INTERNATIONAL CONSORTIUM FOR SUGARCANE MODELLING

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1. INTRODUCTION

The International Consortium for Sugarcane Modelling (ICSM) is an international partnership of research and other organizations that have an interest in sugarcane simulation modelling. Current members are Centre de Cooperation Internationale en Recherche Agronomique pour le Dévelopement (CIRAD), Chiang Mai University (Thailand), Commonwealth Scientific and Industrial Research Organisation (CSIRO), Mitr Phol Sugar Cane Research Centre, South African Sugarcane Research Institute (SASRI), Sugar Cane Growers Cooperative from Florida (SCGC), Sugar Research Institute of Fiji (SRIF), and Zimbabwe Sugar Association Experiment Station (ZSAES). The current memorandum of understanding (MoU) are valid until November 2017. BSES Limited from Australia and the Kenya Sugar Research Foundation (KESREF) were also signatories to the MoU, but has since withdrawn or ceased to exist.

The goal of the ICSM is to promote the development and application of sugarcane simulation models. Key objectives are to coordinate efforts and generate resources for sugarcane modelling projects, and to promote and enable the sharing of knowledge, information and data in the field of sugarcane modelling.

2. ICSM PROJECT ON "MODELLING WORLD-WIDE GXE INTERACTION"

A group of ICSM members (CIRAD, Florida SCGC, SASRI, ZSAES,) is conducting research to gain a better understanding of the physiological mechanisms underlying the genetic variation in sugarcane crop response to environmental factors. Crop canopy development, radiation interception, biomass accumulation and partitioning of genetically diverse cultivars grown in diverse environments are monitored using a standardized trial and measurement protocol. The ultimate goal is to develop improved concepts for simulating genetic control of crop response to environmental factors, and to implement these in sugarcane models, with a view to use then support crop improvement programs, worldwide. The hypothesis is that realistic models with accurate trait parameter values can be used to identify important traits and their ideal values for given environments (including future climates).

Field experiments have been completed in Pongola, South Africa; Chiredzi, Zimbabwe; La Mare, Reunion Island; and Belle Glade, Florida, USA. Data collected include soil chemical and physical data, crop management data, shoot emergence, tiller population and height, leaf dimensions and appearance, fractional radiation interception, dry aboveground biomass component weights and stalk composition at harvest. In some cases leaf nitrogen and chlorophyll content, stomatal conductance, soil water content, leaf angle, canopy reflectance was also recorded. Data have been captured and made available for model development and evaluation. Table 1 summarizes the status of experiments, data processing and reporting.

Figure 1 illustrates how the climate differed at the different sites. Figure 2 shows how cultivars differed in the development of the crop canopy, while Figure 3 shows cane yields achieved at harvest.

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Table 1. The status of experiments and data processing.

Location	Cultivars	Stage	R 0	R 1	R 2
Pongola, South Africa	CP88-1762, HoCP96-450, N41, R570, ZN7	Experiment	Mar14-Mar15	Mar15-Mar16	Mar16-Apr17
		Data files	Y	Y	
		Technical report	Y	Y	
Chiredzi, Zimbabwe	CP88-1762, HoCP96-450, N41, Q183, R570, ZN7	Experiment	Oct13-Oct14	Jun15-Jun16	
		Data files	y	y	
		Technical report	Y	Y	
La Mare, Reunion	CP88-1762, HoCP96-450, N41, NCo376, Q183, R570	Experiment	Feb15-Jan16	Jan16-Jan17	
		Data files	Y	Y	
		Technical report	Y		
Belle Glade, Florida	CP88-1762, HoCP96-540, N41, NCo376, Q183, R570	Experiment	Dec13-Dec14	Dec14-Dec15	
		Data files	Y	Y	
		Technical report	Y	Y	

Interesting trends emerging from the results are:
- Cultivar N41 generally produced the highest stalk population and R570 the lowest,
- Cultivar Q183 often developed canopy cover the quickest,
- Cultivars often produced the highest cane yield in the environment that they were selected for (N41 in South Africa, CP88-1762 in Florida and ZN7 in Zimbabwe), and
- Although differences in yield were often not statistically significant, the ranking of cultivars at Pongola and Chiredzi, differed from that of Belle Glade and La Mare.

Modelling work commenced in 2016. Matthew Jones submitted a research proposal and registered as Ph.D. student with the University of Pretoria. His supervisors will be Abraham Singels, John Annandale and Graeme Hammer. Matthew spent a week In Montpellier with CIRAD to gain a better understanding of the Mosicas model and how to operate it.

The DSSAT-Canegro, Mosicas and APSIM-sugar models were set up for simulating the different experiments. Canegro simulations were conducted for set up for Pongola R0 and R1, Chiredzi R0, La Mare R0 and R1. Mosicas simulations were conducted for Pongola R0 and R1, and La Mare R0 and R1. An APSIM-Sugar simulation was conducted for Pongola R0.
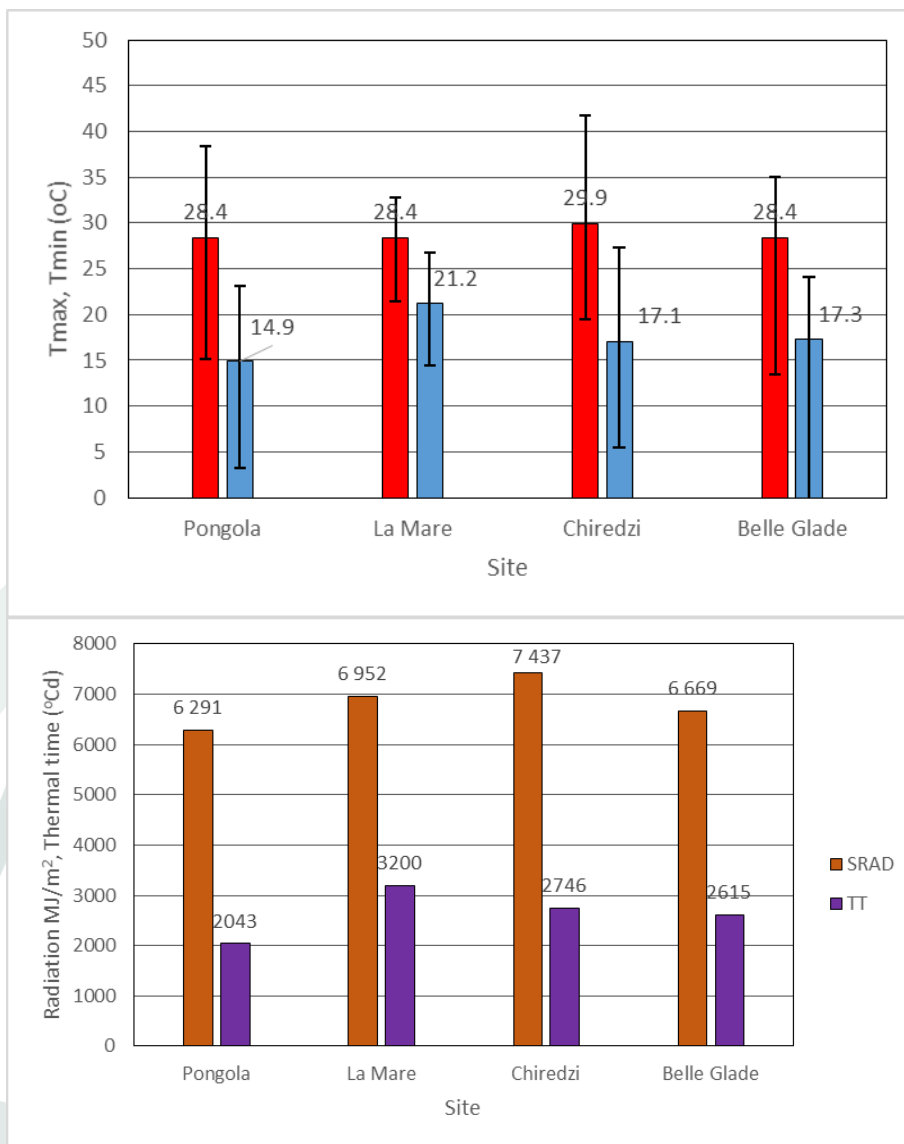
Figure 1. Growing period average maximum and minimum temperature (top), and total solar radiation and thermal time (bottom) for the different sites for the plant crop experiment.
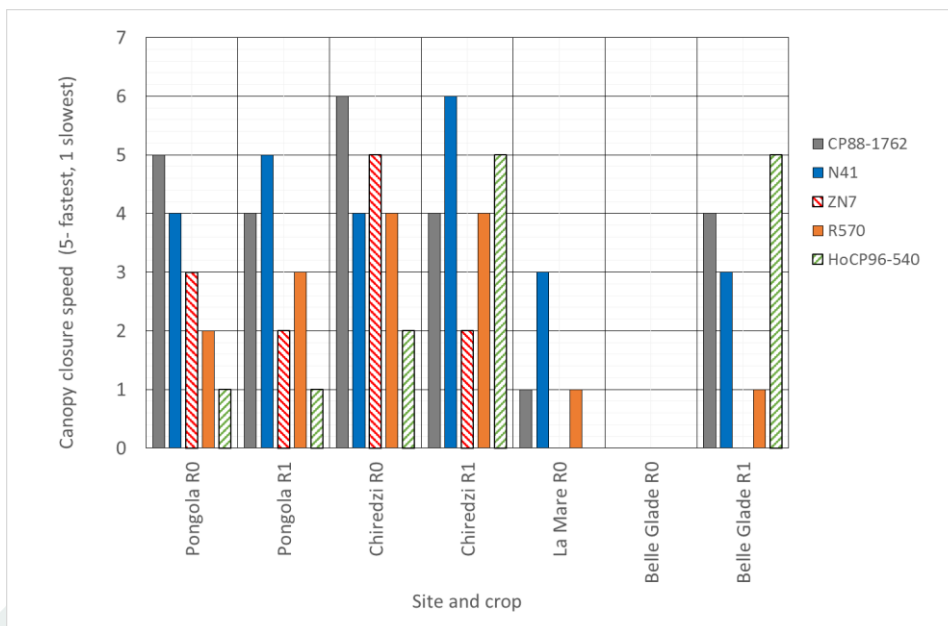
Figure 2. Index to compare rate of canopy development for the different genotypes in the different experiments.
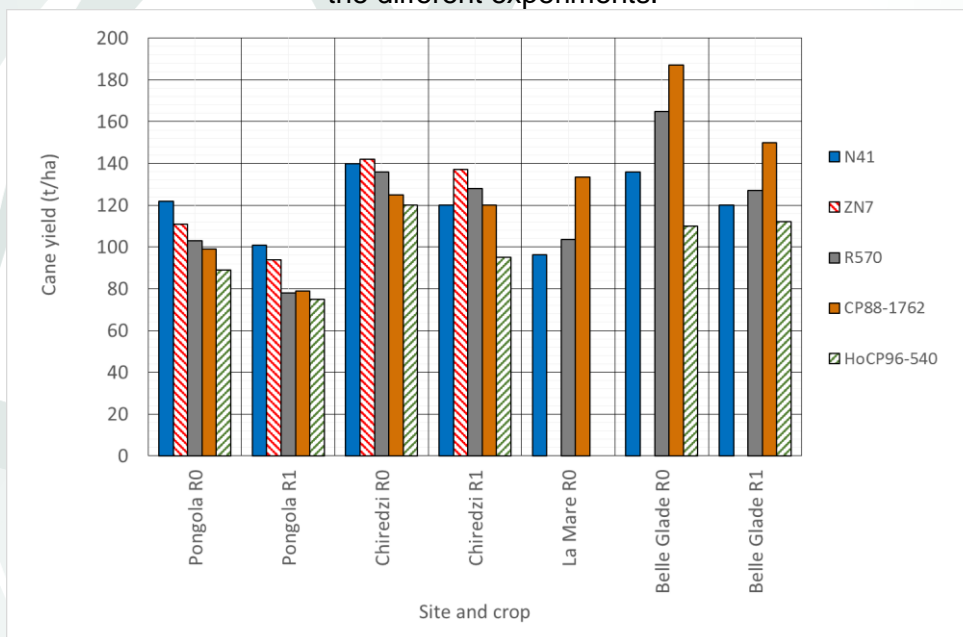

Figure 3. Cane yield at the final harvest for the different cultivars in the different experiments.

An ICSM trait modelling workshop was held on 26 and 27 June 2027 at Mount Edgecombe. The objective was to explore different approaches to the simulation of genetic trait impacts in sugarcane and to plan research actions for developing improved modelling capabilities in this area.

Recent advances in genetic trait modelling in DSSAT and in APSIM-Sugar were presented by Gerrit Hoogenboom of the University of Florida and Geoff Inman-Bamber of James Cook University. Fabio Marin of ESALQ reported on different approaches to model calibration, namely automatic calibration of multiple parameters vs manual stepwise calibration. Natalie Hoffman presented results from her research on estimating trait

parameter values for South African cultivars. Phil Jackson of CSIRO presented a breeder's perspective on how crop physiology and modelling can assist sugarcane breeding. The ICSM project team reported on the status of the experimental work and the processing of captured data.

Mathias Christina of CIRAD, Matthew Jones and Fabio Marin of ESALQ reported on the simulation of the different ICSM experiments by the Mosicas, DSSAT-Canegro and APSIM- Sugar models, and identified a few discrepancies in captured experimental data that need to be resolved.   The project modelling team compared the different approaches to modelling key plant processes used in the three models, highlighting key differences.
The workshop gave good direction for progressing the modelling aspects of the project. Efforts should focus on the key physiological traits identified namely radiation use efficiency, transpiration efficiency, plant conductance with reference to gas exchange, and canopy formation. Data processing and storage methods were clarified. The suitability of additional data sets for model development and evaluation were discussed. Topics for two potential scientific publications were also identified.

The workshop was a valuable opportunity for project participants from diverse disciplines to interact and gain a better understanding of the potential value and limitations of using crop models to support sugarcane breeding.   This will strengthen the collaboration going forward.
More details about the workshop is available at
https://sasri.sasa.org.za/agronomy/icsm/igepworkshop2017.php

Project administration
Project finances are summarized in Table 2. Expenditure to date exceeds the budgeted amount slightly (by about 0.7%). It is expected that total project expenditure will not exceed the total budget, because it is anticipated that the local currency will weaken in coming years (effectively causing an increase in local funds), while expenditure and contributions will remain relatively stable.

Table 2. Project budget

Activity	Year	Budget (US$)	Expenditure (ZAR)	Expenditure (US$)	Variance (US$)
Student recruitment	2015	500	0	0	500
Student PC	2016	2 000	23 442	1 803	197
Student bursary	2016	15 000	200 000	15 385	-385
Contributions	2016	-17 500	-257 401	-19 800	2 300
Student bursary	2017	15 000			
Student training (flights)	2017		12 632	972	-972
Modelling workshop	2017	10 000	186 396	14 338	-4 338
Contributions	2017	-25 000			
Student bursary	2018	15 000			
Contributions	2018	-15 000			
Student bursary	2019	15 000			
Contributions	2019	-15 000			
Student bursary	2020	15 000			
Contributions	2020	-16 000			
Report	2020	1 000			
Total:		**0**	**165 069**	**12 698**	**-3 198**

3. ICSM BUSINESS MEETING

A business meeting was held at Mount Edgecombe on 27 June. The meeting was attended by J. Shine (Florida SCGC), A. Singels. A Patton, N. Hoffman, M. Jones, A. Paraskevopoulos (SASRI), S. Chinorumba (ZSAES), C. Posier, M. Christina, J-F. Martine (CIRAD), as well as observers G. Hoogenboom (University of Florida), F. Marin (ESALQ, University of Sao Paulo)

A financial report was presented by the treasurer and accepted by the members present. On 31 March 2017 the ICSM had a balance of funds of ZAR 212 895 (~ $ 16 400), compared to ZAR 103 688 (~ $ 8 000) on 31 March 2016. Income of ZAR 257 400 (~ $ 19 800) was received from project participants and ZAR 148 194 (~ $ 11 400) was spent, mainly on a student bursary, laptop and flights for workshop delegates.

It was agreed to extend the ICSM memorandum of understanding from 2017 to 2022. It was further agreed to make contact with absent members to enquire about the continuation of their membership These organizations are KALRO-Sugar Research Institute (formerly KESREF, contact Betty Mulianga), Mitr Phol (contact person Saravanan Rethinum), Chiang Mai University (Attachai Jintrawet), CSIRO (Peter Thorburn), Sugar Research Australia (formerly BSES Ltd., Frikkie Botha) and SRIF (Sanja Prakash). It was also proposed to invite Swaziland Sugar Association (Jabulani Sifundza), University of Florida (Gerrit Hoogenboom) and ESALQ (Fabio Marin) to join the consortium.

No new research proposals were put forward.

The ICSM management committee was re-elected unanimously: Chairman: J. Shine; Secretary and treasurer: A. Singels.

It was suggested that the next business meeting could be held in Reunion Island to coincide with the ISSCT Agronomy workshop in 2018.

Members were notified about the revamped website to be found at https://sasri.sasa.org.za/agronomy/icsm/index.php