Knowledge management, sensing and control tools for irrigated broadacre cropping
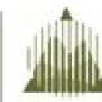
Dr Alison McCarthy, **Michael Scobie, Dr Malcolm Gillies, Lidya Agustina and Dr Joseph Foley**

**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)
- VARIwise, site-specific irrigation decision making

KMSI
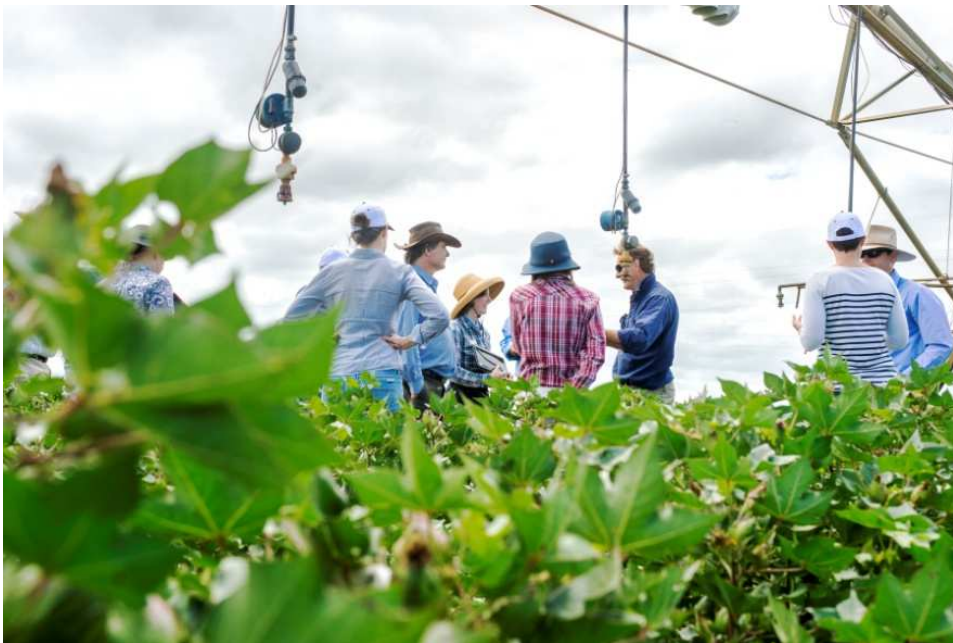
- Suite of tools funded by the Queensland Government as part of the South East Queensland Irrigation Futures project
- Centralised online decision support tools for irrigation, nutrient and energy calculators with benchmarking function to compare across catchments, systems and industries
- Also has simple calculator tools with simple input/output interface
- For growers and industry consultants

kmsi.usq.edu.au

KMSI - IPART
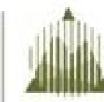
Irrigation Performance Audit and Reporting Tool (IPART)

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

Solid Set

Statistics of Total (All cans):

|	
Distribution Uniformity (%)	81.35
Coefficient of Uniformity (%)	88.45
Minimum Depth Applied (mm)	5.7
Maximum Depth Applied (mm)	12.0
Average Depth Applied (mm)	8.8
Average Depth Applied in Lowest Quarter (mm)	7.2

Statistics of Total (Effective cans):

Distribution Uniformity (%)	81.60
Coefficient of Uniformity (%)	88.44
Minimum Depth Applied (mm)	5.7
Maximum Depth Applied (mm)	12.0
Average Depth Applied (mm)	8.7
Average Depth Applied in Lowest Quarter (mm)	7.1

There are currently 1358 records in the database collected between 27-11-1995 and 27-11-2016

Summary of Current Records

Region	No. of Records	Application System	No. of Records	Crop (Top 10)	No. of Records
Qld	849	Travelling Gun	120	Pasture - Dairy	191
NSW	28	Travelling Boom	34	Nursery - Other	124
Vic	14	Side Roll	34	Lucerne	72
WA	6	Hand Shift	31	Turf - Couch	50
NZ	0	Solid Set	287	Nursery - Protected	39
SA	0	Lateral Move	42	Flowers - Other	30
Tas	0	Centre Pivot	232	Cotton	26
		Drip	60	Tree - Avocado	26
		Microsprinkler	103	Sugarcane	20
				Grain	19

Application Uniformity of Irrigation Systems

Show Legend
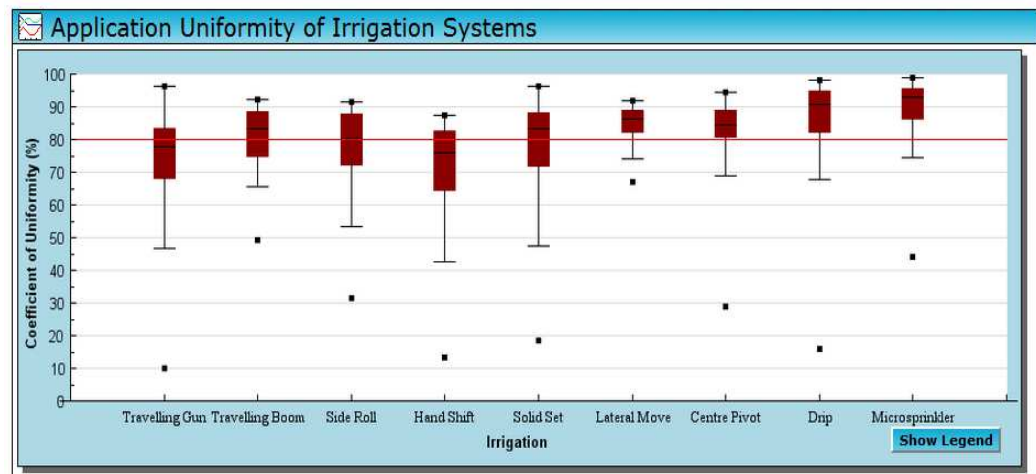
KMSI - IPERT

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	Pump & Motor Combination: ALL
Catchments: ALL	Crops: ALL	Collection Date: from 1-1-1995 to 8-9-2016

891 matches found

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

Report ID	Grower Name/ID	Organisation	Crop	Site	Catchment	Date	Flow Rate (l/sec)	Total Dynamic Head (m)	Energy Consumption (kWh)	Overall Efficiency (%)	Comparison Cost ($/ML)
39	Grower 1	Egg place	Egg plant	Creek Pump	Qld, BorderRivers	14-10-2008	6.2	52.82	660.84	21.76	132.17
45	Grower 2	Tree place	Tree - Pomes	Small dam	Qld, BorderRivers	23-10-2008	12.34	N/A	511.89	N/A	102.38
48	Grower 3	Other place	Tree - Other	Dam	Qld, SunshineCoast	16-11-2008	3.5	64.94	195.24	90.55	39.05

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
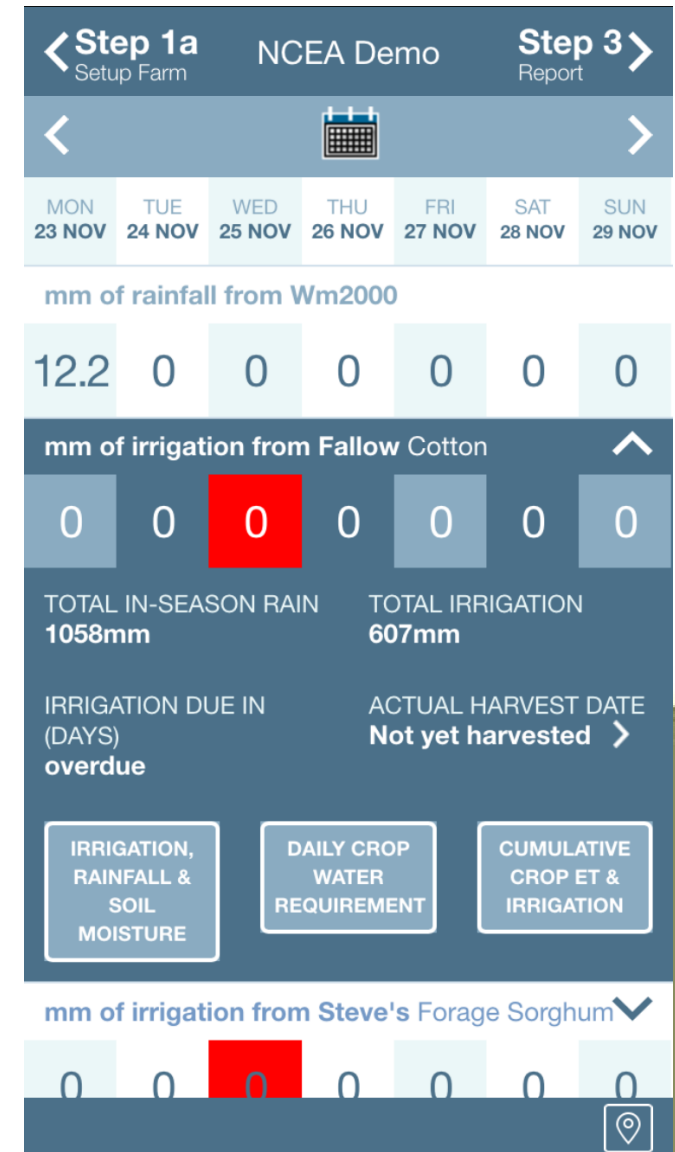
SISCO - surface irrigation

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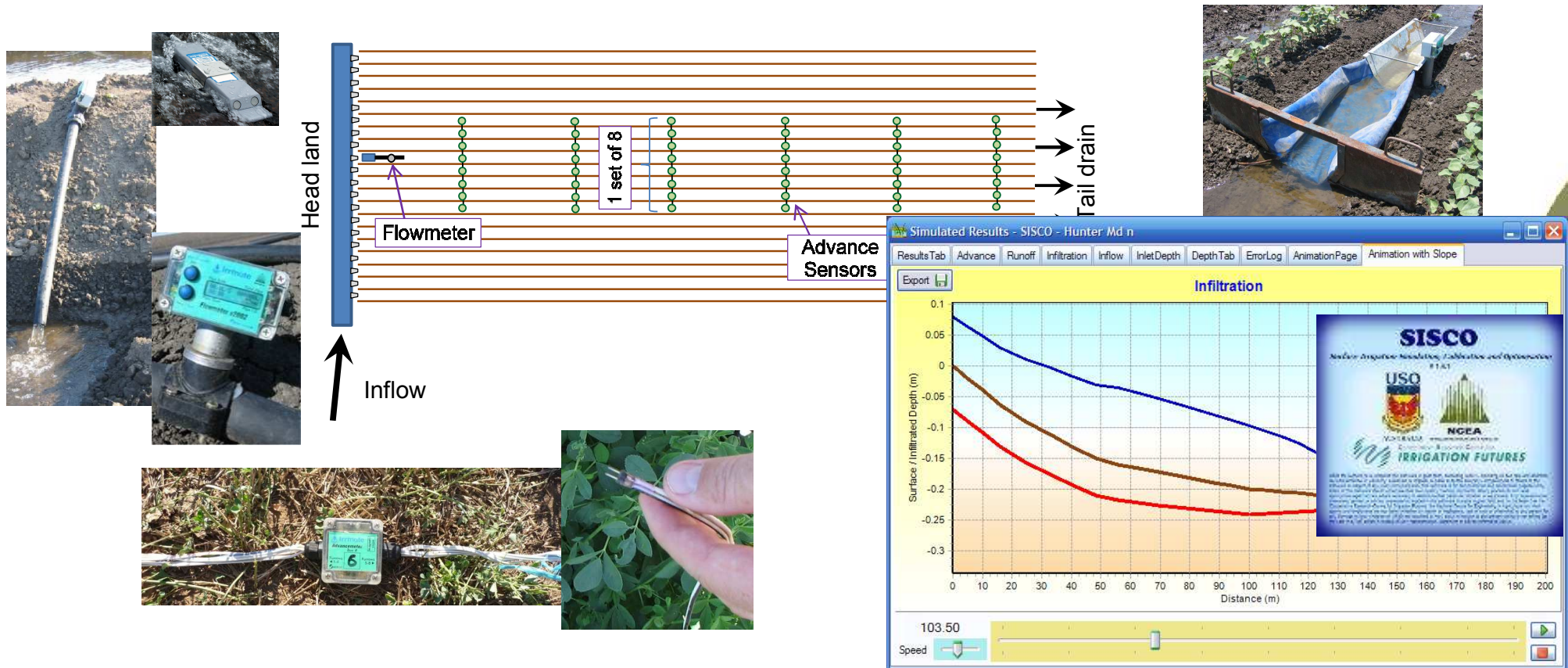
Automation systems

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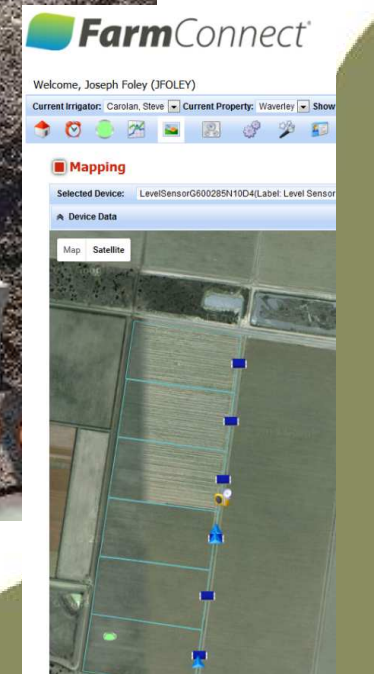
Furrow in Sugarcane

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

(a)

(b)

(c)
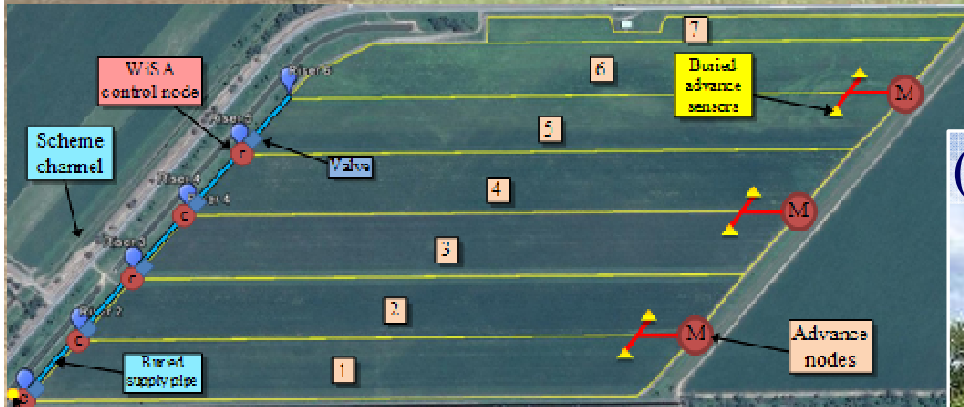
Furrow in Cotton

Using Rubicon control systems

Control Gate

Secondary head channel
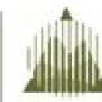

Depth sensor for flow meas. and control of channel system

Bay Drive™

Drop Gate in Concrete Shute

Primary Channel

75mm (67.7 ID) HDPE pipes through Bank

Secondary Channel

Earth Bank

Rotobucks

Cotton on standard 1m spacing

2m   1m   1m
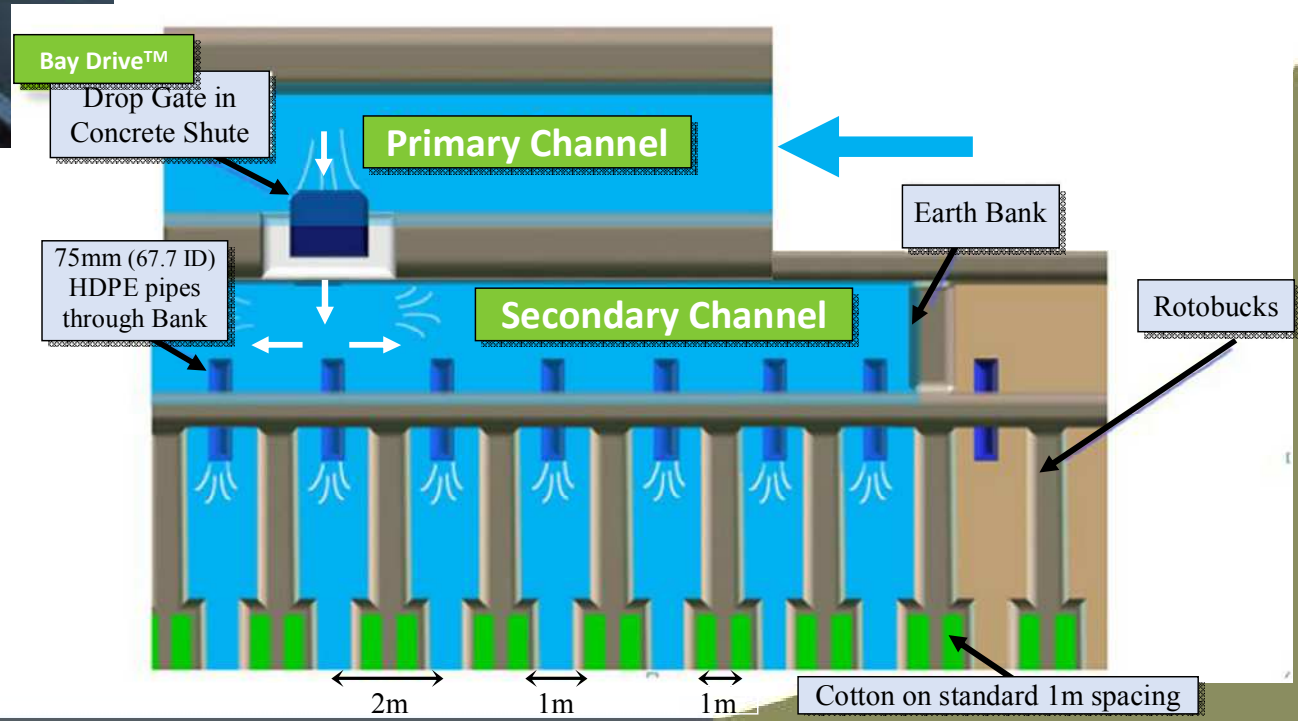
Furrow in Cotton

Current Questions?

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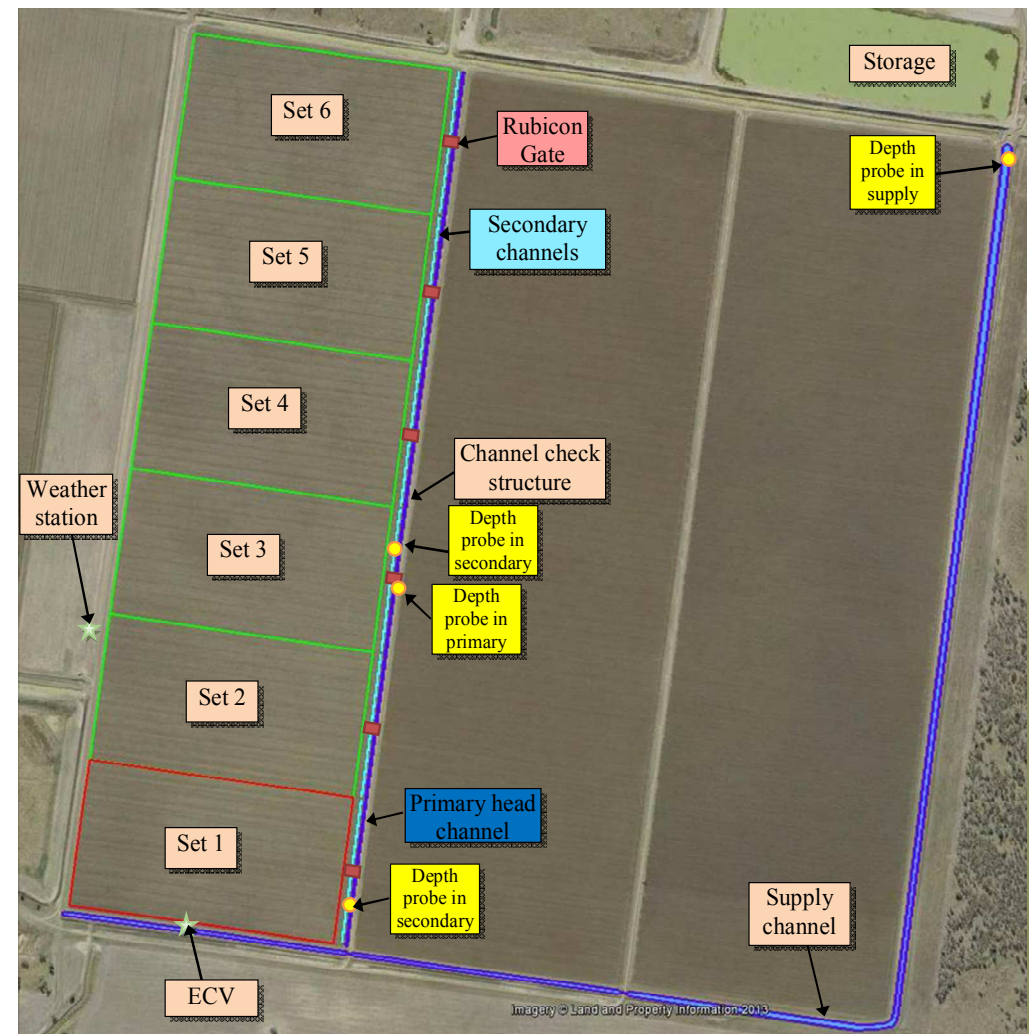
Irrigation advance monitoring

- 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

University of Southern Queensland | NCEA National Centre for Engineering in Agriculture

Surface irrigation system

Overhead irrigation system

Control strategies

Yield (bales/ha) vs Control strategy (Sensor-based, Model-based)

□ 1 point   ▨ 3 points   ▨ 10 points   ■ 44 (All) points

Model calibration

Soil moisture (mm) vs Date (31/10, 20/12, 08/02, 29/03)

— Sensed   — Calibrated model   — Uncalibrated model
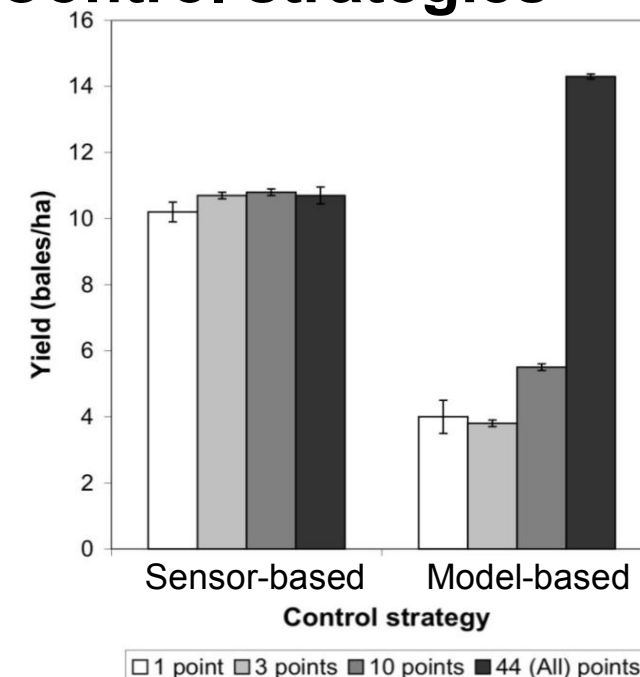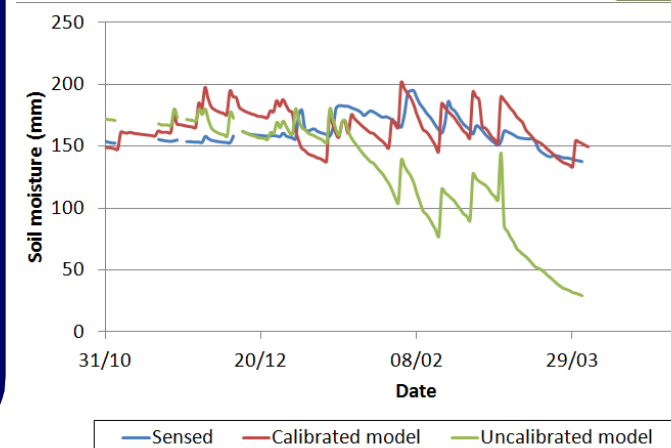
1.   Sensors

- fixed sensors
- historical maps
- on-the-go sensors
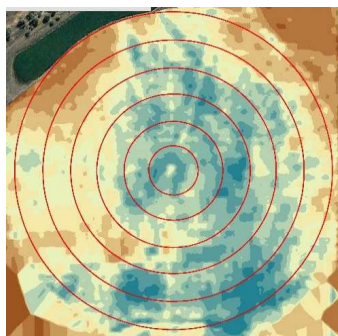
2. Control strategy
- convert data to irrigation application
- sensor or model-based
- model-based control needs calibration with infield data

3. Real-time irrigation adjustment
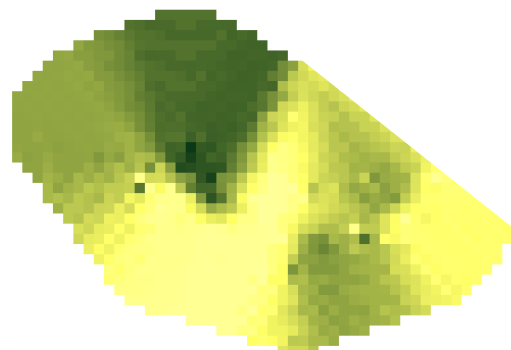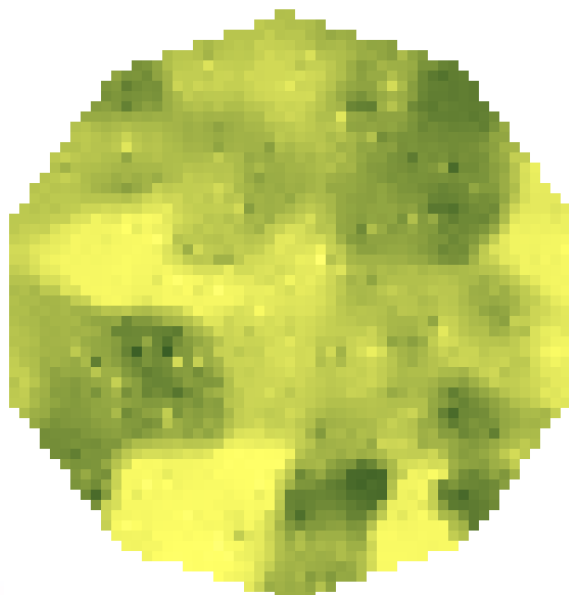
- actuators to apply irrigation
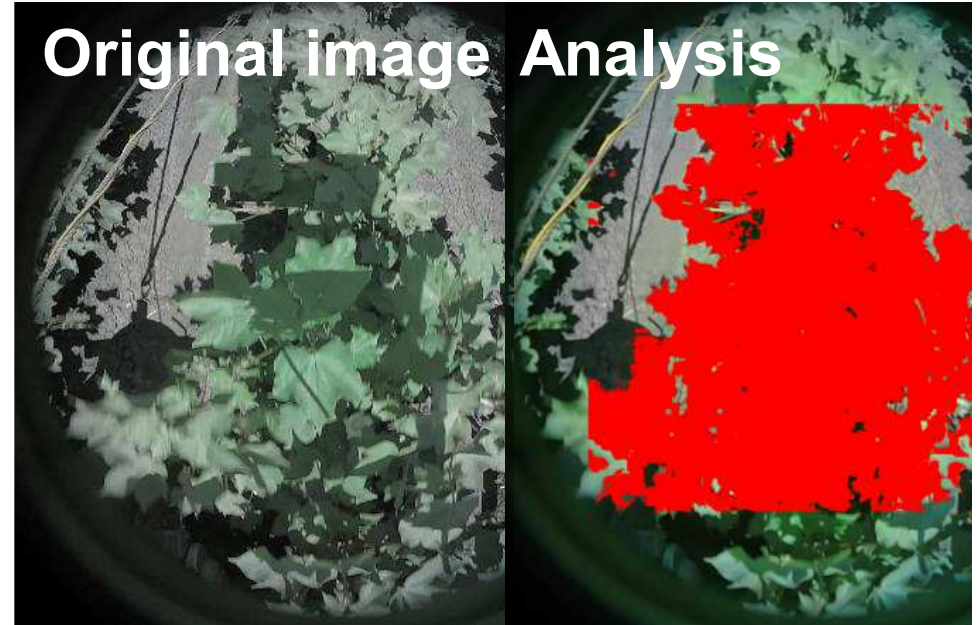
Camera-based sensors

Smartphone camera

Height from quad bike sensor

Canopy cover from cameras
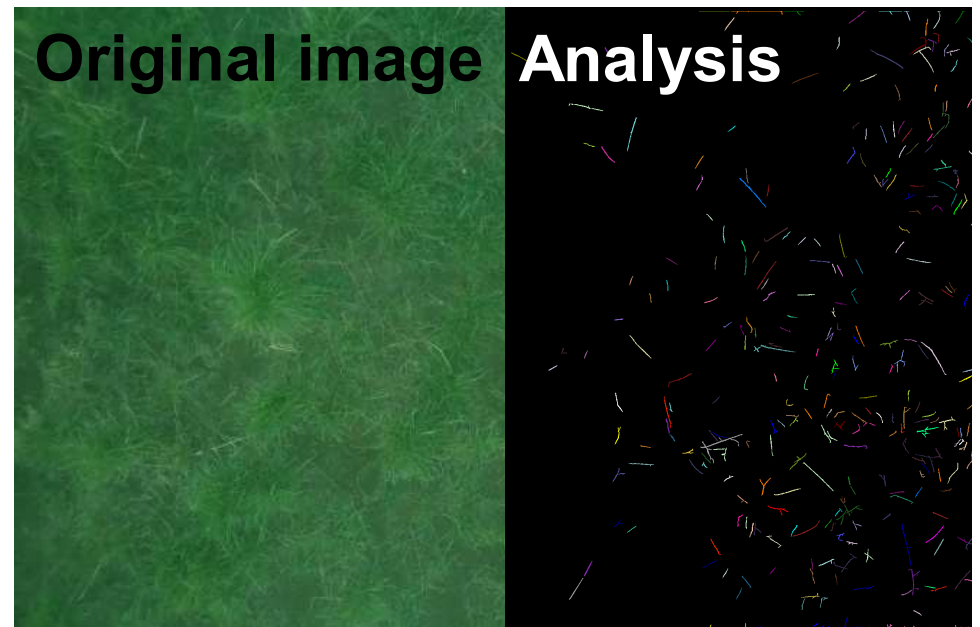
0   Height (mm)   250

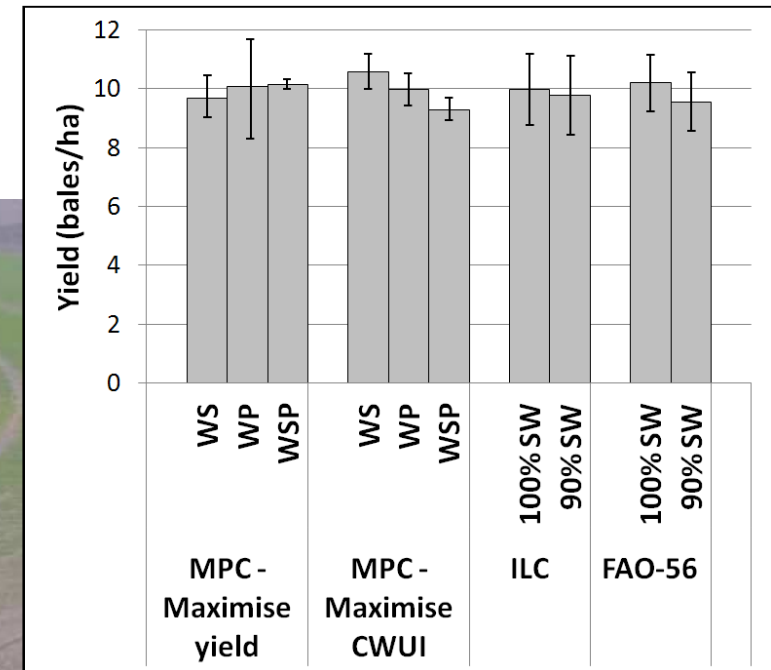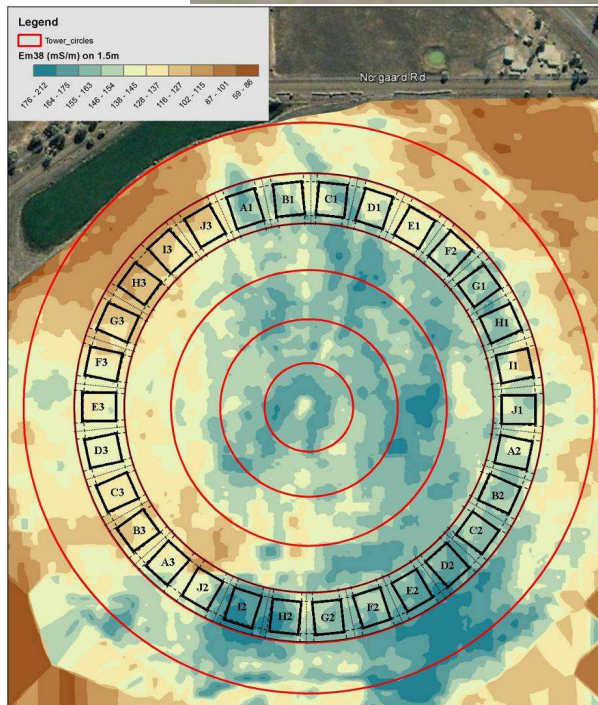Original image   Analysis

Original image   Analysis

Control system implementation on centre pivot

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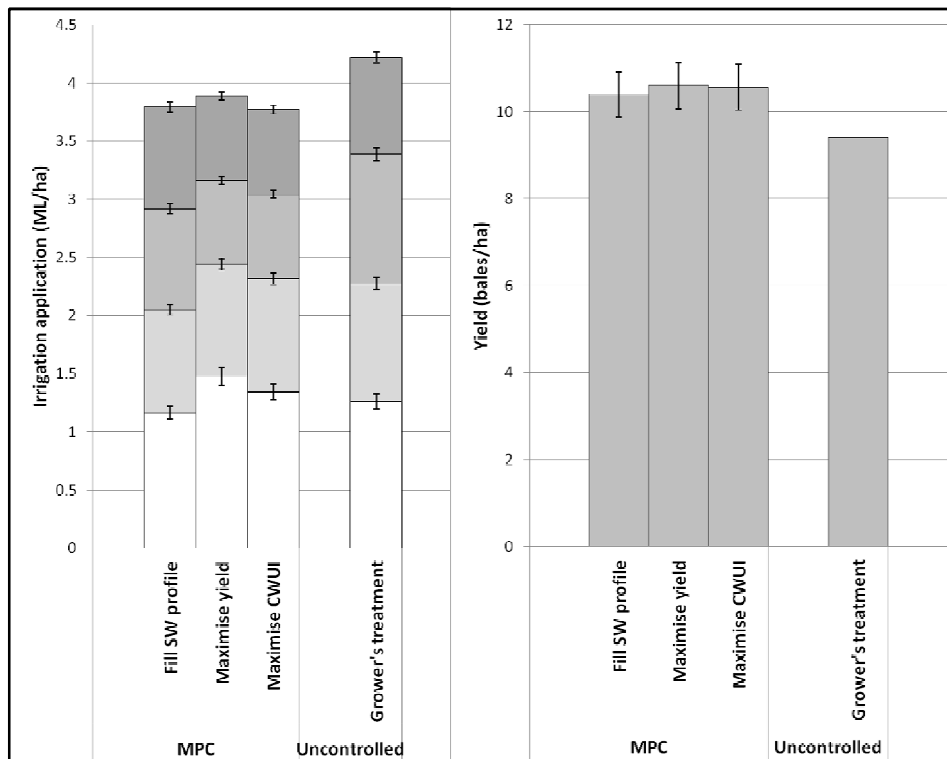
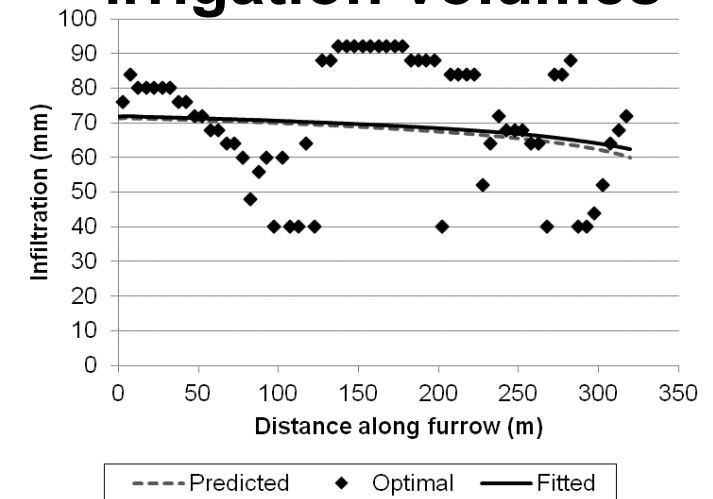# Control system implementation for surface irrigation

Crop growth and fruiting

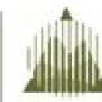**Soil-water, weather**

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