SHORT COMMUNICATION

EVALUATION OF AN OPERATIONAL IRRIGATION ADVISORY SERVICE TO SMALL-SCALE SUGARCANE FARMERS

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Abstract

Small-scale sugarcane farmers in Pongola have been receiving real-time advice since 2004-2005 to enable them to optimally schedule irrigation. The advice is generated by the web-based My Canesim system, which uses a crop model and online weather data to estimate the best schedule of irrigations for individual fields. The aim of this short communication is to report on the accuracy, reliability and impact of the advice at field and scheme level.

Observations of canopy cover, soil water status and cane yield in four fields in 2005-2006, and in nine fields in 2006-2007, show that model simulations of these variables were reasonably accurate when the model was supplied with accurate input data.

The extent of adherence to advice varied between seasons and between farmers. Some farmers gained confidence in the advice and followed it more closely as time progressed. Some farmers under-irrigated substantially, particularly in 2006-2007, due to low water supply and inappropriate scheduling.

The number of subscribers to the service increased from 25 in 2005 to 41 in 2007, out of a possible 47. A survey amongst users showed that most farmers:

- found the advice useful and easy to understand, and trusted the advice most of time,
- became more aware of the importance of irrigation scheduling in increasing revenue and reducing costs, and
- have changed irrigation practices because of the advice.

Results suggest that it would be beneficial to continue the service to Pongola farmers and to explore opportunities to launch similar services in other irrigated areas of the sugar industry.

Keywords: SMS, sugarcane, irrigation, scheduling, small-scale growers, Canesim, crop model

Introduction

Small-scale sugarcane farmers in Pongola (27°24'S, 31°35'E) have been receiving irrigation scheduling advice since the 2004-2005 growing season to enable them to optimally schedule irrigation to save water, and to achieve good yield and quality (Smith *et al*., 2005; Singels and Smith, 2006). The advice is generated by the web-based *My Canesim* system (Singels, 2007), which uses a crop model to estimate the best schedule of irrigations for individual fields. The aim of this short communication is to report on the accuracy, reliability and impact of the advisory service.

Method

The *My Canesim* system was implemented to simulate, on a daily basis, the cane growth and water balance for subscribed fields, based on field properties and near real-time daily weather data (see Singels and Smith (2006) for full description). The system generates simple irrigation advice for each field and delivers it to farmers using cellular text messages (SMS). Advice is only sent when a change in irrigation practice is required, or on Wednesdays.

Irrigation and soil wetting front depth (WFD) were monitored weekly, and canopy cover (CC) periodically, on four fields in 2005-2006 and on nine fields in 2006/07, according to the methods described in Singels and Smith (2006).

Fresh cane yield (CY) was determined for all fields with good mill delivery data. Seasonal water use (WU) was estimated for all fields with good flow meter data (supplied by Impala Water Users' Association). Average CY yield and seasonal water were calculated for two groups of farmers, namely (i) monitor participants (farmers whose fields were monitored and had good CY and WU data – four in 2005-2006 and eight in 2006-2007), and (ii) advice participants (subscribers to the advisory service whose fields were not monitored but had good CY and WU data – 26 in 2005-2006 and 25 in 2006-2007).

Recorded irrigation data was used as soon as it became available, to adjust input data for simulations. WFD, CC and CY data were used to assess the accuracy of model simulations.

It was assumed that the wetting front would reach a depth of 50 cm (named WFD50 event) when simulated available soil water content (ASW) increased by at least 5 mm/d to a value of more than 80% of the available soil water capacity (ASWC), or when simulated ASW increased by more than 50 mm/d. An index of agreement between simulated and recorded soil water status was calculated as the number of correctly simulated WFD50 events (when a WFD50 event was recorded within a week after the simulated event), divided by the sum of the number of correctly simulated WFD50 events, number of over-estimates (when a simulated WFD50 event was not recorded) and the number of under-estimates (when a recorded WFD50 event was not simulated).

Adherence to advice was quantified by counting the number of unadvised irrigations (UI), unadvised stops (US) and advised irrigations (AI) for each field and each growing season. The adherence score (AS in %) was then calculated as:

$$AS = 100\ (1 - (UI + US)/AI) \qquad \text{Eq. 1}$$

An AS value of 100% implies that the farmer followed the advice exactly, while a score of 0 implies that the farmer executed a number of unadvised actions equal to the number of advised irrigations.

Farmers' perceptions of the reliability, accuracy and impact of the service were explored through personal interviews with 20 farmers, using a questionnaire.

Results and Discussion

Field evaluation

Simulated canopy cover compared well with measurements (root mean square error = 18% and mean bias error = +5%) and the model was able to capture seasonal trends. The accuracy of soil water status simulations was acceptable (IA of more than 50% and a difference between the number of over and under-estimations of less than six) for four fields in 2006-2007 and two fields in 2005-2006. In 2006-2007 the model tended to under-estimate soil water status when the ASWC was very low (e.g. Simelane), when very little water was applied (e.g. Mncwango and Ntshangase), and in poorly drained fields (Khumalo). In 2005-2006 the model tended to over-estimate soil water status for Khumalo and Nene. This could possibly be due to the doubtful quality of recordings at the start of the season when recording procedures were still being established. Further investigation is required to identify appropriate model refinements.

CY (Table 1) was also simulated with acceptable accuracy (root mean square error = 16 t/ha; mean bias error = 0 t/ha), especially given the fact that the field average yield is compared to yield simulated from input data collected in a small sampling area. One exception was the 40% over-estimation of Nene's yield in 2005-2006, which is ascribed to waterlogging that was observed in large areas of the field that was not monitored.

Adherence to advice

The extent of adherence to advice varied between seasons and between farmers. Generally, unadvised stops were a bigger problem than unadvised irrigations, especially in 2006-2007 (see Table 1). This was due to interruptions in the scheme water supply (50 days in 2007 compared to 21 days in 2006), electricity cuts caused by non-payment of accounts (Ntshangase and Mncwango) and pump breakdowns (Simelane).

Some farmers (e.g. Mthembu and Simelane) gained confidence in the advice and followed it more closely as time progressed. For example, Mthembu over-irrigated substantially in 2005-2006, but reduced irrigation in 2006-2007 to match the ideal schedule more closely (Table 1). In contrast, Nene and Khumalo often deviated from advice. In 2005-2006, this was primarily due to excessively long stand times and cycles. The farmers corrected these practices after field visits by extension staff. In 2006-2007, these two farmers often could not irrigate when advised to do so, due to the frequent unavailability of water.

The average simulated cane yield shortfall due to suboptimal scheduling also varied between seasons (from 20% in 2005-2006 to 35% in 2006-2007) and between farmers (5-32% in 2005/06 and 19-44% in 2006-2007).

Impact

The number of subscribers to the service increased from 25 in 2005 to 41 in 2007, out of a possible 47. Farmers were mostly keen to subscribe after the service was explained to them.

A survey revealed that:

- Farmers found the advice useful (20/20), easy to understand (20/20), agreed with it most (12/20) or all of the time (8/20), trusted it most (7/20) or all of the time (13/20), and implemented it most (17/20) or all of the time (3/20).
- Farmers became more aware of the importance of irrigation scheduling in increasing revenue and reducing costs (20/20).

- Most farmers changed irrigation scheduling because of the advice (19/20) and believed that irrigation water use decreased (5/8) or remained the same (3/8).
- The perceived impact on cane yield varied from slightly increased (4/9) to slightly decreased (3/9). The remainder (11/20) were not sure about the impact.
- Sixteen farmers were prepared to pay a small service fee (8/20 – less than R10/ha; 8/20 – between R10 and R50/ha).

The scheme average cane yield and water use in 2006-2007 were substantially lower than in 2005-2006 (70 t/ha and 520 mm compared to 88 t/ha and 783 mm, respectively). This is ascribed to lower availability of water in 2006-2007 as explained previously. For monitor participants, average yield and water use were higher (92 t/ha and 791 mm compared to 78 t/ha and 637 mm, respectively), and the decrease in yields and water use from 2005-2006 to 2006-2007 were much less (0 t/ha and 183 mm compared to 23 t/ha and 373 mm, respectively), than for advice participants. It is possible that the more frequent and intense interaction of *My Canesim* representatives with farmers led to more appropriate irrigation scheduling.

Conclusions

A real-time irrigation scheduling advisory service has been implemented successfully on the Pongola small-scale irrigation scheme. The system simulated canopy cover, soil water status and cane yield with acceptable accuracy, although there is room for improving simulations of soil water status. Some farmers followed the advice closely while others deviated from it, often for ‘legitimate’ reasons such as lack of water supply. Farmers mostly found the advice useful and adapted their irrigation scheduling because of it.

The study revealed that:

- Under-irrigation was more prevalent than over-irrigation, especially in 2006-2007. This can be partly ascribed to inadequate water supply and partly to inappropriate scheduling. The extent of under-irrigation diminished as the level of interaction between project staff and farmers increased.
- It was important to feed accurate, fresh irrigation data into the system to reflect actual practices. Appropriate field instrumentation and staff to collect and transfer data are therefore needed.

Results suggest that that it would be beneficial to continue the service to Pongola farmers and to explore opportunities to implement similar services in other irrigated areas, provided that the stated prerequisites are fulfilled.

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Table 1. Field details and results regarding adherence to advice, water use and cane yield for each monitored field. Cane yield was simulated using actual irrigation as input. The irrigation shortfall is the difference between the optimal (as determined by the model) and the actual irrigation, and the cane yield shortfall is the difference between cane yields simulated from actual and optimal irrigation.

Field details				Adherence to advice					Water			Yield		
Grower	Harvest date	Crop age (days)	ASWC (mm)	AI	#I	UI	US	Adherence score (%)	Rain (mm)	Actual irrigation (mm)	Irrigation shortfall (%)	Simulated CY (t/ha)	CY shortfall (%)	Measured CY (t/ha)
Mthembu D	22-Jun-07	359	90	18	23	2	0	89	801	690	14	96	20	112
Simelane NM	6-Jul-07	354	50	22	17	0	5	77	810	548	43	86	25	73
Thabethe BE	3-Apr-07	231	100	17	10	0	7	59	658	407	31	70	35	81
Mncwango M.T	10-Apr-07	330	120	17	5	2	10	29	738	127	78	75	30	81
Ntshangase MA	29-May-07	389	90	25	5	0	20	20	790	75	91	70	44	74
Phakathi FD	30-Sep-07	344	120	24	13	1	10	54	634	632	35	100	19	89
Mbokazi A	25-Aug-07	361	100	24	12	0	12	50	703	534	36	88	31	116
Khumalo MH	19-Dec-07	371	105	31	13	0	18	42	863	576	38	114	25	–
Nene TZ	25-Dec-07	371	120	24	14	1	9	58	841	627	29	113	21	–
Mthembu D	26-Jun-06	392	90	20	27	5	0	75	511	1424	-36	114	5	126
Simelane NM	1-Jul-06	322	50	26	14	1	12	54	495	868	14	81	19	71
Khumalo NC	7-Dec-06	387	105	25	11	1	13	44	685	570	48	96	32	91
Nene TZ	13-Nov-06	343	120	21	16	3	5	76	602	934	-6	111	8	79

ASWC – Available soil water capacity (mm)
AI – number of advised irrigations
#I – number of actual irrigations
UI – number of unadvised irrigations
US – number of unadvised stops
AS – adherence score (%)
Rain – total rainfall recorded by the automatic weather station for the growing season (mm)