Integrating weather based crop modeling and soil water monitoring technologies to provide improved decision support for sugarcane irrigation management

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Introduction and Background

- Weather based crop models are good at estimating past and future evapotranspiration (ET), irrigation needs and yields over large areas (Allen et al., 1998; Annandale et al., 2005)
- Capacitance soil water sensors are useful for measuring current soil water status at a point (Fares et al., 2011; Evett et al., 2012)
- Opportunity to combine (integrate) the two technologies for enhanced irrigation management.
Objectives

• Integrate real-time capacitance probe data into a weather-based sugarcane crop simulation model.

• Assess the value of the integrated system for irrigation management - 13 case studies.
Study area: Onderberg (Mpumalanga)
Irrigation Systems

- 8 drip systems: 1 day cycle, 7 mm/day design capacity.

- 5 Overhead system:
  - 3 dragline (7 day cycle, 24 - 48 mm capacity),
  - 2 centre pivots (2 day cycle, 12 - 15 mm capacity)

- Estates, private commercial farms, and some small scale farms
Overview of daily integration process

1. Infer irrigation data

2. Convert to available soil water content

3. Outputs
Overview of daily integration process

1. Infer irrigation data

2. Convert to available soil water content

3. Outputs
1. Inferring irrigation event data

- Need to calculate irrigation events to
  - Input required for simulations
- Indicated an irrigation event when
  - Significant number of small increases in SWI over a long (6-12hr) period (drip, overhead)
  - A large increase in SWI over a short (2hr) period (overhead)
  - Only when rainfall at the field, nearby field, AWS <1/2 design capacity
1. Inferring irrigation amounts

- \( Irr = \Delta ASWC + ET - R \)
  
  For days with \( R < 0.5 \) design capacity
Overview of daily integration process

1. Infer irrigation data
2. Convert to available soil water content
3. Outputs
2. Soil water data conversion

- **ASWC** = **TAM** – (**FC_{SWI}** - **SWI**) . **CR**

- **ASWC** – available soil water content (mm)
- **TAM** – ASWC at field capacity (mm)
- **SWI** – soil water index as measured by probe (%)
- **FC_{SWI}** – SWI field capacity determined from point where drainage stops (%)
- **CR** – conversion ratio determined from night time irrigation or dry periods of extraction (mm/%)
2. Estimation of $\text{FC}_{\text{SWI}}$
2. Estimation of CR
Overview of daily integration process

1. Infer irrigation data

2. Convert to available soil water content

3. Outputs
3. Output from integrated MyCanesim

- Tables
  - Current and future Irrigation advice
  - Current crop water use and yield
  - Final crop water use and yield
- Graphs
  - Available soil water content graph
  - Crop status graph
  - Water budget graph
Evaluation

• Irrigation amounts: design capacity vs inferred application
  
• Compare simulated water use and yield for:
  – Optimal irrigation (simulated)
  – Inferred irrigation (estimated)
  – Corrected ASWC (closest to reality)
Comparison of irrigation amounts
Simulations: Irrigation (mm)

Seasonal Irrigation (mm)

Fields

Irrigation: Optimal (simulated)
Inferred irrigation

0 200 400 600 800 1000 1200 1400
8A 8C 17 G7 G1 G4 3B 7 12 81

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Evapotranspiration (mm)
Information transfer

- Met with farmers, extension and scientists, at Onderberg and Umfolozi
- Showed Aquacheck graphs and MyCanesim simulations
- Gave integrated MyCanesim outputs (booklets) to farmers
- Identified good and bad management of irrigation, agronomy and impacts on yield
- Discussed improvements to management and to the integrated system
Soil water graph – G1
Aquacheck soil water: Lebombo G1
Crop Status Graph - Buffelspruit 17
Conclusions

1. Probe based soil water status data successfully integrated with weather based MyCanesim simulation system.

2. Integrated MyCanesim provides enhanced support for irrigation water management for sugarcane.
   • Irrigation practices can be adjusted and
   • Yields and water use efficiency can be benchmarked.

3. Evaluation suggest:
   • Inferred drip amounts > design - probes were located close to emitters.
   • Inferred overhead amounts < design - canopy interception and poor system efficiency.
   • Irrigation derivation algorithm needs improvement
   • Simulations suggest that good irrigation practices were followed in 10 out of 12 cases
   • Actual yields were well below (>30%) SWC-corrected simulated yields in 3 cases – indicating problems other than irrigation.

6. Capacitance soil water data is useful for irrigation water management

7. In this project we mainly used the integrated MyCanesim to look at past actions. We need to test real-time scheduling with the integrated system.
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MyCanesim soil water balance: Lebombo G1

Rainfall
- Irrigation
- ASWC
- TAM
- ADL
- Stress level
- ASWC Probe

Date:
- 11/11/2011
- 12/11/2011
- 1/11/2012
- 2/11/2012
- 3/11/2012
- 4/11/2012
- 5/11/2012
- 6/11/2012

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