



Australian Government
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VARIwise: towards autonomous irrigation and a grower's guide

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A Research Centre of the University of Southern Queensland

USQ UNIVERSITY OF
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fulfilling lives

Irrigation control system



Surface irrigation system



Overhead irrigation system

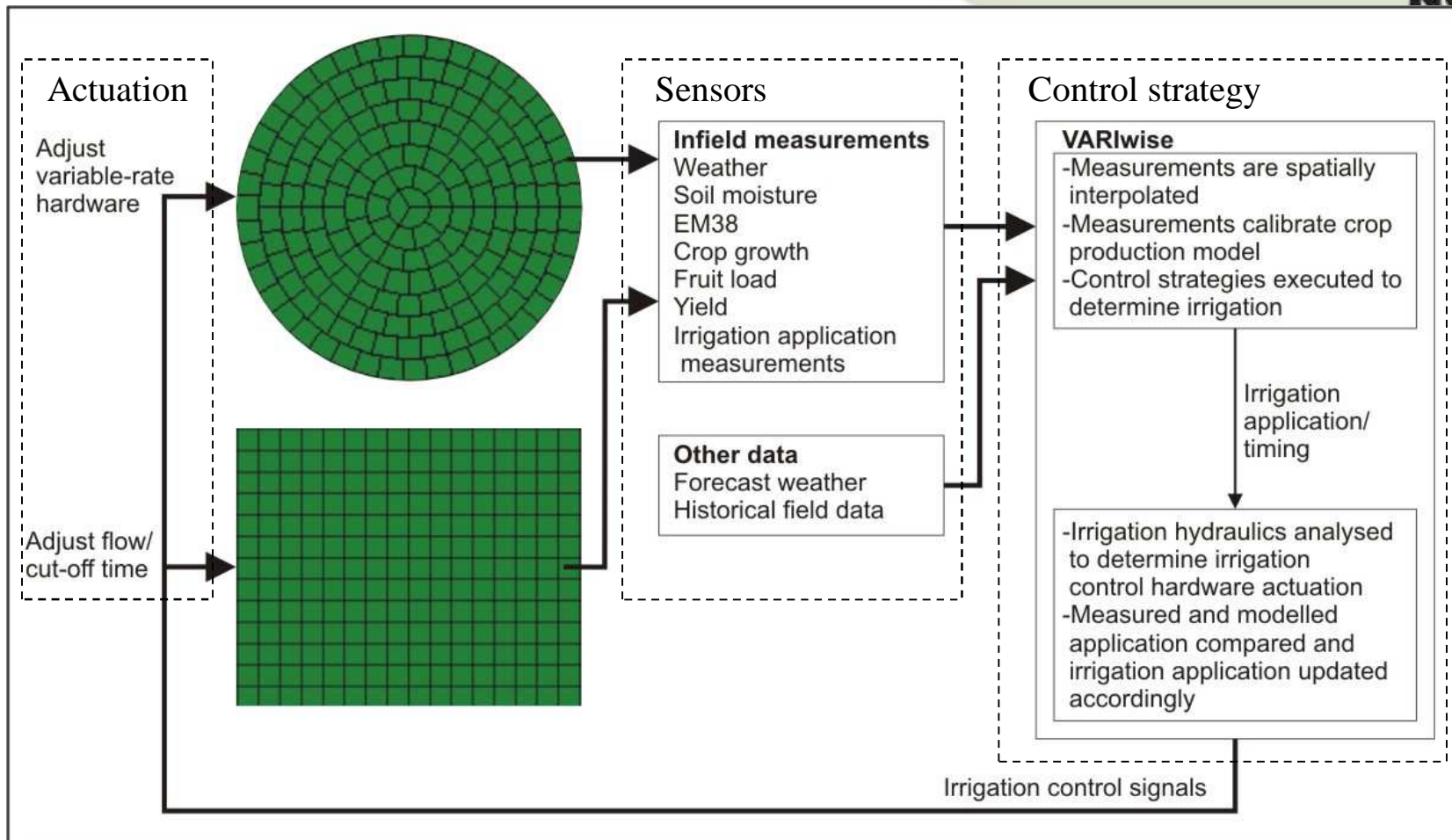


1. Sensors

2. Control strategy

3. Real-time
irrigation
adjustment

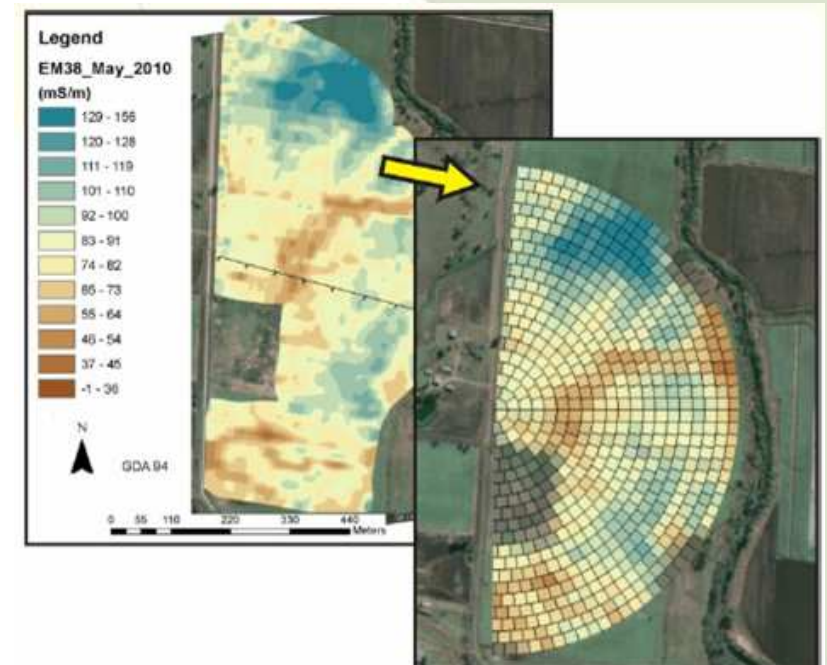
'VARIwise' irrigation control system



VARIwise control framework



- Use sensed data to determine irrigation application/timing
- 'VARIwise' simulates and develops irrigation control strategies at spatial resolution to 1m² and any temporal resolution
- Control strategies based on difference between measured and desired performance



Outline



- Previous research projects
 - PhD on VARIwise development
 - Postdoc on field evaluation
- Current research project
 - Fertigation/irrigation optimisation
 - VARIwise Lite
 - Spatial resolution of data collection and control
- Related NCEA projects
 - Artificial intelligence
 - Sensor refinement
- Future research
 - Grower tools, other crops



Previous research – development of control strategies



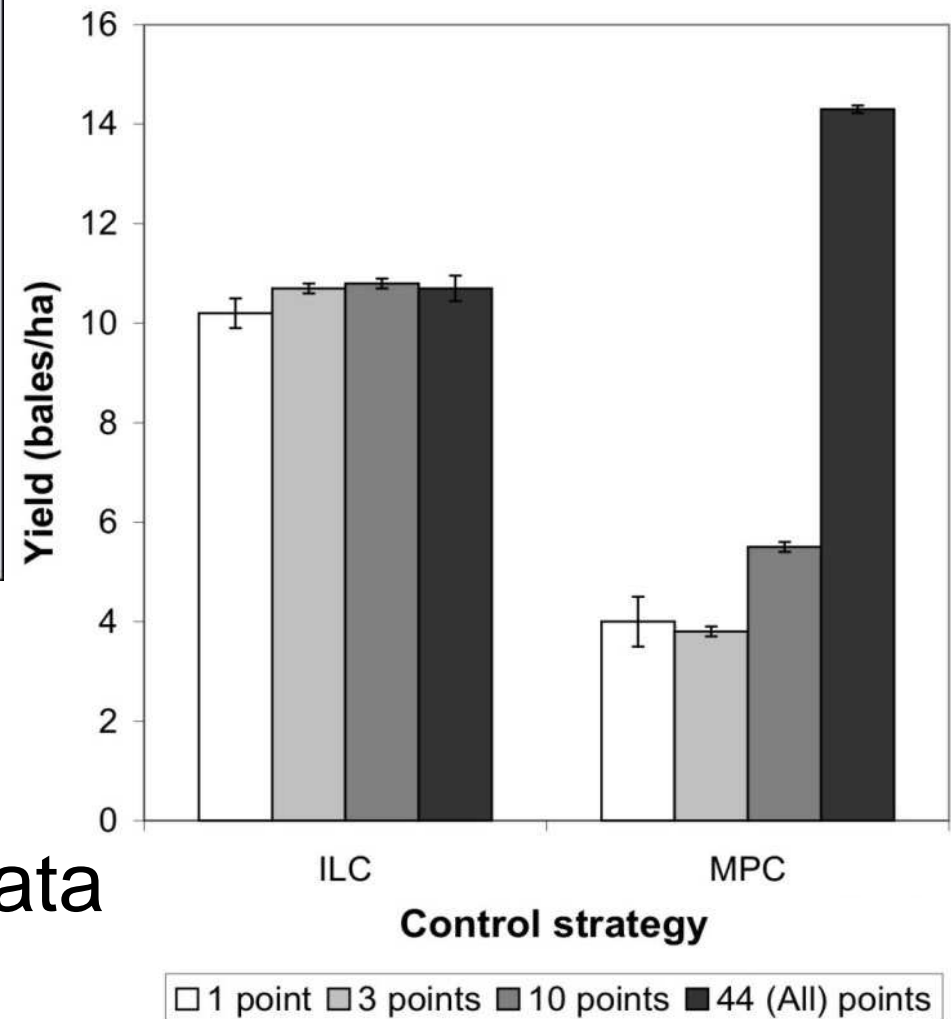
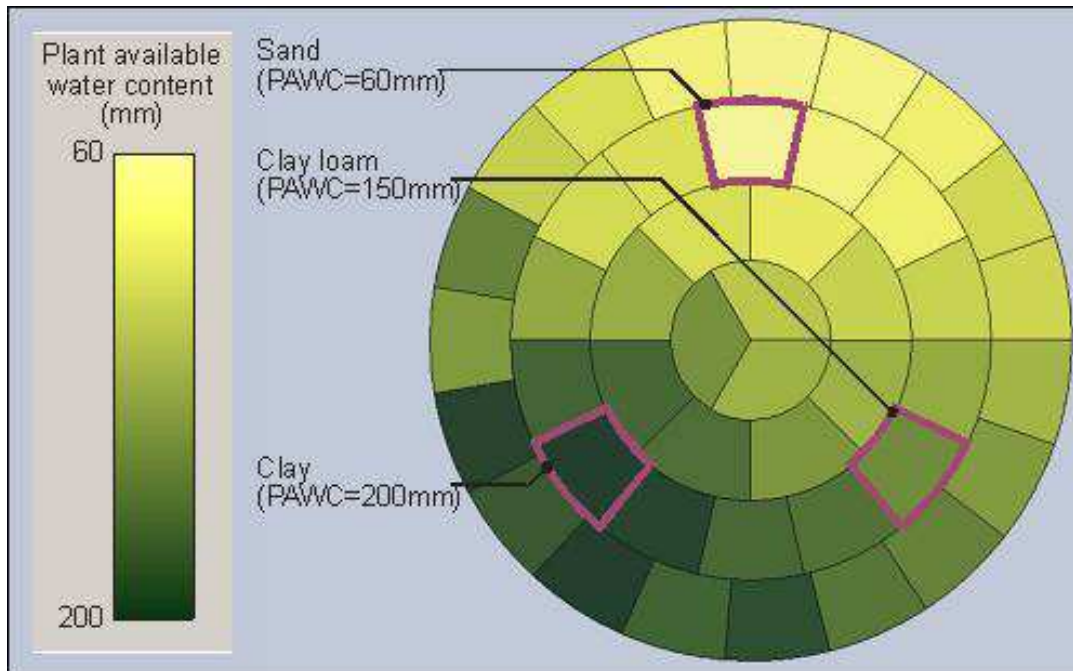
■ 1. Iterative learning control

- Uses the error between the *measured* and *desired* soil moisture deficit after the previous irrigation,
- . . . to *adjust* the irrigation volume of the next irrigation event.
- ‘Learns’ from history of prior error signals to make better adjustments.

■ 2. Model predictive control

- A *calibrated* crop model simulates and *predicts* the next required irrigation, i.e. volumes and timings
 - according to evolving crop/soil/weather input
 - separately for all cells/zones
 - can choose alternative end of season targets

Previous research – spatial resolution data requirements



- MPC needs high resolution data to maximise yields
- ILC performed best when data is sparse

Previous research – sensor development for surface irrigation



Previous research – sensor development for overhead irrigation



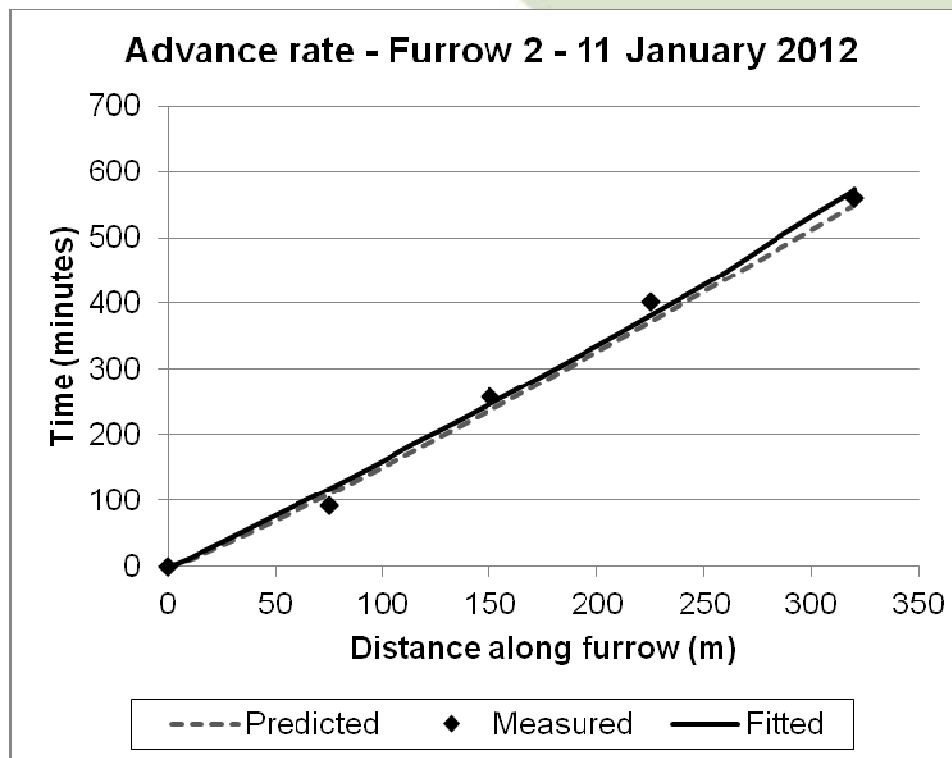
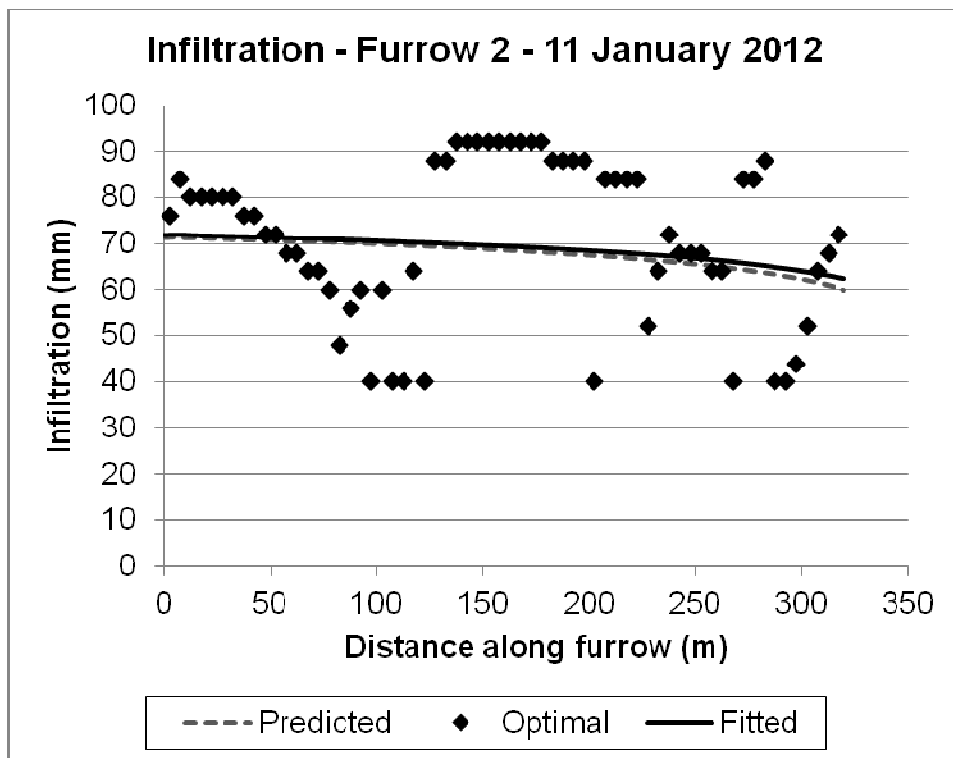
Overhead-mounted platform for centre pivots/lateral moves



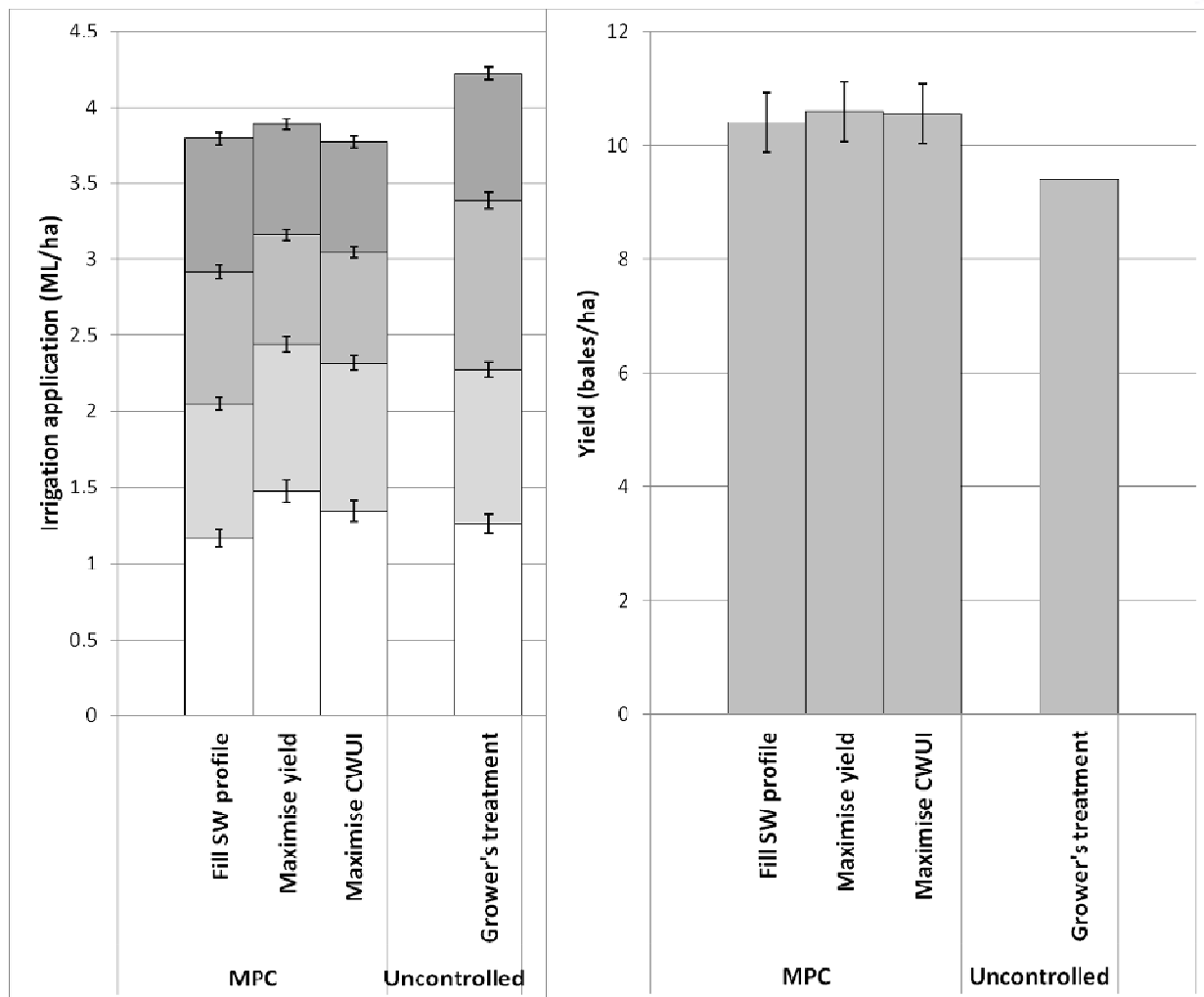
Previous research – adaptive control of surface irrigation



- Does not allow high resolution of irrigation application control

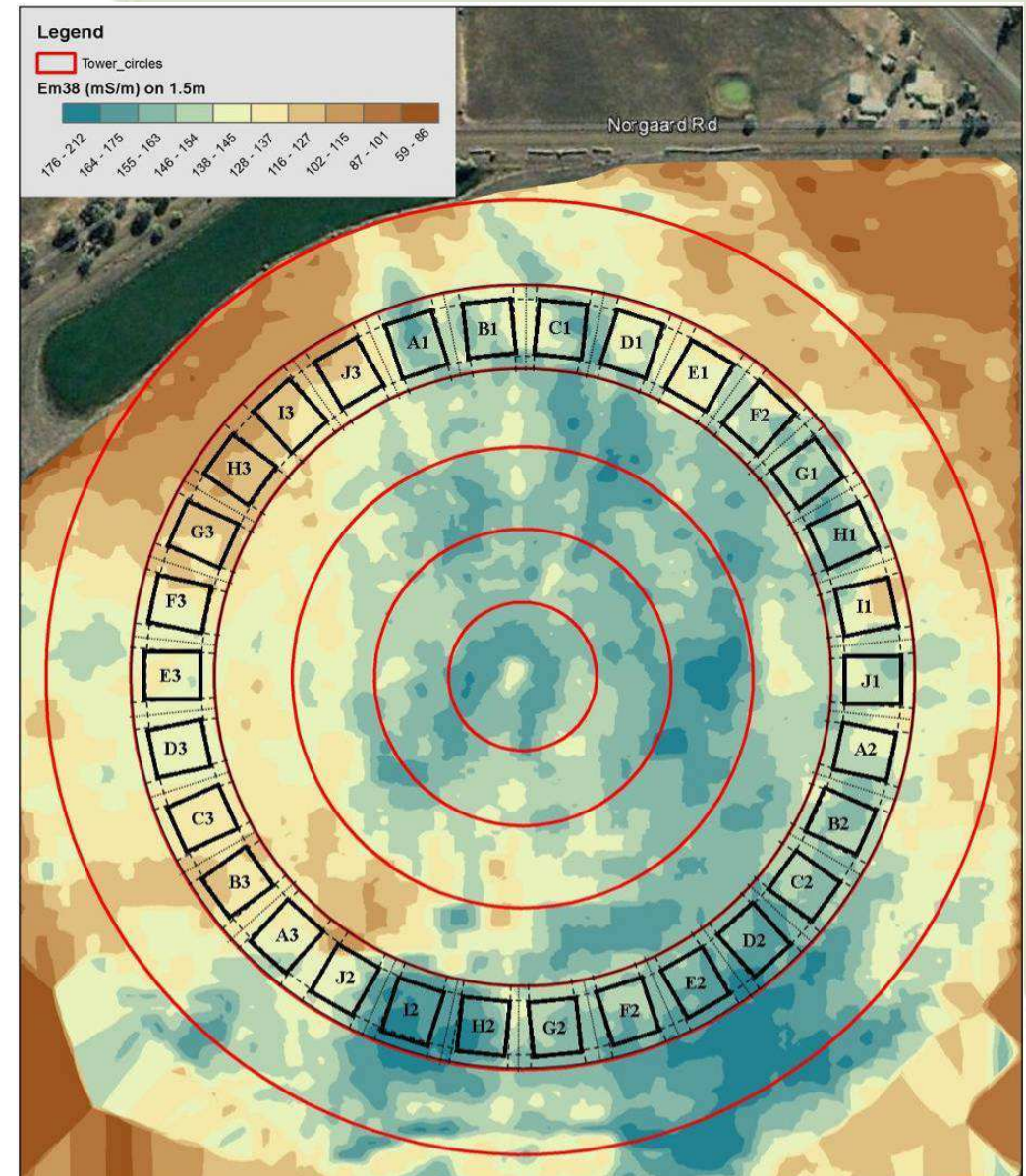


Previous research – surface irrigation trial

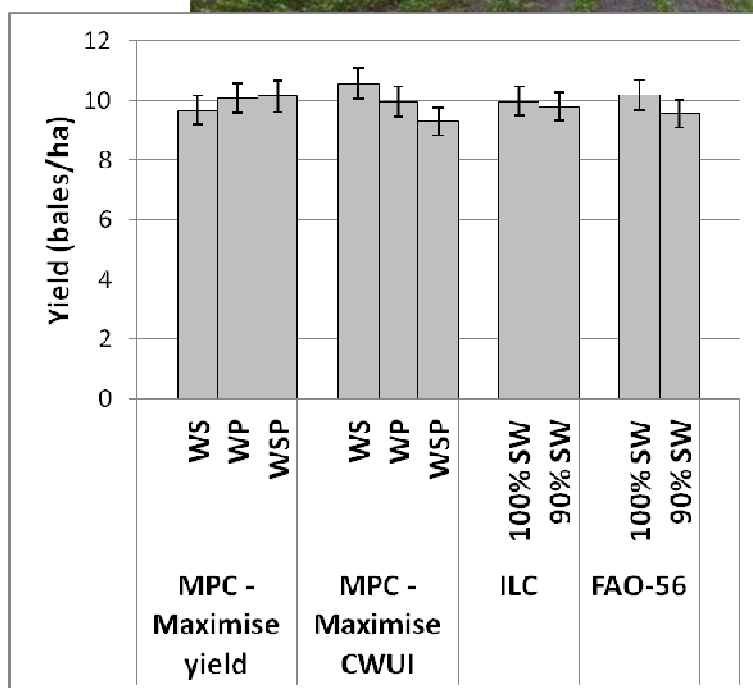


Previous research – overhead irrigation trial

	Control strategy	Performance objective	Data input
A	MPC	Maximise yield	WSP
B	MPC	Maximise yield	WS
C	MPC	Maximise yield	WP
D	MPC	Maximise CWUI	WSP
E	MPC	Maximise CWUI	WS
F	MPC	Maximise CWUI	WP
G	ILC	Fill soil water profile	WS
H	ILC	Achieve set soil water deficit	WS
I	FAO-56	Fill soil water profile	WS
J	FAO-56	Achieve set soil water deficit	WS



Previous research – overhead irrigation results



Current project – spatial resolution of measurement and control



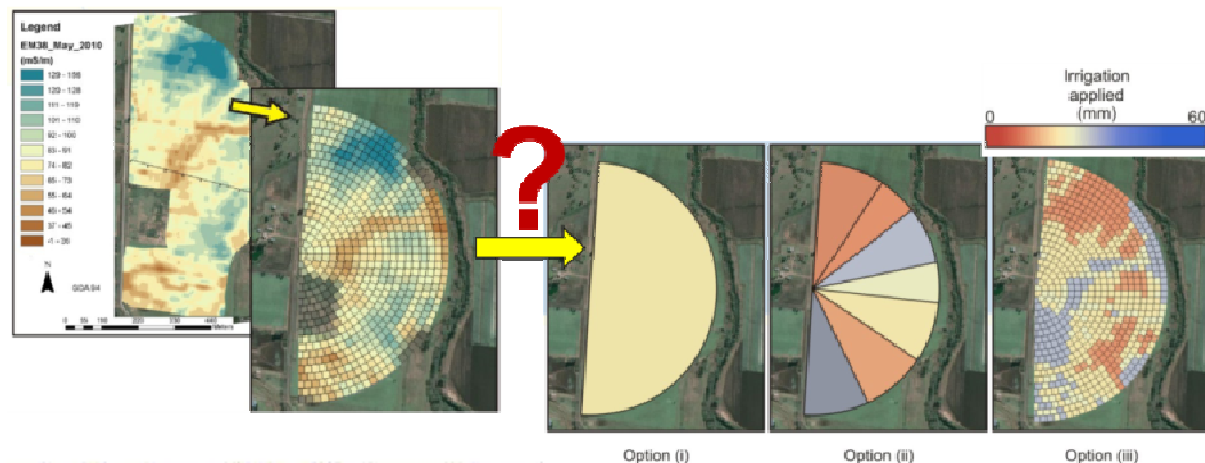
Current project – irrigation/fertigation control



Current project – simulation studies



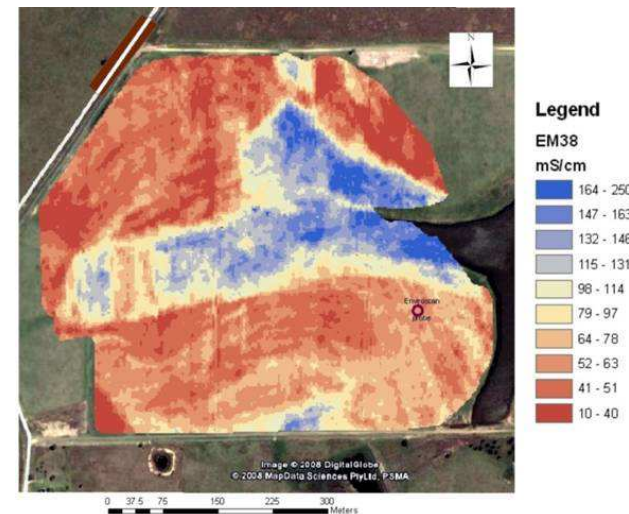
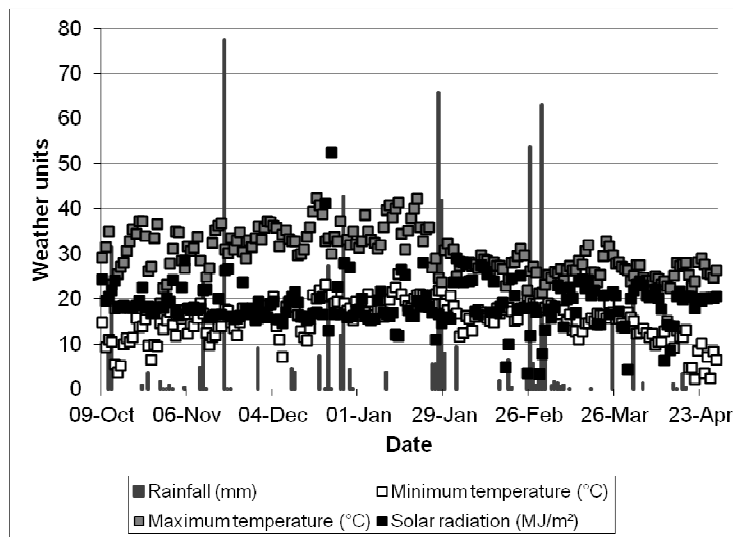
- Monitoring weather, soil, plant and irrigation infiltration
- Simulation studies in VARwise:
 - How many soil/plant/irrigation measurements
 - Irrigation/fertigation optimisation
 - Which performance objective



Current project – VARwise Lite



- Pre-run lookup tables of irrigation scenarios
- Different regions, soils, weather profiles
- OZCOT model will be used
- Calibration checked using industry data



Other NCEA research



- Control system:
 - Sensing - remote advance rate detection, soil-water, nitrogen status
 - Control strategies - artificial intelligence for irrigation/fertigation optimisation

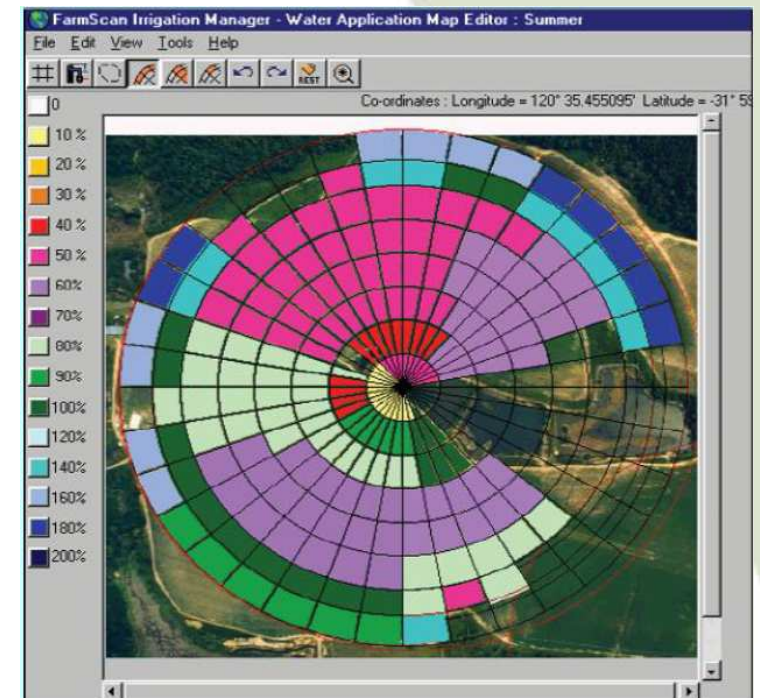


Advance rate – infield camera



Future research

- Sensors, control strategies need to be integrated as a user tool for growers:
 - Grower guide for general management
 - Software and hardware integrated with commercial automated variable-rate hardware
 - Application to other crops



Conclusion

- Control strategies and sensors for automated, site-specific irrigation management
- Evaluated irrigation control strategies on surface and overhead irrigation systems
- Need to develop grower tools for industry to use the control system



Acknowledgements



- Cotton Research and Development Corporation
- Nigel Hopson, Lindsay Evans, Neil Nass and Ian Speed for providing field trial sites
- Dr Malcolm Gillies for surface irrigation model support
- Dr Jochen Eberhard for data collection assistance