SHORT COMMUNICATION

MODELLING TRASH MANAGEMENT AND ITS IMPACTS: MODEL PERFORMANCE

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Introduction

Evaluating the costs and benefits of trashing/burning requires situation-specific quantification of expected yields and other agronomic and economic factors. Costs of long-term field trials covering all possible combinations of climate zones, soils and periods of the year are prohibitive, so good simulation modelling is necessary. The objective of this short communication is to demonstrate the performance of a newly-developed, stand-alone trash model to be integrated into the Canesim sugarcane simulation model.

Keywords: modelling, sugarcane, green cane harvesting, trash blanket, water balance

Methods

The model

The effects of sugarcane trash on the water balance and plant growth conditions (available soil water and soil temperature), as well as changes to the trash itself, are calculated simultaneously, with a timestep of one day. Trash deposited on the simulated soil surface at harvest is divided into a bottom ‘contact’ layer with a maximum thickness of 5 cm and a top layer accounting for the remainder. Decomposition of the trash occurs mainly in the bottom layer (due to shielding against drying by the top layer), the thickness of which is maintained by attributing trash from the top layer (until it disappears) to the bottom layer. The model accounts for reduced evaporation according to Scopel *et al*. (2004). Stormflow is calculated according to Schmidt *et al*. (1998) and Lumsden *et al*. (2003). Equations to determine rain/irrigation interception by the trash were derived from Thompson (1965). Soil and trash temperatures are estimated pragmatically from a weighted average of recorded air temperature, trash temperature of the previous day, and a long term average temperature. A virtual canopy is simulated according to the equations used in the Canesim model (Singels and Donaldson, 2000), in order to estimate crop water use, and along with evaporation, stormflow and drainage, to calculate a soil water balance. A more detailed description of the model is provided by Jones and van den Berg (2006).

Modelling experiments

Simulated results are compared with yield records from the BT1 (van Antwerpen *et al*, 2001) trashing vs burning trial at the South African Sugarcane Research Institute, Mount Edgecombe). The BT1 treatments, ‘Trash, tops raked, with fertiliser’ and ‘Burnt with fertiliser’, were modelled for the period 1978-2005. Calculated transpiration is correlated with measured yield to evaluate the performance of the model, assuming adequate nutrition and equivalent radiation and soil characteristics. Features of the water balance of each crop are compared to assess modelled effects of the different treatments.

Results

Results of the trial runs are presented in Figures 1, 2 and 3. On average, per crop, the modelled trash intercepted 44 mm of rain water, reduced runoff/stormflow by 39 mm and soil evaporation by 152 mm, resulting in an increase in drainage of 53 mm, and an increase in transpiration of 92 mm. The average difference (trashed-burnt) in the corresponding observed cane yields was 8.1 t/ha.

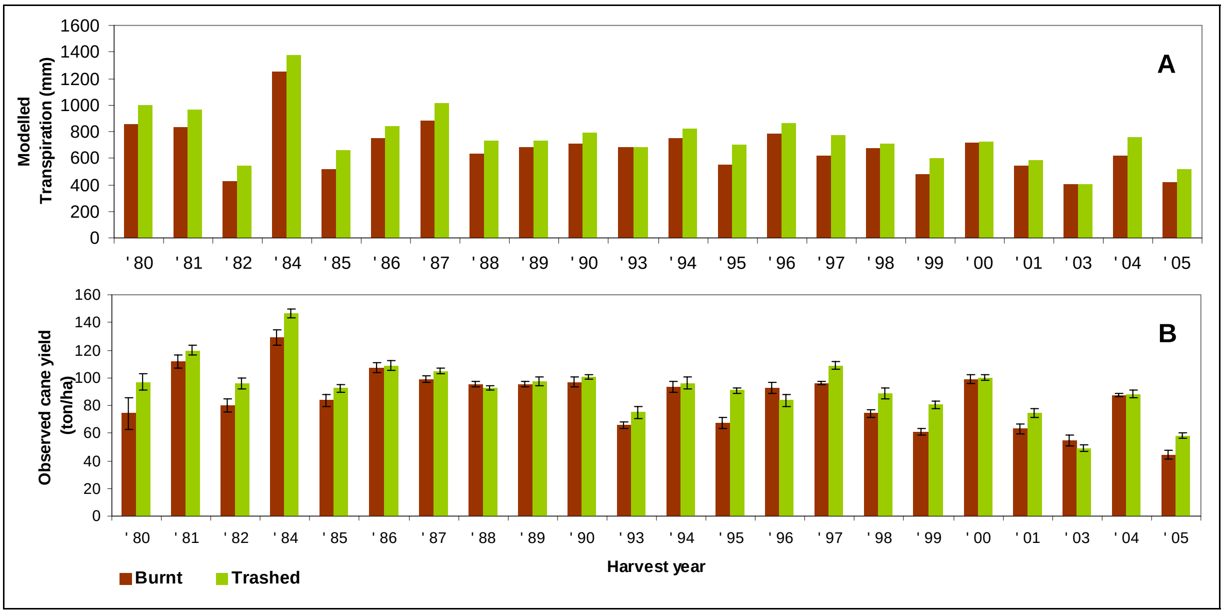

Figure 1. Results for the BT1 trial (1978-2005). (A) Total transpiration calculated for each crop; (B) Correspondent yields observed. Error bars represent plus and minus one standard error in observed data.

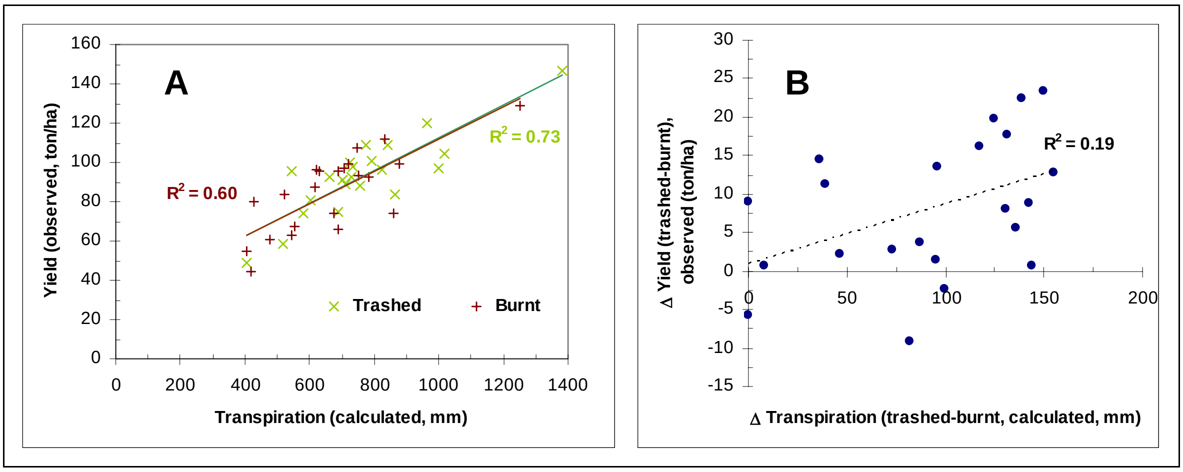

Figure 2. (A) Relationship between total transpiration simulated for each crop with the correspondent observed yields for trashed and burnt conditions; (B) Observed differences in yield of trashed and burnt plots compared with simulated differences in transpiration.

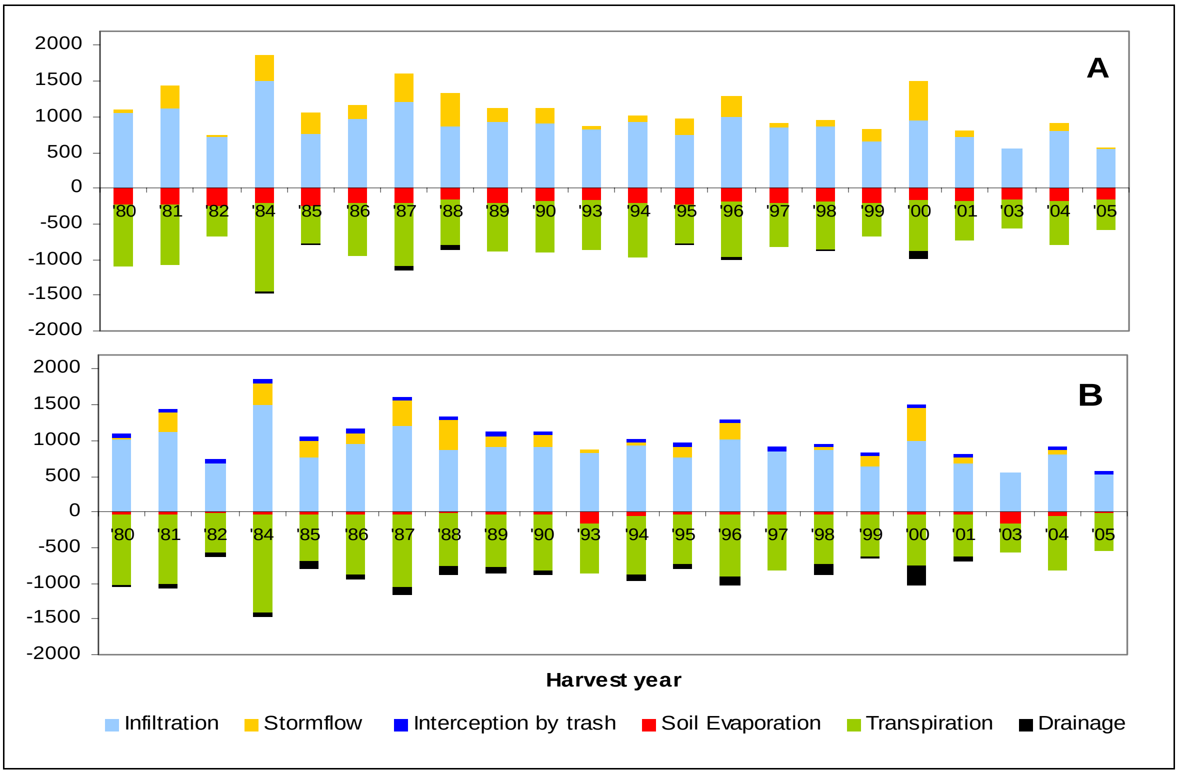

Figure 3. Components of the water balance modelled (total amounts per crop in mm) for (A) burnt and (B) trashed conditions.

Discussion

The results presented in Figure 2 show a good correlation between observed yields and calculated transpiration; even better for trashed than for burnt conditions. The practically-coinciding regression lines of Figure 2A suggest that, overall, the simulations also give a good estimate of the differences between trashed and burnt regimes. However, results of individual years show poor correspondence, albeit significant at the 5% level, as shown in figure 2B. This cannot be substantially improved because the standard errors in the observations (Figure 1B) are too large to exactly quantify differences in yield between treatments for individual years. The discrepancies for 1996 could possibly be due to very dry initial conditions, followed by particularly wet conditions between three and six months after ratooning.

The results in Figure 3 suggest that much of the water saved by a trash blanket (through reduced soil evaporation and storm flow) contributes to drainage, which would eventually result in increased base flow. This illustrates some of the potential value of the model for environmental impact assessments.

Being a ‘work in progress’, the model still has its weaknesses. These lie particularly with the somewhat speculative nature of the simulation of soil and trash temperatures, which affect trash decomposition and emergence rate. The procedure seems to work well for Mount Edgecombe conditions, but requires further testing and possible amendments for different climate zones. Simulation of runoff is crippled by the low time resolution of rainfall records and lack of data for validation.

Future work

Trashing/burning data for further testing and/or fine tuning of the model are being collected in the Midlands, Pongola and Komatipoort. The trash model is intended to eventually become part of the Canesim model, and possibly of the Canegro model as well. The amended Canesim model will enhance SASRI crop forecasting and will assist the industry in making site-specific analyses of the pros and cons of green cane harvesting. Output from the model lends itself to linking up – or eventual integration – with the SASRI 'Economics of trashing' spreadsheet model (Wynne and van Antwerpen, 2004) and the IrriEcon V2 irrigation management model (under construction). Furthermore, SASRI is initiating research into nitrogen management under trash, which could provide data for extending the model.

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