Knowledge management, sensing and control tools for irrigated broadacre cropping

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National Centre for Engineering in Agriculture
Institute for Agriculture and the Environment
University of Southern Queensland
NCEA’s irrigation research

- Knowledge Management System for Irrigation (KMSI)
- SISCO – surface irrigation modelling
- Automation through commercial control systems (Rubicon, WiSA, Valmont, Lindsay-Zimmatic)
- VARlwise, site-specific irrigation decision making
Suite of tools funded by the Queensland Government as part of the South East Queensland Irrigation Futures project

Centralised online decision support tools for irrigation, nutrient and energy calculators with benchmarking function to compare across catchments, systems and industries

Also has simple calculator tools with simple input/output interface

For growers and industry consultants

kmsi.usq.edu.au
KMSI - IPART

Irrigation Performance Audit and Reporting Tool (IPART)

- Assist in the evaluation and collation of infield irrigation application system performance data

### Solid Set

#### Statistics of Total (All cans):

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distribution Uniformity (%)</td>
<td>81.35</td>
</tr>
<tr>
<td>Coefficient of Uniformity (%)</td>
<td>88.45</td>
</tr>
<tr>
<td>Minimum Depth Applied (mm)</td>
<td>5.7</td>
</tr>
<tr>
<td>Maximum Depth Applied (mm)</td>
<td>12.0</td>
</tr>
<tr>
<td>Average Depth Applied (mm)</td>
<td>8.8</td>
</tr>
<tr>
<td>Average Depth Applied in Lowest Quarter (mm)</td>
<td>7.2</td>
</tr>
</tbody>
</table>

#### Statistics of Total (Effective cans):

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distribution Uniformity (%)</td>
<td>81.60</td>
</tr>
<tr>
<td>Coefficient of Uniformity (%)</td>
<td>88.44</td>
</tr>
<tr>
<td>Minimum Depth Applied (mm)</td>
<td>5.7</td>
</tr>
<tr>
<td>Maximum Depth Applied (mm)</td>
<td>12.0</td>
</tr>
<tr>
<td>Average Depth Applied (mm)</td>
<td>8.7</td>
</tr>
<tr>
<td>Average Depth Applied in Lowest Quarter (mm)</td>
<td>7.1</td>
</tr>
</tbody>
</table>

There are currently 1338 records in the database collected between 27-11-1993 and 27-11-2016.
Irrigation Pump Evaluation and Reporting Tool (IPERT)

- Assist in the evaluation and collation of on-farm irrigation pumping system performance data

### Search Results:
- **Organisations:** ALL
- **Growers:** ALL
- **Catchments:** ALL
- **Pump & Motor Combination:** ALL
- **Collection Date:** from 1-1-1995 to 8-9-2016

891 matches found

<table>
<thead>
<tr>
<th>Name</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Median</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow Rate (l/s)</td>
<td>0.14</td>
<td>1759</td>
<td>93.1</td>
<td>20.56</td>
<td>279.88</td>
</tr>
<tr>
<td>Total Dynamic Head (m)</td>
<td>1.87</td>
<td>372.07</td>
<td>57.34</td>
<td>54.84</td>
<td>36.45</td>
</tr>
<tr>
<td>Energy Consumption (kWh)</td>
<td>6.78</td>
<td>2222.22</td>
<td>356.67</td>
<td>324.08</td>
<td>233.59</td>
</tr>
<tr>
<td>Overall Efficiency (%)</td>
<td>2.42</td>
<td>100</td>
<td>44.86</td>
<td>45.72</td>
<td>18.66</td>
</tr>
<tr>
<td>Comparison Cost ($/ML)</td>
<td>2.44</td>
<td>688.1</td>
<td>74.82</td>
<td>66.06</td>
<td>53.2</td>
</tr>
<tr>
<td>Energy Consumption (kWh/ML)</td>
<td>0.41</td>
<td>66.74</td>
<td>6.92</td>
<td>5.52</td>
<td>5.56</td>
</tr>
</tbody>
</table>

### Table

<table>
<thead>
<tr>
<th>Report ID</th>
<th>Grower</th>
<th>Crop</th>
<th>Site</th>
<th>Flow Rate (l/sec)</th>
<th>Total Dynamic Head (m)</th>
<th>Energy Consumption (kWh)</th>
<th>Overall Efficiency (%)</th>
<th>Comparison Cost ($/ML)</th>
<th>Energy Consumption (kWh/ML)</th>
</tr>
</thead>
<tbody>
<tr>
<td>39</td>
<td>Grower 1</td>
<td>Egg plant</td>
<td>Creek Pump, Qld, Border Rivers</td>
<td>6.2</td>
<td>52.82</td>
<td>660.84</td>
<td>21.76</td>
<td>132.17</td>
<td></td>
</tr>
<tr>
<td>45</td>
<td>Grower 2</td>
<td>Tree place</td>
<td>Tree - Pomes, Small Dam, Qld, Border Rivers</td>
<td>12.34</td>
<td>N/A</td>
<td>511.89</td>
<td>N/A</td>
<td>102.38</td>
<td></td>
</tr>
<tr>
<td>46</td>
<td>Grower 3</td>
<td>Other place</td>
<td>Tree - Other, Dam, Qld, Sunshine Coast</td>
<td>3.3</td>
<td>64.94</td>
<td>195.24</td>
<td>90.55</td>
<td>39.05</td>
<td></td>
</tr>
</tbody>
</table>
KMSI - MIM

Metering & Irrigation Management Tool (MIM)

- Assists farmers in managing their metered water usage through provision of meter readings, farm and field information.
- Mobile friendly
KMSI – SID

Scheduling Irrigation Diary (SID)

- Irrigation recording and scheduling features based on evapotranspiration (ET)
- Web based tool, also available in iOS and Android with the Augmented Reality feature
- There will be demo during the field day
SISCO - surface irrigation

- Tool for modelling furrow & border check irrigation
- Needs good field measurements
- Can predict distribution of water across field
- Enables users to optimise performance
Automation systems

- First step = Remote control
- Second step = Automated control
- Third Step = Smart automated control
**Furrow in Sugarcane**

**Using WiSA control systems**

a) Linear actuators on valves  
b) Pressure sensor in cylinder/pipe  
c) Buried end of row sensors  
d) Flowmeters
Using Rubicon control systems

Control Gate

Depth sensor for flow meas. and control of channel system

Secondary head channel

Bay Drive™ Drop Gate in Concrete Shute

Primary Channel

Secondary Channel

75mm (67.7 ID) HDPE pipes through Bank

Earth Bank

Rotobucks

Cotton on standard 1m spacing

Control Gate
Furrow in Cotton

Current Questions?
- Channel and pump control
- How to estimate spatial soil moisture?
- Spatial variability of rain?
- Sensing advance?
Irrigation advance monitoring

- Thermal and visible camera on 10 m tower
- Upload image on motion detection

Camera tower

Thermal images from head ditch

23/10/2015 20:24:44.401
VARIwise: site-specific irrigation control system

1. Sensors
   - fixed sensors
   - historical maps
   - on-the-go sensors

2. Control strategy
   - convert data to irrigation application
     - sensor or model-based
     - model-based control needs calibration with infield data

3. Real-time irrigation adjustment
   - actuators to apply irrigation

Control strategies

Model calibration

Yield (bales/ha)

- Sensor-based
- Model-based

Soil moisture (mm)

Date

31/10 20/12 08/02 29/03
**Camera-based sensors**

**Smartphone camera**

Height from quad bike sensor

Canopy cover from cameras

| Height (mm) | 0 | 250 |

Original image | Analysis
Control system implementation on centre pivot

Real-time camera-based plant sensing to update irrigation:
Control system implementation for surface irrigation

Crop growth and fruiting

Soil-water, weather

Control strategy determines irrigation volumes
Conclusions

- Tools developed for growers, consultants and automated irrigation data management and processing
- Used for manual or automated management
- Next steps:
  - Evaluation of SISCO and VARIwise control strategies at cotton, sugarcane and dairy pasture over next two years
Acknowledgements

- Cotton Research and Development Corporation, Federal Government Rural R&D for Profit Program, Queensland Government, TIA, Dairy Australia, Sugar Research Australia and Queensland Department of Natural Resources for funding support

- Cotton growers Lindsay Evans and Neil and Lachlan Nass for providing field trial sites