictive models provide sufficient accuracy. This could replace conventional leaf sampling and analysis methods.
- Assessment of relative response using test strips of non-limiting nutrients (similar as is more commonly being used in maize and wheat N management). This would provide a more objective assessment of the responses of such trials, while also potentially eliminating the need for traditional leaf analysis.
- Use of the remotely sensed data within a more complete precision farming management system, where nutrient management strategies are adapted to target specific zones based on the combined data outputs. This may include identifying area of under-performance that would require more attention in the future, though the approach would unlikely benefit within season management.

Drones (or unmanned aerial vehicles) provide a platform from which above-canopy RS sensed information can be collected quickly and over large areas with relatively little effort, allowing for both intensive and extensive monitoring of fields. An advantage of a drone-based system is that readings can potentially be collected under cloud-cover, whereas aircraft or satellite-based system can be constrained (Robson et al. 2014). Given that much of the interest in the use of real-time RS leaf

nutrient content monitoring would likely coincide with the active crop growing season (i.e., spring and summer period when rainfall and cloud cover is expected to be greatest), this gives ground and drone-based RS technologies a distinct advantage. Regardless of the approach to obtaining spectral signatures, be it at the leaf or canopy level using aerial platforms, it is still a requirement that calibration be undertaken, and suitable predictive models be developed. Deriving an optimal subset of spectral bands for accurately modelling leaf nutrients could translate to significantly cheaper (compared with the cost of a research-grade spectroradiometers) customised sensors that can be deployed on drones, tractors, or boom-sprayers for real-time measurements (Tisserand 2019, Amaral et al. 2018).

Despite the increasing use of remotely sensed leaf nutrient data in other field crops (such as maize and wheat), only a limited number of studies have explored the utility of *in situ* remote sensing for estimating leaf nutrient concentrations in sugarcane. Probably the earliest study to employ spectral data in sugarcane research is Jackson et al. (1980). The researchers modelled N and potassium (K) deficiency in sugarcane using red (630-690 nm) and infrared (760-900 nm) bands and band ratio-ing. Almost three decades later, Mokhele and Ahmed (2010) modelled N and silicon (Si) in five cultivars of 7-month-old and 10-month-old sugarcane plants as a proxy for monitoring *Eldana saccharina*. Similarly, Abdel-Rahman et al. (2010) employed spectral data and narrowband spectral indices for estimating sugarcane leaf N concentration in N19. Both 2010 studies successfully demonstrated the utility of *in situ* hyperspectral data to model sugarcane leaf N concentration, highlighting the potential to upscale models to airborne, drone, and satellite-borne sensors. While the work of Mokhele and Ahmed (2010) and Abdel-Rahman et al. (2010) were limited to modelling N in the context of P&D stress, the studies did highlight the potential for using hyperspectral data for modelling plant nutrients. Unfortunately, there has been no follow-on research toward refining and operationalising the developed models for the SA sugar industry.

Elsewhere, Miphokasap et al. (2012) also employed spectral data and narrowband spectral indices to model N and P variation in three sugarcane cultivars. The study highlighted the differences in N and P between cultivars. This is significant, within an operational environment, where there is variability in N and P concentration across fertilisers, as well as variability in N and P use efficiency and uptake by different sugarcane cultivars under variable growing conditions. Similarly, Portz et al. (2012) used a handheld N sensor to calibrate spectral signatures to N content of sugarcane crops at 0.2, 0.4 and 0.6 m stalk heights in Brazil. They reported good calibration co-efficients (R^2 = 0.79 to 0.94), though found measurements at the 0.2 m growth stage proved too early, whilst sensor saturation occurred at the 0.6 m stage. While they found better calibrations using separate functions for each growth stage, the combined model still provided a reasonable calibration (R^2 = 0.84 with a very low RMSE of 9.14 g kg^{-1}). Miphokasap and Wannasiri (2018) successfully predicted (R^2 = 0.78 and RMSE = 0.035%) and mapped canopy N concentration using satellite acquired hyperspectral data in Thailand, thus providing guidance on large scale N management, where deficient (or over-supplied) areas could be more accurately targeted for investigation and correction). Dalen et al. (2019) reported moderately good estimates of stalk N content (as well as yield and fibre) from canopy-based measurements using red and red-edge reflectance-based vegetation indices, collected at 3 to 16 weeks after N application. In perhaps the only drone-based data acquisition study, Shendryk et al. (2020) used multispectral sensors to estimate N content in sugarcane in N-rate trials in Australia. While the calibration models were generally not strong (R^2 = 0.5 to 0.6), they indicated that the approach would still allow areas of underperforming sugarcane (due to N deficiency) to be identified reasonably early in the season where additional top-ups could still practically be applied. They also suggested that this approach could be adapted to enhance split-application of N (i.e., reduced application at or soon after planting/harvest with top-up applied based on crop response derived from RS data). However, at this time it appears that the use of *in situ* and RS nutrient data is not being used to guide nutrient management in sugarcane crops. In the only study found where real-time RS data was evaluated to adjust N-application rate in sugarcane, Amaral and Molin (2013) and Amaral et al. (2015 and 2018) evaluated an above-canopy sensor to predict N content, then developed an algorithm to estimate N application rate which was evaluated using a boom-mounted sensor on a tractor to measure canopy N content and variably apply N as the tractor passed through a field. They were able to successfully implement this system under field conditions, though did highlight that the most successful application of the technology was achieved when individual rows were assessed and treated, but that up to three rows could be measured by a single sensor and treated without a major loss in precision N application.

An alternative approach that does not focus on direct measurement of N concentration but considers the response ratio of NDVI of a control (zero treatment) against a non-limiting treatment taken early in the season to predict the harvest response has shown some potential in N management. Lofton et al. (2012) found that the use of a mid-season response index based on the response between a 0 N (control) and non-limiting N plots predicted harvest responses moderately well in sugarcane in Louisiana. This approach can be adapted, where nutrient monitor plots with an adjusted application strategy (mainly N) could be implemented that provides a comparison to a standard practice. The magnitude of the response index could provide an indication of the likely improvement that might be expected at harvest. This would require further testing and development over a wide range of conditions.

In light of the potential benefits of using RS data in nutrient management, a project has commenced at SASRI (starting April 2022) that has a main objective to develop a methodology using *in situ* hyperspectral data (in the spectral range 350-2500 nm) and advanced modelling techniques for estimating leaf nutrient concentration in sugarcane leaves (Project 21CM01). The specific objectives of the project are to:

- Evaluate the VNIR (400 nm - 1 200 nm) and shortwave infrared (SWIR; 1200 nm- 2400 nm) wavelengths to model leaf nutrients (N, P, K, Ca, Mg, Fe, Zn, Cu, Mn, S and Si) in sugarcane leaves,
- Determine the specific wavelengths required for modelling leaf nutrients, at leaf-level (individual leaf scanning) and canopy-level (overhead scanning),
- Compute existing indices and determine their ability to predict leaf nutrient concentrations,
- Assess the impact of varying leaf nutrient concentrations on model development and performance, and
- Test the general applicability of the developed models across varieties and crop age classes.

Much of this work will initially be carried out using the newly acquired ASD Field Spec instrument to help define the necessary operating parameters to for direct or RS based monitoring of the crop. The outputs of this stage-gate project will form the foundation for follow-on projects that will seek to develop and test optimised narrowband spectral indices to improve nutrient prediction and explore the potential upscaling of the developed models to UAV and/or spaceborne platforms. Outcomes from this project will guide further developments in the future.

- **Drones for fertiliser application**

The use of drones for the precision application of agrochemicals has received much attention in recent years. Several advantages reported include more accurate and precise application of chemicals to specific target areas, thus lowering chemical use and costs (and imparting great environmental suitability). Drone-based applications also reduce operator contact time with the agrochemicals and eliminate the need for labour to carry heavy sprayers across fields (in the case of manual spray operations). Furthermore, the speed of application is often greater than for conventional methods, especially on challenging terrain or where ground access is not possible. Much of the focus has, however, been on agrochemicals to control pests (weeds, pests, disease) and more recently, for application of ripeners for cane maturation. The use of drones to apply fertiliser appears to be a less common practice, though there are several reported instances of drone operators offering the service in the South African sugarcane industry.

Research literature relating the use of drones to apply fertiliser seems limited. Several review papers considering use of drones in agriculture refer to the application of fertilisers, but none provide specific details or application scenarios (e.g., Devi et al. 2020, Dutta and Goswami 2020, Man et al. 2019, Mogili and Deepak 2018).

Feedback received from SASRI Extension Services regarding regional experiences highlighted that where drones where being used for fertiliser application this was mainly restricted to low-rate (10 to 20 kg N/ha) top-up applications of granular nitrogen (N), most notably when the crop had reached the “out-of-hand” stage (i.e., where ground access to the field is limited or not possible). No instances of drone fertiliser application for bulk fertiliser application or foliar treatments were reported. Feedback received from a commercial drone operator indicated that they did not currently consider it economically feasible to apply bulk granular fertilisers to crops using drones (>100 kg/ha), though

noted it was possible but at a much slower coverage rate. At lower rates (either as granular top-ups or foliar sprays) the operator considered drone application to viable and cost-effective compared to more conventional ground-based approaches, particularly where access was a problem. However, the specific cost-to-benefit remains uncertain.

A constraint for bulk (i.e., high rate) granular fertiliser application relate mainly to the payload capacity of the commonly available agriculture drones, this ranging between 10 and 35 kg maximum (see for instance DJI (ww.DJI.com), Hylio (www.hyl.io) and Helio (www.heliocn.com) agriculture drones capable of fertiliser spreading). For instance, typical nitrogen (N) requirements range between 100 and 180 kg N/ha, this being equivalent of between 220 and 390 kg Urea (46)/ha or 360 and 640 kg LAN (28)/ha. A similar situation occurs for potassium (K) where requirements range between 50 and 200 kg K/ha, this equating to 100 to 400 kg potash (KCl)/ha. While phosphorus (P) application rates tend to be much lower (10 to 40 kg P/ha), this still is the equivalent of 45 to 180 kg MAP/ha. It should also be noted that generally some combination of all these nutrients is required (often as a bulk blend), thus total mass of fertiliser required can be several hundred kg/ha. With current drone payloads it seems unlikely that it will be effective for bulk fertiliser application purposes. Feedback received from the commercial drone operator indicated that 200 kg/ha granular fertiliser could be applied at a rate of about 1.5 ha/hr (or 12 ha over 8 hrs). This may improve as drone payload and flight time capacity increases in the future.

In the case of top-up nutrient applications, traditionally this is restricted to N applications later in the growing season to compensate for N deficiency due to external factors that have either promoted N losses (e.g., high rain leading to N leaching losses) or better than expected growth than initially considered in developing the nutrient programme for that season. In these instances, top-up applications of between 10 to 40 kg N/ha (or 22 to 90 kg urea/ha) are often used. As often the tops-ups are needed in established standing cane with full canopy cover, ground access will be limited and thus any compensatory N application does not get applied. Drone-based top-ups may thus offer some advantage under these conditions. At these lower top-up rates, it appears feasible depending on actual application rate required and drone payload capacity. In the case of P and K, top-ups are typically not applied as these elements are less prone to losses from the soil, while application later in the growing season has not been shown to be particularly effective at enhancing crop uptake or yields.

Foliar nutrient treatment (liquid fertilisers) appears to be a potential area of growth. While bulk supply of major nutrients is not practically feasible by foliar feeding (see section on Foliar Fertiliser Application), the treatment of specific deficiencies may be possible. In the case of N, often urea solutions of around 4% are used in foliar applications (or 200g urea (or 96g N) in a 10L applicator tank up to 1.6kg urea (or 768 g N) in a 40L applicator tank). At higher concentrations risk of leaf scorch can occur and are thus not normally advised. As these rates provide a very small proportion of the crop N requirement, there appears to be limited benefit of this approach apart from minor top-ups. Similarly, typical micronutrient spray application recommendations require a 1 to 2% solution sprayed at between 200 and 400 L/ha, though feasibly this could be reduced to much lower spray rates with higher solution concentrations. Specific guidelines provided by the fertiliser supplier will need to be adhered to prevent crop damage and ensure adequate application rates.

Where growers are interested in using drones to apply fertiliser these should be discussed with a local service provider that can indicate the application rates possible with their available equipment and associated costs and compare this to their more conventional approaches. It is also important that soil constraints and nutrient limits be adequately addressed during site preparation, as nutrient application is limited in its capacity to adequately address major nutrient requirements.

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For further information contact Dr Louis Titshall (Senior Scientist: Crop Nutrition and Soils) or Dr Thandile Mdlambuzi (Scientist: Crop Nutrition and Soils).


Dr Louis Titshall Dr Thandile Mdlambuzi

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41. Soil classification.

Priority Topic

No

SASRI Response and Action

Sugarcane grows well on good soils, but it is also important to have greater knowledge on how to manage degraded or low potential soils on their farms. Soil classification offers small scale growers the opportunity to know the soils in the farms, how they differ across their farms and be in a position to make informed decisions about their soils. However, traditional soil classification requires specialist knowledge and extensive experience to undertake properly, thus is generally beyond the scope of most growers and requires that costly consulting service be acquired to map soils. To address these concerns SASRI has commenced two projects:

Project 18TD08 (Capacitating Small Scale extension in estimating yield potential in SSG regions using simple soil data) that started in 2021 seeks to address issues around soil classification for SSGs. The aims of the project are to:

- enable extension personnel to use soil data to estimate yield potential in the SSG regions; and
- develop a database for each extension region.

Project 21KE03 (The development and linking of soil management units to better management practices in the Northern irrigated regions) that started in April 2022 seeks to address aspects around this issue. The project aims to establish a set of simple classifiers so that soil management units (SMU) can be more easily defined (i.e. without the need for complex classification knowledge), where the best management practices can be linked to specific SMUs. This will allow growers to more easily define the practices that they should consider for their soil types. This work will seek to refine the information presented in the SASRI soil bulletin “Identification and management of the soils of the South African sugar industry” (available from the SASRI E-library)

For further information contact Dr Rian van Antwerpen (Senior Scientist: Crop Nutrition and Soils; and Manager: Systems Design and Optimisation Research Programme), Dr Louis Titshall (Senior Scientist: Crop Nutrition and Soils) or Dr Thandile Mdlambuzi (Scientist: Crop Nutrition and Soils).


Dr Rian van Antwerpen Dr Louis Titshall Dr Thandile Mdlambuzi

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42. Soil erosion.

Priority Topic

No

SASRI Response and Action

SASRI has over the past years developed content to inform growers on the importance of soil compaction and erosion. Project 19TD03 (Soil conservation and learning resources for small-scale

extension) is a SASRI project that seeks to develop teaching and training material to help address and bring awareness around these issues. A newly developed information sheet which will be published soon by KMU from SASRI will also assist in providing educational awareness on how to prevent and or combat soil erosion. The text below is a summary of the content in the new information sheet that will be published in due course (Managing soil erosion)

Soil compaction

Soil compaction is simply an increase in the density of the soil due to compression by wheels of in-field equipment. Compaction mostly occurs near the soil surface (30 cm depth) or in the deeper layers of the soil. When compaction has occurred, it leads to dense, low permeability layers that reduces water infiltration, increased water runoff and erosion, could export topsoil and valuable nutrients, reduce air movement in soil and impede root growth, it is just undesirable. In sugarcane production, harvesting and crop extraction can cause compaction. Harvesting and cane extraction during wet conditions is sometimes an unavoidable practice, but infield traffic will cause damage through compaction, sealing/capping and physical damage to cane stools. Yield losses as high as 40% have been recorded. Soils are most susceptible to compaction when their moisture content is near field capacity. Traffic over the cane row has a more severe effect on yield than traffic in the interrow. Amelioration through ripping is only slightly beneficial. Tines can have a detrimental effect due to root pruning, which inhibits growth of the subsequent crop.

It is necessary to adopt practices that limit the extent of the impact and using practices that aim to remediate compacted soils will minimise negative consequences. These include the following.

- Reducing infield traffic (especially on wet soils).
- Adopting controlled traffic systems.
- Avoid working on wet soils (particularly near field capacity moisture content).
- Traffic over the cane row has a more severe effect on yield than traffic in the interrow due to stool damage.

It is worth noting that amelioration of soils that have been compacted is very expensive and may have limited success where it is not undertaken properly.

Additional reading related to erosion

- Information Sheet 6.2: Compaction
- Information Sheet 14.1: Soil quality and degradation
- Information Sheet 14.4: Infield traffic management

Also see:

- van Antwerpen and Miles. 2019. Identifying and addressing soil compaction. The Link September 2019
- Miles and van Antwerpen. 2017. Compaction and crusting: a frequent problem in ratoons. The Link January 2017
- Meyer. 2002. Soil compaction: A matter of managing risk. The Link May 2012
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Soil erosion

Soil is a primary, non-renewable resource for field crop production, and must be protected and conserved. Soil phenomenon such as soil erosion is very disruptive to the soil and could result in a reduced productive potential of the soil. Losses of topsoil through soil erosion either by wind or water has major consequences on crop production. Under Small-Scale farmlands there has been heavy visibility of soil erosion as compared to large scale grower's farmlands and this then suggests that Small-Scale grower farmlands are susceptible to soil erosion compared to Large Scale. According to the South African Conservation of Agricultural Resources Act (No 43 of 1983), it is a requirement to undertake measures that protect and conserve natural resources, including the soil. As such it is imperative that measures to remediate, minimise and prevent the negative impacts of erosion be undertaken.

- *Impacts of erosion and soil loss*

  The consequences of erosion can be devastating to any agricultural production, where the loss of topsoil leads to the lowering of the ability of that land to support crop growth. A loss of 1 mm of soil over one hectare is the equivalent of between 10 and 14 tons of soil. Some have estimated that this is the loss of about 20 kg sucrose per hectare. Unfortunately, the loss of a one or two millimetres of soil is not readily observed in fields, so often gets ignored. However, if you consider that the soil surface layers are the most important in terms of supplying nutrients and water to a crop, it becomes very apparent why erosion must be prevented. When losses become noticeable it indicates soil loss may be in excess of 150 tons per hectare (about 15 mm of topsoil). This can easily occur on unprotected soils on steep slopes and under high intensity rainfall events, a common feature in large parts of the sugarcane growing region. The impacts of this loss include the following.

  - Lost nutrients, organic matter and water holding capacity reducing the productive capacity of the soil. This increases input requirements to maintain yields.
  - Exposure of subsoil layers that are lower productivity soils. It is both costly and slow to return them to productive condition.
  - Loss of productive area due to formation of gullies limiting your ability to access or cross lands and reducing the area that can be planted. Gully repairs are costly and it is a slow process for the area to recover.

  Erosion impacts are not just limited to fields though and affects the surrounding and downstream areas as well as users, both within and beyond the farm boundaries. These include the following.

  - Damage to roads reducing field access (lost time and efficiency) and requiring repairs (time and cost).
  - Sedimentation, silting and blockage of ponds, dams, rivers and waterways. This lowers the water storage capacity of dams, and increases flooding risks and water treatment costs, while negatively impacting on the ecology of these water ecosystems. Dredging, excavating and removal of sediment build up is costly and can also lead to further damage.
  - High nutrient loads in erosion sediments that are introduced into water bodies lead to nutrient enrichment (eutrophication) which promotes algal blooms and encourages invasive water plant to proliferate, negatively affecting water quality and stream flow.
  - Ultimately erosion sediments can reach the sea, where plumes of cloudy water are evident from river outlets after large inland rainfall events, this adversely affecting near-shore ecology.

- *Types of erosion*

Erosion is the general term used to describe several processes that lead to soil loss. It is a natural process, though certain conditions and practices can greatly increase the risk and rate of it occurring. Broadly erosion it divided into three types: 1) mass movement, 2) wind and 3) water erosion (Splash, Sheet, Rill, Gully, Pipe or Tunnel, Streambank and Collapse). More information is found from the soils book and information sheet.

Mass Movement: This refers to the downward sliding of sections of soil and rock from steep slopes. This may be seen as soil creep and slumping in sections of a slope, and in severe cases, become landslides where entire slopes collapse and move down a hillside. It is associated with unstable soils on steep slopes. It is often triggered by prolonged rainfall and saturation of the soil. In most farming situations the impact tends to be localised to the affected slope and is more likely to occur in hilly areas.

- *Causes of erosion and soil loss*

Erosive forces are a combination of several factors and conditions that, when they occur in the right combination and intensity, can lead to soil loss. These include natural factors related to the characteristics of the landscape and soil and climatic conditions, and the management factors that can affect the risk of erosion and rate of soil loss.

- *Natural factors*

The dominant drivers include the following.

a) **Steepness of slope:** Steeper slopes increase the rate of run-off and reduce time for infiltration, thus leading to greater energy in water flow to move soil particles downhill.
b) **Length of slope:** The longer a slope is the more water can accumulate and the greater the energy it can have to dislodged and remove particles.
c) **Soil texture:** Clay soils tend to have lower erodibility than sandier soils, this due to the higher cohesiveness of higher clay soils. However, in clay soils that lack cohesion when wet (often dispersive and sodic soils), erodibility can be high. Freely draining sandy soils, while lacking cohesion between soil particles, tend not to erode easily due to high infiltration and drainage rates. However sandy soils associated with poor drainage are more susceptible to soil loss. Silty soils tend to be the most erodible due to low cohesion and small particles that can be easily moved by water.
d) **Soil structure and aggregate stability:** The clay type and amount influence the soil structure. Soils with good structure and stability will resist erosive forces as the particles are held together more strongly. Some management practices can adversely affect soil structure.
e) **Organic matter content:** High organic matter soils tend to be less erodible that low organic matter soils. Management can have a dramatic impact on organic matter levels.
f) **Soil permeability and water content:** In soils that have poor ability to absorb and drain water, there is greater risk of run-off leading to erosion.
g) **Climatic variables:** In general wetter regions are more likely to experience higher levels of erosion over time, where both the frequency and intensity of rainfall events are key factors. Frequent rainfall events can lead to soils becoming very wet thus reducing water infiltration and increasing the amount of run-off and thus the risk of erosion. High intensity rainfall events can increase the effect of raindrop splash and overwhelm the ability of soil to absorb water leading to considerable soil dislodgement and run-off. If these events occur on sites that are more susceptible to erosion the negative impacts can be greatly increased.

- *Management factors*

Any practice that adversely affects the stability of the soil or increases its direct exposure to erosive forces greatly increases the risk of erosion. When combined with the natural factors that increase erosion risk, the interaction effect can lead to large soil losses. Key management factors include the following.

a) **Water flow control structures:** Poor planning, design and maintenance of roads, waterways, drains, culverts, contour berms and terraces all contribute to the concentrating of water flows that increase the erosive power of the water.
b) **Field layout:** Poor row alignment in fields can lead to the concentrating of water flows. Rows and terraces that do not follow contours and are inappropriately spaced for the steepness and shape of slope and erodibility class of the soil will increase erosion risk. Excess water flow should be directed toward suitably designed grassed water ways that can control the flow. Roads in fields must also follow contours and their design should not lead to excessive concentrating of water flow.
c) **Poor drainage:** Compaction and the development of sodic conditions are leading management induced causes of poor drainage. Poor drainage increases the risk of excess water run-off, and it may be necessary to install drainage or remedy the condition limiting drainage (e.g. rip compacted soils) to reduce erosion risk.
d) **Soil preparation and disturbance:** While a necessity to prepare lands, ploughing, tilling, ripping and other forms of soil disturbance all increase the risk of erosion. This is due to the break-up of soil aggregates, increased exposure of bare soil surface to erosive forces, as well as promoting the breakdown and loss of organic matter. Where such disturbances coincide with other factors driving erosion the risk increases substantially (e.g., ploughed fields on slopes have higher risk of erosion if they are present during high intensity rainfall events). Plan fields that will be left bare for the dry winter period to reduce the risk of soil loss through erosion.

e) **Soil cover:** Bare soils are highly susceptible to erosive forces. Soil cover, in the form of live vegetation (green manures during fallows and sugarcane in the crop cycle), or biomass mulches (green cane harvesting with much retention and or cool burns with retention of tops) are required to protect the soil surface from water drop impact, to slow water flow down, and to improve infiltration and soil structural stability. Long bare fallows and unnecessary delays in replanting a crop or green manure greatly increase erosion risk and should minimised as far as possible.
f) **Loss of organic matter:** Practices that lower soil organic matter levels will increase the erodibility of a soil. Excessive tillage, cane and mulch burning, bare fallows and lack of organic inputs are the main contributing factors to organic matter decline.
g) Poor root health: Roots play a pivotal role in holding soil together, particularly in the upper soil layers. Poor soil health leads to poor root health, thus reducing the ability of roots to help protect against erosive forces.

- *Detecting and monitoring soil loss and erosion*

While some forms of erosion are clearly observable and unmistakable (e.g. gullies, muddy streams and drainage lines), there are many less obvious indicators that, if noticed and acted on, can prevent unnecessary soil loss and costly remediation to reverse the impacts. Key indicators to look for include the following.

- Bare soil is a good indicator of erosion risk.
- Crust development.
- Formation of soil pillars (small columns of soil topped with a stone or rock).
- Thin, gravelly surface layers (fine material has been washed way).
- Signs of rills forming (small channels developing in fields). Rills appearing on the lower sections of slopes may indicate that the terrace spacing is inappropriate for that slope and soil type.
- Exposed roots and rocks.
- Cracked or scarred appearance on hillslopes caused by minor slumping and channels developing.
- Cloudy and muddy run-off water from fields and waterways. The more erosion that has occurred the muddier the water will be.
- Sediment fans (thin layers of clay fanning outward from a water outlet) at foot-slopes seepage areas and from drainage channels indicate fine material is being eroded. This could signify tunnel development on soils with unstable subsoils.
- Sediment build-up behind obstructions such as berms, depressions, rocks, trees and fenceposts that slow water flow down. These indicate movement of material from further up the slope.
- Silting and sediment build-up in dams and ponds.

- *Prevention and remediation*

While it may not be possible to change natural factors affecting erosion, understanding how they contribute to erosion is the first key step in minimising risk, as it allows appropriate management decision to minimise the potential risk and impact. There are numerous best practices to consider which include the following.

- Do not plant areas unsuitable for cultivation (notably steep slopes, shallow soils and wetlands).
- Ensure proper design and maintenance of water control structures and roads (both off and in field) and row alignment to contours on slopes.
- Minimise in field traffic and soil disturbance – adopt controlled traffic and minimum tillage practices.
- Remediate conditions that promote runoff (compaction, sodicity, poor drainage).
- Keep the soil covered as follows.

    a) Adopt green manure fallows.
    b) Reduce soil preparation time to lower time soil is bare and exposed.
    c) Green cane harvest and mulch (or where burning, retain tops and scatter).
    d) Use strip planting and harvesting, especially on slopes.

e) Keep unplanted areas vegetated with suitable ground cover.
f) Promote good soil health as this improves root health of any live cover.

- Use weather forecasting tools to try avoiding major soil preparation operations coinciding with high rainfall events. In areas subject to unexpected storm events, it may be better to move soil preparation operations to parts of the season where these events occur less frequently.
- Repair eroded areas immediately and act on any indication of developing erosion to prevent it developing further.
- Apply organic amendments where possible to promote build-up of soil levels and improve soil stability and overall health.
- Do not over irrigate.
- Inspect and monitor continuously for signs of erosion and act immediately if detected.

Numerous resources are available to guide the layout and design of fields, roads and other water flow structures, as well as guidance on practices that minimise risk and promote soil health. Consult your regional Extension Officer or SASRI specialist for specific guidance or visit the SASRI Knowledge Hub for downloadable content. Useful guidance on implementing conservation practices is also available in the SUSFARMS guidance material (visit https://sasri.org.za/susfarms/

Additional reading related to erosion

- Information Sheet 1.2: Gully stabilisation and repairs
- Information Sheet 14.1: Soil quality and degradation

Also see:

- Titshall, van Antwerpen and Stranack. 2021. If you lose it, you can't use it: soil loss and erosion. The Link May 2021
- Miles and van Antwerpen. 2014. Keeping soils covered. The Link May 2014

For further information contact Dr Rian van Antwerpen (Senior Scientist: Crop Nutrition and Soils; and Manager: Systems Design and Optimisation Research Programme), Dr Louis Titshall (Senior Scientist: Crop Nutrition and Soils) or Dr Thandile Mdlambuzi (Scientist: Crop Nutrition and Soils).


Dr Rian van Antwerpen Dr Louis Titshall Dr Thandile Mdlambuzi

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43. Soil compaction.

Priority Topic

No

SASRI Response and Action

Refer to Topic 42.

44. Nematodes

Priority Topic

No

SASRI Response and Action

SASRI has Information Sheets that may assist, as follows.

IS_8.2.1_Nematodes
IS_8.2.2_Nematode_Management

Commercial nematology laboratories offer analytical services.


Dr Stuart Rutherford

For further information contact Dr Stuart Rutherford (Principal Scientist: Integrated Pest and Disease Management; and Manager of the Crop Protection Research Programme).

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COMMUNICATION PLANS

Communication Plan: Topic 2 (All Round Varieties)

SOUTH AFRICAN SUGARCANE RESEARCH INSTITUTE
2022 COMMUNICATION PLAN FOR RDE TOPICS

1. Purpose of Template:
In many instances internal discussion and analysis of the RDE topics raised annually by SASRI stakeholders reveals that **sufficient information exists** to address the issue and that no specific project is required. In these instances, a **Communication Plan** is required to promote dissemination of the information to SASRI staff and a wide audience of growers and other industry stakeholders.
Please Note: A Communication Plan differs from a Communiqué. – A **Communiqué** is a response informing the originating RDE Committee of how the issue they submitted is to be addressed. – A **Communication Plan** is intended to describe how the known information regarding the issue is to be disseminated more widely amongst all appropriate industry stakeholders.
• The purpose of this template is to assist in guiding researchers' thinking about how such information dissemination might be best achieved. • Progress with implementation of the Communication Plan will be discussed with the relevant Programme Manager during scheduled Quarterly Progress Meetings.

2. Details of Communication Plan Developer:			
Name:	Thobile Nxumalo and Marvellous Zhou		
Resource /Centre:	BFRU	Date:	11/5/2022

3. Communication Plan Reference Number: (*to be assigned by Research and Knowledge Managers*)	

4. RDE Issue Details:			
Year:	2022	Topic Number:	2
Region:	Irrigated	Programme Area:	VI

5. Communication Plan Outline:

Please indicate with a tick-mark the traditional Knowledge Exchange activities you will you use for information dissemination (more than one activity is encouraged).

Publications		Presentations		Discussions/Workshops	
• The Link and/or Ingede		• Staff Colloquium for ESs		• Grower Day	X
• Extension Newsletters	X	• SASTA		• Grower Study Group	
• Information Sheet update	X	• Other (specify below)		• Short Course	
• Information Sheet new				• Other (specify below)	
• Other (specify below)					

Please specify any non-traditional Knowledge Exchange activities that you will use to disseminate available information on this RDE issue (e.g. partnering with a service provider [such as Canegrowers], one-on-one-meetings with growers identified as early-adopters).

We are already collaborating with RCL (Futhi Msimango; Agronomist), there are variety evaluation trials on their farms in Malelane and Komati. In addition, two new trials will be planted in Komati in late October 2022.

Provide the objectives and desired dates, if known, of the Knowledge Exchange activities you have specified in (a) and (b) above. Also, indicate how you will assess whether the Knowledge Exchange activities have been successful.

Knowledge Exchange Activity	Target Audience (include language requirement)	Objective(s)	Implementation Date(s) / Period(s)	Measure to Determine Successful Knowledge Exchange
Grower days	Mpumalanga growers	Show performance of released varieties in early and late season VE trials	Early season = March/April, Late Season = October/November	Questionnaire to be adminstered to measure knowledge of old and new varieties,Marius Adendorff, Jan Erasmus and Etienne de Beer (Extension Specialists) in design and interpretation of information.
Grower days	Mpumalanga growers	Show variety development in Plant Breeding trials and performance of promising genotypes in demonstration plots	Early season = March/April, Late Season = October/November	Questionaire to determine collective and individual farmer variety needs
Grower day	Pongola growers	Show performance of released varieties in early and late season VE trials	Early season = March/April, Late Season = October/November	Questionaire to be adminstered to measure knowledge of old and new varieties
Grower day	Pongola growers	Show variety development in Plant Breeding trials and performance of promising genotypes in demonstration plots	Early season = March/April, Late Season = October/November	Questionaire to determine collective and individual farmer variety needs

6. Communication Plan Budget and Resources Requirements:

Provide an estimate of the budget required to implement the Communication Plan (consult KMU Manager and Extension Manager as necessary)

1. Transport to Mpumalanga for the grower days for Marvellous Zhou (MZ) and Thobile Nxumalo (TN)
Accommodation in Mpumalanga x 2 x 4 days.
Travel and subsistence allowance, Vehicle mileage, Toll gate charges (will be done to coincide with PB & VE trials work travels).
Refreshments for grower day participants = R6000 (consulted with BFRU RM).

2.Transport to Pongola for the grower days for MZ and TN.
Accommodation in Pongola x 2 x 4 days.
Travel and subsistence allowance, Vehicle mileage, Toll gate charges (will be done to coincide with PB & VE trials work travels).
Refreshments for grower day participants = R6000 (consulted with BFRU RM).

Describe the resources you will require to implement the Communication Plan (consult KMU Manager and Extension Manager as necessary).

Printing questionaires x 50 (consulted with KE Manager).
Printing sign boards with variety names 20 Varieties x 2 on A1 paper (1 set for Mpumalanga, 1 set for Pongola) (consulted with KE Manager).
Portable loud-speaker.

7. General
Provide additional information relevant to the development and implementation of the Communication Plan on the RDE Issue.
Extension Specialists in Mpumalanga and Pongola will invite growers to the grower days, and will advise MZ and TN on the best dates and days of the week. Data from VE and PB trials on the performance of irrigated varieties will be summarised for Extension newsletters and for presentation at Grower days. Data from Mpumalanga and Pongola VE trials will be summarised. Data from promising geotypes in Plant Breeding trials will be analysed and summarised and included in presentations and/or Grower days. Info-Sheets to be updated for the irrigated varieties.

Return to Topic 2

Communication Plan: Topic 6 (Variety Herbicide Sensitivity)

SOUTH AFRICAN SUGARCANE RESEARCH INSTITUTE
2022 COMMUNICATION PLAN FOR RDE TOPICS

1. Purpose of Template:
In many instances internal discussion and analysis of the RDE topics raised annually by SASRI stakeholders reveals that **sufficient information exists** to address the issue and that no specific project is required. In these instances, a **Communication Plan** is required to promote dissemination of the information to SASRI staff and a wide audience of growers and other industry stakeholders.
Please Note: A Communication Plan differs from a Communiqué. – A **Communiqué** is a response informing the originating RDE Committee of how the issue they submitted is to be addressed. – A **Communication Plan** is intended to describe how the known information regarding the issue is to be disseminated more widely amongst all appropriate industry stakeholders.
• The purpose of this template is to assist in guiding researchers' thinking about how such information dissemination might be best achieved. • Progress with implementation of the Communication Plan will be discussed with the relevant Programme Manager during scheduled Quarterly Progress Meetings.

2. Details of Communication Plan Developer:			
Name:	Anushka Gokul		
Resource /Centre:	PERC	Date:	May 2022

3. Communication Plan Reference Number: (*to be assigned by Research and Knowledge Managers*)	17RDxx

4. RDE Issue Details:			
Year:	2022	Issue Number:	6
Region:	Irrigated North	Programme Area:	Crop Protection

5. Communication Plan Outline:

Please indicate with a tick-mark the traditional Knowledge Exchange activities you will you use for information dissemination (more than one activity is encouraged).

Publications		Presentations		Discussions/Workshops	
• The Link and/or Ingede	√	• Staff Colloquium for ESs		• Grower Day	√
• Extension Newsletters		• SASTA		• Grower Study Group	
• Information Sheet update		• Other (specify below)	√	• Short Course	
• Information Sheet new	√	Will be included in the lectures of the senior certificate course and the junior certificate course. (Pesented under the weeds section).		• Other (specify below)	
• Other (specify below)				The topic is also an SSG issue. Topics from the survey will potentially be include in the SSG 19TD08 project	

Please specify any non-traditional Knowledge Exchange activities that you will use to disseminate available information on this RDE issue (e.g. partnering with a service provider [such as Canegrowers], one-on-one-meetings with growers identified as early-adopters).

With Extension, execute an survey to review use/misuse of agrochemicals. This survey will assist with the focus of the commnication sub-topics.

Provide the objectives and desired dates, if known, of the Knowledge Exchange activities you have specified in (a) and (b) above. Also, indicate how you will assess whether the Knowledge Exchange activities have been successful.

Knowledge Exchange Activity	Target Audience (include	Objective(s)	Implementation Date(s) / Period(s)	Measure to Determine Successful

	language requirement)			Knowledge Exchange
Conduct a survey	Growers (LSG and SSG)	To determine why growers are experiencing negative cane growth following the application of chemicals.	June 2022	Feedback from extension specialist and growers
Link Article	LSG and SSG	Article to address the errors made in the application of agrochemicals causing diverse effects in fields. (errors identified by the survey)	Oct 2022	Feedback on recommendations, as reported back directly by growers & extension specialists.
Ingede	SSG's	Article to address the errors made in the application of agrochemicals causing diverse effects in fields. (errors identified by the survey)	Oct 2022	Feedback on recommendations, as reported back directly by growers & extension specialists.
Information sheet	Growers (LSGs & SSGs)	Addressing the errors made in the application of agrochemicals.	Dec 2022	Feedback on recommendations, as reported back directly by growers & extension specialists.
SSC +JCC lecture notes	New growers (LSG and SSG)	Addressing the errors made in the application of agrochemicals within lectures	March 2022 and on going	Feedback from students and growers
Growers day	SSG	Provide feedback on the survey and address errors made in the application of agrochemicals.	As per 19TD08 planned dates	Feedback and adoption from SSG. Feedback from extension specialists.

6. Communication Plan Budget and Resources Requirements:

Provide an estimate of the budget required to implement the Communication Plan (consult KMU Manager and Extension Manager as necessary)

- No budget required for the information sheet, Link and Ingede article
- No budget required for the SCC and JCC lectures as it will be incorporated in the on-going weed lecturing sessions.
- No budget required for the SSG growers day as the topic will be covered in the 19TD08 project

Describe the resources you will require to implement the Communication Plan (consult KMU Manager and Extension Manager as necessary).

- The compilation, dissemination and evaluation of the survey (extension specialists. assistance will be required)
- Specific resources will not be required as information will be incorporated in current lectures (SCC + JCC) and projects (19TD08). Lecture notes will be updated according to survey outcomes.

7. General

Provide additional information relevant to the development and implementation of the Communication Plan on the RDE Issue.

Return to Topic 6

Communication Plan: Topics 11 and 29 (Carbon Footprint of Sugarcane Production)

SOUTH AFRICAN SUGARCANE RESEARCH INSTITUTE
2022 COMMUNICATION PLAN FOR RDE TOPICS

1. Purpose of Template:
In many instances internal discussion and analysis of the RDE topics raised annually by SASRI stakeholders reveals that **sufficient information exists** to address the issue and that no specific project is required. In these instances, a **Communication Plan** is required to promote dissemination of the information to SASRI staff and a wide audience of growers and other industry stakeholders.
Please Note: A Communication Plan differs from a Communiqué. – A **Communiqué** is a response informing the originating RDE Committee of how the issue they submitted is to be addressed. – A **Communication Plan** is intended to describe how the known information regarding the issue is to be disseminated more widely amongst all appropriate industry stakeholders.
• The purpose of this template is to assist in guiding researchers' thinking about how such information dissemination might be best achieved. • Progress with implementation of the Communication Plan will be discussed with the relevant Programme Manager during scheduled Quarterly Progress Meetings.

2. Details of Communication Plan Developer:			
Name:	Ashiel Jumman		
Resource /Centre:	PERC	Date:	04 May 2022

3. Communication Plan Reference Number: (*to be assigned by Research and Knowledge Managers*)	22RDxx

4. RDE Issue Details:			
Year:	2022	Issue Number:	11 & 29
Region:	Mpumalanga (irrigated)	Programme Area:	CPM

5. Communication Plan Outline:

Please indicate with a tick-mark the traditional Knowledge Exchange activities you will you use for information dissemination (more than one activity is encouraged).

Publications		Presentations		Discussions/Workshops	
• The Link and/or Ingede		• Staff Colloquium for ESs		• Grower Day	
• Extension Newsletters		• SASTA		• Grower Study Group	
• Information Sheet update		• Other (specify below)	X	• Short Course	
• Information Sheet new		A workshop/presentation might be required to translate/communicate the data into simpler language for a non-scientific audience		• Other (specify below)	X
• Other (specify below)				Email communication & sharing of existing Journal Articles	

Please specify any non-traditional Knowledge Exchange activities that you will use to disseminate available information on this RDE issue (e.g. partnering with a service provider [such as Canegrowers], one-on-one-meetings with growers identified as early-adopters).

The issue was raised by Theuns Theunisson of SACGA. The plan is to provide feedback to him directly via email. The email will include the following:

1. Sharing the communique and relevant journal articles
2. Pointing out that the SMRI are conducting LCA work, in conjunction with Stellenbosch University for the sugar biorefineries and new/alternative products. The contact details for the lead researcher, namely, Dr Kitty Foxon, will be shared.
3. Reassuring that SASRI is willing and available to help if any specific further research is required within the agricultural portion of the value chain.

Consideration can be given to copying in the various sugar industry stakeholders (e.g. SMRI, SAS, SACGA & SAFDA) in such an email, or alternatively, sending out a second email to bring everyone on to the same page.

Provide the objectives and desired dates, if known, of the Knowledge Exchange activities you have specified in (a) and (b) above. Also, indicate how you will assess whether the Knowledge Exchange activities have been successful.

Knowledge Exchange Activity	Target Audience (include language requirement)	Objective(s)	Implementation Date(s) / Period(s)	Measure to Determine Successful Knowledge Exchange
Distribution of email, with communique and relevant journal articles attached	Primarily, Theuns Theunission (SACGA) and Kitty Foxon (SMRI). Possibly, copy in representatives from SAS & SAFDA.	To respond directly to the request for quantitative data on carbon footprint of the sugar value chain	May 2022	Seek confirmation from target audience that nothing further is required from SASRI

6. Communication Plan Budget and Resources Requirements:

Provide an estimate of the budget required to implement the Communication Plan (consult KMU Manager and Extension Manager as necessary)

No budget required, assuming the data in the journal articles are easily accesible to target audience. A workshop/presentation might be required to translate/communicate the data into simpler language for a non-scientific audience.

Describe the resources you will require to implement the Communication Plan (consult KMU Manager and Extension Manager as necessary).

If the email is sufficient, no further resources will be required.

7. General

Provide additional information relevant to the development and implementation of the Communication Plan on the RDE Issue.

In the context of the sugar value chain master plan and the prospect of green fuels (e.g. bio jet fuel), it may become necessary for the sugar industry to devise mechanisms to regularly/routinely capture and report on carbon footprints/green house gas emmissions. This was not the request in the current RD&E cycle and, hence, is not being addressed in this communication plan and associated communique. However, if routine monitoring and reporting was to become important, SASRI may have to play a role in helping to facilitate interaction amongst all stakeholders in order to devise an appropriate mechanism or protocol for reporting on carbon footprints and greenhouse gas emissions.

Return to Topic 11
Return to Topic 29

Communication Plan: Topic 15 (More Refined Crop Forecasting Tool)

SOUTH AFRICAN SUGARCANE RESEARCH INSTITUTE
2022 COMMUNICATION PLAN FOR RDE TOPICS

1. Purpose of Template:
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2. Details of Communication Plan Developer:			
Name:	Phil Sithole		
Resource /Centre:	DARU	Date:	10 May 2022

3. Communication Plan Reference Number: (*to be assigned by Research and Knowledge Managers*)	17RDxx

4. RDE Issue Details:			
Year:	2022	Issue Number:	15
Region:	Irrigated North	Programme Area:	SDO

5. Communication Plan Outline:

Please indicate with a tick-mark the traditional Knowledge Exchange activities you will you use for information dissemination (more than one activity is encouraged).

Publications		Presentations		Discussions/Workshops	
• The Link and/or Ingede	X	• Staff Colloquium for ESs	X	• Grower Day	
• Extension Newsletters		• SASTA		• Grower Study Group	
• Information Sheet update		• Other (specify below)		• Short Course	
• Information Sheet new				• Other (specify below)	
• Other (specify below)					

Please specify any non-traditional Knowledge Exchange activities that you will use to disseminate available information on this RDE issue (e.g. partnering with a service provider [such as Canegrowers], one-on-one-meetings with growers identified as early-adopters).

None

Provide the objectives and desired dates, if known, of the Knowledge Exchange activities you have specified in (a) and (b) above. Also, indicate how you will assess whether the Knowledge Exchange activities have been successful.

Knowledge Exchange Activity	Target Audience (include language requirement)	Objective(s)	Implementation Date(s) / Period(s)	Measure to Determine Successful Knowledge Exchange

The Link	Growers	Raise awareness about the available DSPs and their usefulness	Jan 2023 (ahead of new season)	Record new registered users for the DSPs.
Staff Colloquium for ESs	SASRI ESs	Reminder/Refresher for the available DSPs and their applications	Second half of 2022 OR first half of 2023	Feedback from ESs
6. Communication Plan Budget and Resources Requirements:				
Provide an estimate of the budget required to implement the Communication Plan (consult KMU Manager and Extension Manager as necessary)				
None				
Describe the resources you will require to implement the Communication Plan (consult KMU Manager and Extension Manager as necessary).				
None				
7. General				
Provide additional information relevant to the development and implementation of the Communication Plan on the RDE Issue.				
KMU will need to make provision for a 30-min presentation and discussion with ESs during one of the Staff Colloquims (or Extension Indaba) later in 2022 or in 2023.				

Return to Topic 15

Communication Plan: Topic 19 and 37 (Salinity and Sodicity)

SOUTH AFRICAN SUGARCANE RESEARCH INSTITUTE
2022 COMMUNICATION PLAN FOR RDE TOPICS

1. Purpose of Template:
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Please Note: A Communication Plan differs from a Communiqué. – A **Communiqué** is a response informing the originating RDE Committee of how the issue they submitted is to be addressed. – A **Communication Plan** is intended to describe how the known information regarding the issue is to be disseminated more widely amongst all appropriate industry stakeholders.
• The purpose of this template is to assist in guiding researchers' thinking about how such information dissemination might be best achieved. • Progress with implementation of the Communication Plan will be discussed with the relevant Programme Manager during scheduled Quarterly Progress Meetings.

2. Details of Communication Plan Developer:			
Name:	R van Antwerpen & T Mdlambuzi		
Resource /Centre:	PERC	Date:	May 2022

3. Communication Plan Reference Number: (*to be assigned by Research and Knowledge Managers*)	22RDxx

4. RDE Issue Details:			
Year:	2022	Issue Number:	19 & 37
Region:	Komatipoort	Programme Area:	SDO

5. Communication Plan Outline:

Please indicate with a tick-mark the traditional Knowledge Exchange activities you will you use for information dissemination (more than one activity is encouraged).

Publications		Presentations		Discussions/Workshops	
• The Link and/or Ingede	X	• Staff Colloquium for ESs	X	• Grower Day	X
• Extension Newsletters	X	• SASTA		• Grower Study Group	
• Information Sheet update	X	• Other (specify below)		• Short Course	X
• Information Sheet new				• Other (specify below)	
• Other (specify below)					

Please specify any non-traditional Knowledge Exchange activities that you will use to disseminate available information on this RDE issue (e.g. partnering with a service provider [such as Canegrowers], one-on-one-meetings with growers identified as early-adopters).

One-on-one meetings with growers on their request.

Provide the objectives and desired dates, if known, of the Knowledge Exchange activities you have specified in (a) and (b) above. Also, indicate how you will assess whether the Knowledge Exchange activities have been successful.

Knowledge Exchange Activity	Target Audience (include language requirement)	Objective(s)	Implementation Date(s) / Period(s)	Measure to Determine Successful Knowledge Exchange

Grower days	Growers (A/E/Z)	Two way discussion on salts in soils and water.	2nd half of 2022 and first half of 2023.	Extension report on changed behaviour.
Training via 1 day modular courses	Growers (A/E/Z)	Explanation of the development, effects, management and costs associoted with salts in soils and water.	2nd half of 2022 and whole of 2023.	Course assessment completed by course attendees. Extension report on changed behaviour.
Popular articles in The Link and Ingede.	Growers (A/E/Z)	Explanation of the development, effects, management and costs associoted with salts in soils and water.	2nd half of 2022 and whole of 2023.	Extension is approached for clarity.
Up date of info sheets.	Growers (E)	Explanation of the development, effects, management and costs associoted with salts in soils and water.	2nd half of 2022 and whole of 2023.	Extension is approached for clarity.
Staff colloquium for ESs	Extension and staff (E)	Explanation of the development, effects, management and costs associoted with salts in soils and water.	2nd half of 2022 and whole of 2023.	Extension expresses more confidence of their knowledge regarding the effects and management of salts and it impact on yields.
Extension newsletters.	Growers (A/E/Z)	Explanation of the development, effects, management and costs associoted with salts in soils and water.	2nd half of 2022 and whole of 2023.	Extension is approached for clarity.

6. Communication Plan Budget and Resources Requirements:

Provide an estimate of the budget required to implement the Communication Plan (consult KMU Manager and Extension Manager as necessary)

Components that require a budget are grower days and modular courses. In this budget it was assumed that only one of the two will be presented in a region. Regions are Empangeni, Pongola and Malelane/Komatipoort. Two people from SASRI (excluding extension) will attend. Estimated costs are R6600 for accommodation and R12150 for travel by car (R21000 should we drive to nearby locations and fly to Mpumalanga) to attend or to present in all three regions.

It is unlikely that the other activities will incurr costs other than to publish (Link, Ingede, newsletters, info sheets).

Describe the resources you will require to implement the Communication Plan (consult KMU Manager and Extension Manager as necessary).

Exension in the three regions will be approached to stimulate the thought of including salts as a theme in grower days or to include it on the programme of the currently planned contact sessions. Courses have been developed and these will be modified to include the latest results from work by SASRI.

7. General

Provide additional information relevant to the development and implementation of the Communication Plan on the RDE Issue.
Discussion with extension is critical to plan the contents and contact sessions with growers.

Return to Topic 19
Return to Topic 37

Communication Plan: Topic 22 (Irrigation System Automation)

SOUTH AFRICAN SUGARCANE RESEARCH INSTITUTE
2022 COMMUNICATION PLAN FOR RDE TOPICS

Please ensure that you comprehensively address each section of the template.

1. Purpose of Template:

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- The purpose of this template is to assist in guiding researchers' thinking about how such information dissemination might be best achieved.
- Progress with implementation of the Communication Plan will be discussed with the relevant Programme Manager during scheduled Quarterly Progress Meetings.

2. Details of Communication Plan Developer:

Name:	Ashiel Jumman		
Resource /Centre:	PERC	Date:	6 May 2022

3. Communication Plan Reference Number: (*to be assigned by Research and Knowledge Managers*)	22RDxx

4. RDE Issue Details:

Year:	2021	Issue Number:	22
Region:	Mpumalanga	Programme Area:	SDO

5. Communication Plan Outline:

Please indicate with a tick-mark the traditional Knowledge Exchange activities you will you use for information dissemination (more than one activity is encouraged).

Publications		Presentations		Discussions/Workshops	
• The Link and/or Ingede		• Staff Colloquium for ESs		• Grower Day	
• Extension Newsletters		• SASTA		• Grower Study Group	
• Information Sheet update		• Other (specify below)		• Short Course	
• Information Sheet new				• Other (specify below)	X
• Other (specify below)				One on one meeting with grower	

Please specify any non-traditional Knowledge Exchange activities that you will use to disseminate available information on this RDE issue (e.g. partnering with a service provider [such as Canegrowers], one-on-one-meetings with growers identified as early-adopters).

There are too many brands and product options with costs that change rapidly – hence formulation of a catalogue or library of aumotation and control systems with associated costs will quickly become outdated. This issue was raised by a specific gower (Wilscott Radely). For this reason, we recommend a one on one extension visit with the grower to explore the exact area of concern. On estabishing the exact need, Extension and SASRI specialist can either obtain the necessary information and feedback to the grower, or direct the grower to reputable service providers and/or equipment suppliers.

a. *Provide the objectives and desired dates, if known, of the Knowledge Exchange activities you have specified in (a) and (b) above. Also, indicate how you will assess whether the Knowledge Exchange activities have been successful.*

Knowledge Exchange Activity	Target Audience (include language requirement)	Objective(s)	Implementation Date(s) / Period(s)	Measure to Determine Successful Knowledge Exchange
One on One extension visit	Grower: Wilscott Radley	To ID exact needs and/or concerns so that the relevant information can be fedback to the grower	This will be for the extension specialists to drive/champion	Grower feedback and satisfaction
6. Communication Plan Budget and Resources Requirements:				
Provide an estimate of the budget required to implement the Communication Plan (consult KMU Manager and Extension Manager as necessary)				
Nothing at this stage				
Describe the resources you will require to implement the Communication Plan (consult KMU Manager and Extension Manager as necessary).				
Nothing at this stage				
7. General				
Provide additional information relevant to the development and implementation of the Communication Plan on the RDE Issue.				
Should the extension specialists discover that this is a widesrpread issuse, SASRI will have to partner with SABI and SABI member companies to formulate a grower day where equipment manufacturers and suppliers can be given the opportunity to enlighten growers on the topic of irrigation control and automation systems.				

Return to Topic 22

Communication Plan: Topic 30 (Yellow Sugarcane Aphid)

SOUTH AFRICAN SUGARCANE RESEARCH INSTITUTE
2022 COMMUNICATION PLAN FOR RDE TOPICS

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- Progress with implementation of the Communication Plan will be discussed with the relevant Programme Manager during scheduled Quarterly Progress Meetings.

2. Details of Communication Plan Developer:			
Name:	Iona Basdew & Malcolm Keeping		
Resource /Centre:	CBRC	Date:	May 2022

3. Communication Plan Reference Number: (*to be assigned by Research and Knowledge Managers*)	17RDxx

4. RDE Issue Details:			
Year:	2022	Issue Number:	30
Region:	Irrigated North	Programme Area:	Crop Protection

5. Communication Plan Outline:

Please indicate with a tick-mark the traditional Knowledge Exchange activities you will you use for information dissemination (more than one activity is encouraged).

Publications		Presentations		Discussions/Workshops	
• The Link and/or Ingede	√	• Staff Colloquium for ESs	√	• Grower Day	√
• Extension Newsletters	√	• SASTA		• Grower Study Group	√
• Information Sheet update	√	• Other (specify below)		• Short Course	√
• Information Sheet new				• Other (specify below)	√
• Other (specify below)				Training on app for P&D and growers to record YSA infield, platform to share info.	

Please specify any non-traditional Knowledge Exchange activities that you will use to disseminate available information on this RDE issue (e.g. partnering with a service provider [such as Canegrowers], one-on-one-meetings with growers identified as early-adopters).

Group training with growers once the P&D Application (YSA specific: YSA123) is ready for use in-field.

Provide the objectives and desired dates, if known, of the Knowledge Exchange activities you have specified in (a) and (b) above. Also, indicate how you will assess whether the Knowledge Exchange activities have been successful.

Knowledge Exchange Activity	Target Audience (include language requirement)	Objective(s)	Implementation Date(s) / Period(s)	Measure to Determine Successful Knowledge Exchange

Variety Info sheets	Industry	Communicate YSA & thrips variety susceptibility ratings	June 2022	Feedback from Ext & growers
P&D Chairmens' AGM	P&D Committees, Extension	YSA management programme, as developed in LV workshop – cover: Varieties Scouting & App P&D involvement YSA management	20 July 2022	Productive discussion & agreement around YSA management
Staff colloquim	Extension	YSA management programme, as developed in LV workshop – cover: Varieties Scouting & App P&D teams Thresholds Chemicals	20 – 22 July 2022	Productive discussion & agreement around YSA management
Grower days	LSGs – all areas	YSA management programme, as developed in LV workshop – cover: Pest biology and ecology Soil health and infestation IPM, predators, and farmscaping Varieties Scouting & App P&D teams Drones Thresholds Chemicals Bandito strip trials	September 2022: Pongola and Komatipoort	Adoption of management programme and feedback on recommendations, as reported back directly by growers & Extension.
Grower days	SSGs - all areas	YSA management programme, as developed in LV workshop – cover: Pest biology and ecology Soil health and infestation	Every 3-4 months, starting Aug 2022	Adoption of management programme and feedback on recommendations, as reported back directly by growers & Extension.

		IPM, predators, and farmscaping Varieties Scouting & App P&D teams Thresholds Chemicals		
Extension newsletters	Growers (LSGs & SSGs)	Communicate outcomes of grower days	30 Sep 2022	Growers aware of YSA management programme
Link article	LSGs	YSA management programme, summarising grower day info	3 Oct 2022	Adoption of management programme and feedback on recommendations, as reported back directly by growers & Extension.
Ingede	SSGs	YSA management programme, summarising grower day info	3 Oct 2022	Adoption of management programme and feedback on recommendations, as reported back directly by growers & Extension.

6. Communication Plan Budget and Resources Requirements:

Provide an estimate of the budget required to implement the Communication Plan (consult KMU Manager and Extension Manager as necessary)

Presently covered under budgets for YSA projects 19TD02 (8032) and 5609 (Biosecurity)

Estimated Budget: Communication Plan for YSA related issues (No. 30): Lowveld-specific		
Item	**Amount**	**Details**
Flights	25,000	Flights for two separate grower events. Event 1 (talks plus field)= Iona, Malcolm, Ingrid - YSA123 App, Varieties, Management. Event 2 (talks plus field) = Iona, Malcolm - grower recap on major YSA issues.
Accommodation	12,750	Event 1 = Iona, Ingrid, Malcolm x 3 nights (incl. breakfast). Event 2 = Iona, Malcolm x 2 nights (incl. breakfast)
Car hire	6,400	Event 1 = Iona, Ingrid, Malcolm x 4 days. Event 2 = Iona, Malcolm x 4 days
S&T	3,800	Event 1 = Iona, Ingrid, Malcolm x 4 days. Event 2 = Iona, Malcolm x 4 days
Total	**47,950**	

Grower Day: Pongola (Sep 22)
Etienne de Beer has budgeted for a grower day with a focus on P&D and Biosecurity in September 2022.

Grower Day: Komati (Sep 23)
Catering: R2000

Describe the resources you will require to implement the Communication Plan (consult KMU Manager and Extension Manager as necessary).

Grower Day: Pongola (Sep 22)
Catering (Etienne to arrange)
Descriptive handouts (KMU)

Grower Day: Komati (Sep 23)
Catering (Marius to arrange)
Descriptive handouts (KMU)

7. General

Provide additional information relevant to the development and implementation of the Communication Plan on the RDE Issue.

Return to Topic 30

Communication Plan: Topic 35 (Pest and Disease Resistance under Commercial Conditions)

SOUTH AFRICAN SUGARCANE RESEARCH INSTITUTE
2022 COMMUNICATION PLAN FOR RDE TOPICS

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• The purpose of this template is to assist in guiding researchers' thinking about how such information dissemination might be best achieved. • Progress with implementation of the Communication Plan will be discussed with the relevant Programme Manager during scheduled Quarterly Progress Meetings.

2. Details of Communication Plan Developer:			
Name:	Sharon McFarlane, Malcolm Keeping, Stuart Rutherford		
Resource /Centre:	CBRC	Date:	9 May 2022

3. Communication Plan Reference Number: (*to be assigned by Research and Knowledge Managers*)	17RDxx

4. RDE Issue Details:			
Year:	2022	Issue Number:	35
Region:	Irrigated North	Programme Area:	Crop Protection

5. Communication Plan Outline:

Please indicate with a tick-mark the traditional Knowledge Exchange activities you will you use for information dissemination (more than one activity is encouraged).

Publications		Presentations		Discussions/Workshops	
• The Link and/or Ingede	x	• Staff Colloquium for ESs	x	• Grower Day	x
• Extension Newsletters	x	• SASTA		• Grower Study Group	
• Information Sheet update		• Other (specify below)		• Short Course	
• Information Sheet new				• Other (specify below)	
• Other (specify below)					

Please specify any non-traditional Knowledge Exchange activities that you will use to disseminate available information on this RDE issue (e.g. partnering with a service provider [such as Canegrowers], one-on-one-meetings with growers identified as early-adopters).

Provide the objectives and desired dates, if known, of the Knowledge Exchange activities you have specified in (a) and (b) above. Also, indicate how you will assess whether the Knowledge Exchange activities have been successful.

Knowledge Exchange Activity	Target Audience (include language requirement)	Objective(s)	Implementation Date(s) / Period(s)	Measure to Determine Successful Knowledge Exchange
Presentation – staff colloquium	SASRI staff	Define varietal resistance,	20-22 July 2022	Post presentation discussions

		provide information on screening trials		
Article - The Link	Growers English, Afrikaans	Define varietal resistance, provide information on screening trials	Sep 22	Extension and grower feedback
Extension newsletter	Growers English, Afrikaans	Define varietal resistance, provide information on relevant screening trials	Jan 22	Extension and grower feedback
Grower day: Pongola	Growers English, Afrikaans	Describe variety evaluation procedures for pests and diseases. Visit trial sites	Sep 22	Discussions with growers
Grower day: Komati	Growers English, Afrikaans	Describe variety evaluation procedures for pests and diseases. Visit trial sites	Sep 23	Discussions with growers

6. Communication Plan Budget and Resources Requirements:

Provide an estimate of the budget required to implement the Communication Plan (consult KMU Manager and Extension Manager as necessary)

Grower Day: Pongola (Sep 22)
Etienne de Beer has budgeted for a grower day with a focus on P&D and Biosecurity in September 2023.
Sharon: To coincide with a trip to plant a trial at the RS so no extra budget required.
Malcolm: Budget to fall under YSA KE plan

Grower Day: Komati (Sep 23)
Catering: R2000
Sharon: Flight – R8085; Car hire – R795; Accomodation – R2835; S&T – R458; **TOTAL – R12 173**
Malcolm: Flight – R8085; Accomodation – R2835; S&T – R458; **TOTAL – R11 378**

Describe the resources you will require to implement the Communication Plan (consult KMU Manager and Extension Manager as necessary).

Grower Day: Pongola (Sep 22)
Catering (Etienne to arrange)
Descriptive handouts (KMU)

Grower Day: Komati (Sep 23)
Catering (Marius to arrange)
Descriptive handouts (KMU)

7. General

Provide additional information relevant to the development and implementation of the Communication Plan on the RDE Issue.

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