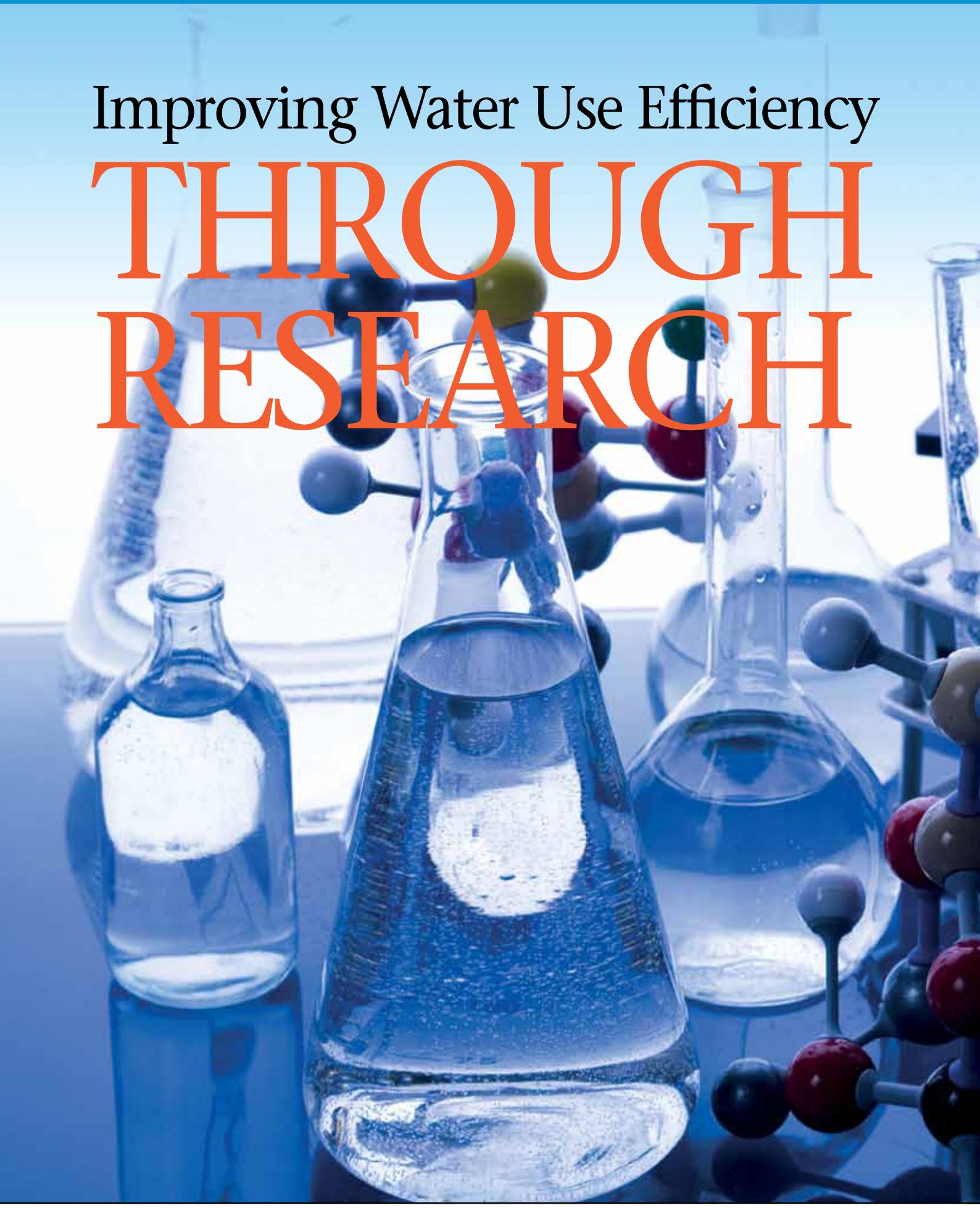
Improving Water Use Efficiency THROUGH RESEARCH



The ever-increasing demand on South Africa's limited water supply places the agricultural sector under enormous pressure to use this scare resource efficiently. To this end, several SASRI research projects are aimed at providing the sugarcane farmer with the knowledge and tools to assist with more efficient water use. This article highlights some of the water-related projects included in SASRI's research programme.

Using satellite imagery to determine water use efficiency

SASRI has been collaborating with the University of KwaZulu-Natal (UKZN) and WaterWatch from the Netherlands in a Water Research Commission funded project to promote the efficient use of water for irrigated sugarcane production in Mpumalanga. The Surface Energy Balance Algorithm for Land (SEBAL) model uses satellite imagery to calculate weekly estimates of evapotranspiration, evapotranspiration deficit, biomass growth and biomass water use efficiency. Assessing this data spatially over time, can assist farmers, extension specialists and water user association staff detect uneven water distribution (in a field or across an irrigation scheme), instances of under-irrigation and slow growth due to agronomic problems such as water logging, pest and disease problems or nutrient deficiency.

The project aims to confirm the degree of accuracy of the information provided by the SEBAL model. Comparison of data sets from 13 fields in Mpumalanga showed reasonable agreement between SEBAL satellite data and estimates of biomass production and crop water use based on in-field measurements and Canesim crop model estimates. The spatial data was disseminated as images on a website (www.sugarcanelook.com), which exposed various users to data that can be used to evaluate evapotranspiration, evapotranspiration deficit and growth spatially. The data disseminated through the website was used by TSB as well as farmers and consultants to evaluate reasons for spatial variability within fields and across production areas. There still exists a need to improve the dissemination service, e.g. simplifying the parameter maps by including indicators, disseminating the data faster and through other means (e.g. SMS, e-mail) and making data available timeously. The project will also investigate whether crop forecasts can be improved by using SEBAL data.

Energy use efficiency of irrigation operations

In light of the rapidly increasing cost of energy and global concern over carbon emissions, it is necessary to assess where, how much and how efficiently energy is consumed. SASRI, in collaboration with the National Centre of Engineering in Agriculture (NCEA), are developing a tool to

estimate energy use for irrigation and mechanical operations. Benchmarking energy use helps to identify where inefficiencies may lie. Studies in Australia have shown that energy savings of 50% in irrigation operations are possible. In irrigation, energy efficiency is strongly related to system design, maintenance and operational regimes - all of which affect water use efficiency. Therefore, addressing the energy concerns will, in turn, drive awareness and better management practices relating to irrigation and water use efficiency.

Drought tolerance potential of commercial sugarcane varieties

The unpredictability of rainfall is a major concern for growers in the rainfed regions of our industry with droughts having a negative impact on production over several years. Since sugarcane varieties remain in production for between five and fifteen years, knowledge of varietal drought tolerance potential would allow for more informed decision-making when selecting varieties prior to planting.

Using historical field trial data and statistical modelling, SASRI has determined the drought tolerance potential of commercial sugarcane varieties. The first step was to establish a reliable methodology of quantifying the level of drought stress, defined through a drought stress index (DSI), employing the sugarcane growth model, Canesim, and then using the selected DSI to evaluate and rate the drought tolerance potential of commercial varieties.

The two rainfed regions, coastal and midlands were analysed separately due to the difference in climatic conditions. Coastal varieties were rated as being susceptible (N16, N19, N39 and NCo376) or intermediate (N27, N29, N33, N36, N41, N45, N47) to water stress. For the midlands varieties, ratings could not be established mainly due to the length of the crop cycle. This technique has value in SASRI's Plant Breeding programme where water stress responses of new cultivars are unknown. The drought stress tolerance indices will be included in SASRI's Variety Information Sheets to further assist growers with variety choice decisions.

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Drought tolerance induced by genetic modification

While it is important to determine the water stress potential of released varieties, one of the more strategic projects at SASRI aims to induce drought tolerance through the use of genetic modification. The goal of this project is to induce drought tolerance in sugarcane by transgenesis (the introduction of a novel/foreign gene to the sugarcane genome). The objectives are to obtain proof of principle by inserting genes coding for dehydration-responsive element binding proteins

(DREB) into a drought susceptible sugarcane cultivar and submitting the resulting transgenic plants to abiotic stress. Since the DREB genes may also confer resistance to cold and high salt, a secondary aim is to assess tolerance to these stresses. The project will also develop screening techniques to assess the transformed phenotype quickly and efficiently.

Resource use efficiency of biomass genotypes

Worldwide, there is an increasing shift towards renewable energy which includes biomass crops. Sugarcane is considered an ideal crop for this purpose. Not only does it produce very high biomass yields, but stalks also contain high amounts of fermentable sugars and fibre which can be used for bio-fuel or electricity production. Indications are that high biomass genotypes may use resources, especially water, more efficiently than existing sucrose cultivars. If this is true, these genotypes can be used for biomass production for energy in areas where these resources are scarce, such as low rainfall areas or areas with poor soils. This project will provide quantitative information on dry biomass yield, theoretical second-generation ethanol yield, water use and radiation capture of conventional sugarcane genotypes, a high-fibre sugarcane hybrid and an Erianthus clone as compared to other bioenergy crops namely, Napier grass, forage sorghum and sugar beet. This information will be used to calibrate crop models, such as Canesim, which will be used on an industry-wide basis to determine the economic and environmental feasibility of sugarcane production for energy in marginal areas, benchmarked against other potential energy crops.

Submitted by SASRI specialists
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