Adaptive Precision Broad-acre Irrigation Systems in Australia

savings in labour, water & energy

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Irrigation of Broadacre Crops

- Most common irrigated crops are:
  - Dairy Pasture, cotton, rice, sugarcane, grains
- Irrigation is mostly surface irrigation with some areas under Centre pivots and Lateral moves
- The performance of surface irrigation varies widely
  - Can usually be improved through better management
- Automation is one of the answers:
  - Enables improved management
  - Possibility of Precision Irrigation

Trends in Australia

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Lining Channels in small sections with high seepage

Total Channel Control (TCC) Where all scheme structures are controlled from farm level upwards. Minimising operational losses

Automated Irrigation?

- The concept of automation has been around for 30+ years but it tends to be:
  - Too costly
  - Unreliable
  - Not suited to furrow irrigation
- In Last 7 years automation has been adopted Victoria (southern AUST) in border check irrigated pasture

Automate this Process

Re-Evaluate

(1) Measure the irrigation

(2) Estimate the soil infiltration rates SISCO Calibration

(3) Simulate & Evaluate irrigation performance SISCO Modelling

(4) Optimise by changing management - e.g. inflow rate and time

Irrimate™ for Furrow Irrigation

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Irrimate™ for Furrow Irrigation
Example – Border Check – Pasture in Victoria

- Scheme flowmeter
- Level sensors
- Bay Gates
- Floodtech probes
- Soil mois. sensors

Automation systems
- First step = Remote control
- Second step = Automated control
- Third Step = Autonomous control

Current project funded by Cotton, Sugar and Dairy industries

Four separate field sites:
1. Furrow irrigation in sugarcane near Ayr in the Burdekin, FNQ
2. VRI Centre Pivot in cotton on Darling Downs, QLD
3. Furrow irrigation in cotton near Wee Waa, NSW
4. VRI Centre Pivot on dairy pasture in north western Tasmania
SUGAR - The Problem

- > 95% of cane in the Burdekin is furrow irrigated
- Efficiencies ranging from 20% – 100%
- Rising water and pumping costs
- Poor irrigation can have adverse impacts on groundwater and the Great Barrier Reef
- Irrigation is very labour intensive

Adoption of best management practices requires even more labour
Burdekin Delta – Sugar Cane

Field Site 1
- 5 Irrigation blocks – 82 ha, 1300m long rows
- 5 (WiSA) control nodes (1 per valve)
- 1 PST on control node 1 + Doppler flowmeter inside supply
- Advance sensors (100–200m from end with nodes outside field)
- Farmer wants to minimise Tail-water

Field Site 2 (27 ha)
Field Site 3 (51 ha)

Field Site 1 – Automation System
a) Linear actuators on valves
b) Pressure sensor in cylinder/pipe
c) Flow meter on supply
d) Buried advance sensors
e) Rain gauges

Irrigation system can now be controlled from computer or smartphone

Buried Advance Trigger Sensors
- SISCO to identify Optimal optimal trigger distance
- Probes were buried at these locations
- Farmer now uses these sensors to automatically switch blocks
Net Benefit per ha

- Net Benefit $144/ha
- Yield increase $264/ha
- Capital cost of full system is $85/ha per yr over 7 years

Field Site 2 – Pressure Monitoring

- Low Pressure:
  - Pump issue?
  - Burst fluming?
  - Valve failed to close?

- High Pressure:
  - Valve failed to open?
  - Too many pumps operating?

The system can react to these Pressure Limits

Field Site 3

- 11 Irrigation blocks – WHOLE farm is automated
- 6 control nodes & 11 valves
- 2 pumps with flowmeters and PST’s
- 3 drain level sensors

Field Site 3

- Water source:
  - River pumps for furrow
  - Channel and recycle pit for drip
- 45 ha of Drip
- 53 ha of Furrow
- Farm is located 40km drive from home
Field Site 3 – Off peak power

- Can now schedule all irrigations to occur in off peak power periods
  - Offpeak is 9pm to 7am Monday–Friday + Sat and Sun
  - Savings of around $122.40 per hectare

Benefits for Sugar Cane Sites

All sites:
- Significant labour saving and improved irrigation timing

Site 1:
- Able to save water and sell water (temporary trade)

Site 2:
- Able to save water and pumping costs

Site 3 (53 ha):
- Energy Saving of $6,487 per year (switching to off peak)
- Saving over 12,000km of driving per year
- Able to irrigate more frequently and increase crop yield.
  - Yields above 200 t/ha on both drip and furrow with similar
  - water use on both
2013-2015 trials
• Testing a range of techniques to deliver water to furrows from gravity head channels

Blind head ditch
• Head ditch flows up to 1.5 m³/s
• Field split into bays, 308 m wide (154-155 pipes)
• sPTB’s are 75mm PE pipe

Small Pipe through the bank system
Using Rubicon control systems

Automation system for Furrow irrigated Cotton
108 ha trial
6 x 18 ha bays
Total area now developed on this farm >2,000 ha

Adaptive Precision Irrigation Systems
Senses the crop requirement and applies the correct volume of water when & where it is needed.

VARIwise
- Split the field into spatial zones
- Collect soil & crop information for each zone
- Model crop in each zone and calibrate the model using spatial crop measurements
- The model determines:
  - When to irrigate
  - How much to apply to each zone

VARIwise for cotton
- Cameras used to determine plant growth and cotton development (e.g. boll count)
- Crop model refined (daily time step) using actual growth, soil moisture, irrigation applications
- VARIwise adjusts the variable rate sprinkler application map
- Cameras used to determine plant growth and cotton development (e.g. boll count)
VARIwise for dairy pastures

- Pasture height used for grazing, irrigation - image analysis for leaf length
- Compared with weekly quadbike height data

Location of cameras on pivot

Prescription map development

- Linked with variable-rate hardware for Valley and Lindsay Zimmatic machines for cotton and dairy:

Rainfall uniformity?

- Taggle NCEA raingauge system tested over 12.5 km
- Google Earth Smartphone app

Canopy Temperature – Testing in Sugarcane and Cotton
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