Surface Irrigation for Energy and Water Use Efficiency

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Premise
Surface irrigation (bay and furrow) with automation and real-time optimization:

- can give application efficiencies equivalent to pressurised systems;
- uses much less energy per unit of water than pressurised systems; and
- should be the preferred system for the majority of our broad acre crops, fodder and pasture.
Where have we come from?

Previous performance of surface irrigation
Sugar (Qld) 1994/95

- Burdekin region - 52 irrigations
- Application efficiencies 14 to 90%
- Average efficiencies
  - Cracking clay 62%
  - Alluvial & Non-sodic duplex 35%

Cotton (late 1990’s)

Average application efficiencies for furrow irrigation less than 50% (range 17 to 98%)- over 300 evaluations
Ord (sugar) early 2000’s

- 30 irrigations, cracking clay soil
- average application efficiency 61% (range 36 to 81%)

Bay irrigated pasture (Vic) 2009

- 7 soil types, 9 irrigations
- average application efficiency 69% (46 to 86%)
Where do simple improvements take us?
Performance improvement – Surface irrigated cotton

Farmer management – average efficiency 48%

Flow rate 6 l/s cut off at 90% of advance time – average efficiency 74%
Furrow evaluations 2007 (Cotton) (Montgomery & Wigginton)

47 irrigations on 9 farms
Application efficiencies for drip irrigation of dried vine fruit (Schrache, 2011)
What can we achieve with advanced technology?
Application efficiencies in excess of 85% are possible NOW using high flow rates and real-time optimisation

e.g. High flow-rate bay irrigation trials (Vic) 2010
5 soil types, 5 irrigations
Application efficiency 90% (82 to 95%)
Automation hardware and software for bay irrigation is available, e.g., ‘FarmConnect’ system from Rubicon Water.

NCEA has adaptive real-time optimisation based around the simulation model SISCO.
Energy usage?
Jackson et al. (2010)

- Measured the energy consumption for irrigated cropping in two regions (surface water source and groundwater source)
- Estimated the energy cost of converting surface irrigation to pressurised (centre pivot or drip) based on arbitrary improvements in application efficiency

However they did not include improved surface irrigation in the analysis
Energy consumption included:

- energy consumed during irrigation - which is entirely for pumping and is a direct function of the quantity pumped and the head (lift + pressure) added to the flow.

plus

- the energy used for other farm operations to give total energy use.
### Energy consumption for irrigation of a hypothetical grain crop from a surface water source

<table>
<thead>
<tr>
<th>System</th>
<th>Water applied (ML/ha)</th>
<th>Water savings (ML/ha)</th>
<th>Energy use (MJ/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current surface irrigation ($E_a$ 55%)</td>
<td>7.3</td>
<td></td>
<td>9700</td>
</tr>
<tr>
<td>Real-time optimised surface irrigation ($E_a$ 85%)</td>
<td>4.7</td>
<td>2.6</td>
<td>9700</td>
</tr>
<tr>
<td>Centre-pivot irrigation ($E_a$ 90%)</td>
<td>4.4</td>
<td>2.9</td>
<td>17000</td>
</tr>
<tr>
<td>Drip irrigation ($E_a$ 95%)</td>
<td>4.2</td>
<td>3.1</td>
<td>16000</td>
</tr>
</tbody>
</table>
**Take home message**

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