# INTERNATIONAL CONSORTIUM FOR SUGARCANE MODELLING

# ANNUAL PROGRESS REPORT 2019/20

#### A. Singels and M. Jones May 2020

## 1. INTRODUCTION

The International Consortium for Sugarcane Modelling (ICSM) was established in 2006 and 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), South African Sugarcane Research Institute (SASRI), Sugar Cane Growers Cooperative from Florida (SCGC), Sugar Research Australia Limited (SRA), Sugar Research Institute of Fiji (SRIF), and Zimbabwe Sugar Association Experiment Station (ZSAES). The current memorandum of understanding (MoU) is in place until November 2022.

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 them to 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).

Growth analysis experiments were conducted from 2013 to 2016 (plant and ratoon crops) in Pongola, South Africa; Chiredzi, Zimbabwe; La Mare, Reunion Island; and Belle Glade, Florida, USA using different cultivars (N41, R570 and CP88-1762 at all sites, and HoCP96-540, Q183, ZN7 and NCo376 at some sites). Data collected include soil chemical and physical data, weather 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.

The first step was to evaluate existing concepts of genotype (G) and environmental (E) control of plant processes for explaining crop development, growth and yield, using the data collected in the experiments. Main findings included:

 Final yields showed significant E and GxE variation; dry above-ground biomass and stalk yields were highest in La Mare and lowest in Pongola. Cultivar



rankings in stalk dry mass for the common cultivars (N41, R570, CP88-1762) varied significantly between Es.

- Significant E variation in phenotypic parameters describing germination, tillering and timing of the onset of stalk growth revealed shortcomings in the underlying simulation concepts.
- Significant G variation was found for germination rate, leaf appearance rate and canopy development rate, and maximum radiation use efficiency, indicating strong G control of the associated underlying processes.
- Solar radiation was found to influence tillering rate and duration of the tillering period, challenging the current theory of thermal time as the sole driver of these processes.

This work was captured in a scientific paper that appeared in Field Crops Research (Jones et al., 2019).

In the second phase of the project the objectives were to calibrate, assess, and identify weaknesses and recommend improvements to, three sugarcane models, DSSAT-Canegro, Mosicas and APSIM-Sugar. It was found that cultivar CP88-1762 developed canopy cover faster, intercepted more radiation and out-yielded, R570 and N41 in Es with cool early-season conditions (Belle Glade and Pongola), while R570 outperformed the other Gs in the warm early season E (La Mare). This dynamic was not adequately captured by any of the models. Models simulated G differences in apparent radiation use efficiency (RUEa) accurately for the 3-6 and 6-9 month biomass sampling periods, but not for seasonal RUEa. Data shortcomings prevented us from making strong conclusions regarding E or GxE effects in RUEa. The key recommendation from this study is that sugarcane models must accommodate G-specific base temperature model input for germination and canopy development processes; this is anticipated to result in improved simulation of GxE interaction effects on growth and yield.

For the remainder of the project (2020-21) the focus will be on the development of an improved model for simulating G and E effects on crop growth, and evaluating its potential for supporting sugarcane breeding. The project is due for completion in March 2021.

## Short research visit to Montpellier

The ICSM sponsored a research visit by Matthew Jones to Montpellier, France in February 2020 to attend the iCropM2020 crop modelling conference and to collaborate with CIRAD to plan improvements to the modelling of genotype specific shoot emergence and canopy development. The conference presented comprehensive and detailed coverage of the 'state of art' in crop modelling, and in particular modelling genetic effects. Many of the presentations, related discussions and networking were highly relevant and valuable to the trait modelling research conducted in the ICSM project. Matthew presented progress with the ICSM trait modelling research in the form of a poster paper (Jones et al., 2020b) and received valuable feedback.

The collaboration with CIRAD was similarly successful. Genotypic specific germination responses to temperature formed the core of discussions, and a plan has been devised for tackling model improvements in this regard. A full travel report is available from the ICSM website.

## 3. ICSM ADMINISTRATION

A business meeting of the International Consortium of Sugarcane Modelling was held on 5 Sep 2019 during the ISSCT Congress in Tucuman, Argentina. It was attended by 16 persons from 10 research organizations including ICSM members: CIRAD, CSIRO, SASRI



and Florida SCGC. Activities of the ICSM were reviewed and potential future projects and activities discussed. These included:

- sharing of experimental and other data required for modelling
- modelling of nitrogen and phosphorous relations
- training workshops to build capacity

A new management committee was elected, namely Jim Shine of Florida SCGC as chairperson, and Abraham Singels of SASRI as secretary. There was a lot of interest from non-member organizations to join the ICSM.

### **Finances**

Income of ZAR163 273 was received in 2019/20 in the form of contributions by project participants, while expenses of ZAR115 000 as a bursary payment, and ZAR 39 976 for international travel, was incurred. The balance of funds at 30 March 2020 was ZAR 299 375, compared to ZAR291 079 at March 2019. The exchange rate at time of writing was ZAR18.76/US\$.

#### Personal information

Matthew Jones has been appointed as full-time crop modeller at SASRI from October 2019, and was therefore not eligible for further bursary payments from that time. He will continue the work required in the project and is aiming to complete his Ph.D. by March 2021. Abraham Singels is due to retire in July 2020, but will continue working for SASRI as a part time contractor. He will continue in his role as ICSM project manager and student supervisor until project completion.

# 4. **REFERENCES**

- Jones, M.R., Singels, A., Chinorumba, S., Patton, A., Poser, C., Singh, M., Martiné, J-F., Christina, M., Shine, J., Annandale, J., Hammer, G. 2019. Exploring processlevel genotypic and environmental effects on sugarcane yield using an international experimental dataset. Field Crops Research 244, doi.org/10.1016/j.fcr.2019.107622
- Jones, M.R., Singels, A., Chinorumba, S., Poser, C., Christina, M., Shine, J., Annandale, J., and Hammer, G. 2020a. Evaluating process-based sugarcane models for simulating GxE effects observed in a global dataset. Field Crops Research [under revision].
- Jones, M.R., Singels, A., Chinorumba, S., Patton, A., Poser, C., Singh, M., Martine, J-F., Christina, M., Annandale, J., Hammer, G. 2020b. Assessment of two sugarcane models for predicting genotype by environment interactions, using an international dataset. Poster presented at the iCROPM2020 Symposium held from 3 to 5 February 2020 in Montpellier, France.

https://sasri.sasa.org.za/agronomy/icsm/index.php

