IrriSAT - an Irrigation management and crop water use benchmarking system

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Outline

• Overview of the IrriSAT system - main components

• Science behind IrriSAT - background

• Experience with IrriSAT in Cotton and viticulture irrigated systems

• Future directions R&D
Aims / Goals / Approach

• **Aim** - to overcome the costs and complexities of irrigation scheduling

• **Driving Goal** - capturing the bulk of the ‘market’ and providing them with a tool for assisting irrigation decisions to deliver real water savings or efficiency improvements

• **The Approach** – use emerging technologies* –
  
  • Satellite Remote Sensing (a world wide sensor system)
  
  • SMS (a world wide information delivery platform)

* 1st SMS message was sent in 1992 (20 years ago)
Landsat 5 satellite launched in 1984 (28 years ago)
Overview of IrriSATSMS

Satellite images used to determine plant performance of an irrigators crop

Incorporates management/soil/water/salinity constraints

Determination of a crop coefficient (Kc) from satellite image

Representing Individual Paddocks

ETo from Weather Station and ETo forecast

Potential Evaporation based on Atmospheric Demand

$ET_c = ET_o \times K_c$

Crop water use determined and irrigation requirement

Daily irrigation scheduling information delivered to irrigators
How does IrriSAT help me irrigate?

• Using the FAO 56 approach

Actual water use of crop

Reference water use – weather station or 7 day forecast

Crop Coefficient – relates your crop to the reference crop

\[ \text{ETc} = \text{ETo} \times Kc \]
Limitations of traditional kc approaches
Gaining individual crop coefficients

- Multi-spectral satellites overpass every 8-16 days
- Images of everyone's individual crop is taken with a 30x30m resolution
- This information can be used for gaining site and management specific crop coefficients
NDVI

- \( \text{NDVI} = \frac{R_{\text{NIR}} - R_{\text{red}}}{R_{\text{NIR}} + R_{\text{red}}} \)

\[
\frac{(0.50 - 0.08)}{(0.50 + 0.08)} = 0.72
\]

\[
\frac{(0.4 - 0.30)}{(0.4 + 0.30)} = 0.14
\]

\[
\text{NDVI} = \frac{\text{Band 4} - \text{Band 3}}{\text{Band 4} + \text{Band 3}}
\]
Determining Kc from NDVI - grapevines

\[ Kc = f \left( \text{NDVI} \right) \]
• Weather data used to calculate reference crop water use (ETo)
ETo - http://www.irrigateway.net/weatherstations
How does the IrriSAT schedule?

\[ ET_c = ET_0 \times K_c \]

Actual water use of crop

.. But still in a format that's not much use for irrigators! (mm/day)

..Need to convert to a pump run time
IrriSATSMS
IrriSATSMS Making the scheduling information useful

Irrigation

Rainfall
Daily SMS delivery of irrigation scheduling information

Seasonal water balance information

Pump/dripper run time to replace ET since last irrigation or rainfall
Example of daily SMS sequence

Reference or zero point
IrriSAT
Spatial Irrigation scheduling / water management information
Cotton - Crop Variability

Gwydir (prototype)

Choose a map by date:

Load

Legend:

1.1

0.3
Percentage of Irrigators within water balance group

<table>
<thead>
<tr>
<th>Group</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Within +/-0.2 ML/ha</td>
<td>50%</td>
</tr>
<tr>
<td>With +/-0.5 ML/ha</td>
<td>25%</td>
</tr>
<tr>
<td>More 0.5 ML/ha</td>
<td>5%</td>
</tr>
<tr>
<td>Less 0.5 ML/ha</td>
<td>10%</td>
</tr>
<tr>
<td>Stopped</td>
<td>10%</td>
</tr>
</tbody>
</table>
Waterbalance traces – MIA 2008/09 season

Majority of irrigators closely followed system

Two week period of high ETc
IrriSAT - Benchmarking
Regional Crop Water Use

Legend

Total seasonal crop water consumption

ML/ha/season

8.6

< 0.5

Season based on period from 15-Oct-2010 until 15-April-2011

Data projection UTM38-WSG84
Yield/production/water use relationships

- Low deficit irrigations
- Lateral Move Systems

Graph showing
- ETc-Yield relation
- Solid
- Single skip
- 2.0 m rows
- Double skip

Cotton yield [bales/ha]
Seasonal crop water use (Irrisat) [mm]
IrriSATSMS/IrriSATWEB Nodes

• **Current Areas (2011-2012 irrigation season)**
  - Murrumbidgee (Grapes and Citrus)
  - Hawkesbury-Nepean (Turf, Pasture, Citrus, Stone fruit)
  - Gwydir/Namoi/ Walgett (Cotton)
  - Goulburn Valley (Grapes)
  - Mildura (Grapes and Citrus)

• **International Nodes being established**
  - Cambodia
  - Iraq
Future directions R&D
Future directions

• Establishing IrriSAT nodes in developing countries – Iraq and Cambodia

• Incorporating thermal band for stress determination in wine grape production

• Finding alternatives for Landsat

• Whole of irrigation area water ordering/demand management from large storage dams
  • Murrumbidgee Irrigation Area – 200,000 irrigated hectares – 1300 GL allocation
  • 7 days travel time from dam release to off-take in Irrigation Area
  • 24 hr water availability for customers
  • Over/under order losses are financially costly for the Irrigation company
Cumulative 3 & 7 day ET$_{ref}$ forecast

Date (m/d/yy)

Cumulative ET$_{ref}$ (short) [mm]

Cumulative 3-day ET$_{ref}$ (short) forecast
Cumulative 3-day ET$_{ref}$ (short) observed
Cumulative 7-day ET$_{ref}$ (short) forecast
Cumulative 7-day ET$_{ref}$ (short) observed
Cumulative 7-day ET$_{ref}$ (short) 25yr avg
## Irrigation Demand Management

<table>
<thead>
<tr>
<th>Farm No.</th>
<th>Kc</th>
<th>CSIRO Forecast Eto (Next 7 days)</th>
<th>Forecast Water Demand (Next 7 days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1045</td>
<td>0.5</td>
<td>65</td>
<td>28 ML</td>
</tr>
<tr>
<td>1085</td>
<td>0.9</td>
<td>65</td>
<td>39 ML</td>
</tr>
<tr>
<td>144</td>
<td>0.95</td>
<td>65</td>
<td>27 ML</td>
</tr>
<tr>
<td>784</td>
<td>0.21</td>
<td>65</td>
<td>82 ML</td>
</tr>
<tr>
<td>108</td>
<td>0.22</td>
<td>65</td>
<td>74 ML</td>
</tr>
<tr>
<td>1478</td>
<td>0.35</td>
<td>65</td>
<td>56 ML</td>
</tr>
<tr>
<td>221</td>
<td>0.7</td>
<td>65</td>
<td>10 ML</td>
</tr>
<tr>
<td>2658</td>
<td>0.18</td>
<td>65</td>
<td>11 ML</td>
</tr>
</tbody>
</table>

Total Demand Forecast For this off-take: 327 ML
Conclusions

• IrriSAT provides useful real time information on crop water use across large areas at low cost – validated with actual irrigators across the major production areas in Australia

• IrriSAT when combined with yield data provides detailed information on benchmarking the performance of irrigation/row configurations and effects on irrigation decisions on yield

• The system is scalable and provides useful information for individual farmers. It also scales from the farm to the irrigation system level for water ordering.
Further Information

• Download IrriSATSMS technical report

• Visit the IrriGATEWAY website
  [www.irrigateway.net](http://www.irrigateway.net)