A cybernetic precision sugarcane irrigation system informed by the IrrigWeb crop model

Everingham Yvette[1] (yvette.everingham@jcu.edu.au), Wang Eric[2], Steve Attard[3], McGlinchey Mark[4], Linton Aaron[5], Xiang Wei[2], Philippa Bronson[2], Inman-Bamber Geoff[1]

[1] *James Cook University, Townsville, Queensland, Australia*; [2] *James Cook University, Cairns, Queensland, Australia*; [3] *AgriTech Solutins, Ayr, Queensland, Australia*; [4] *SQR Software, Cascades Pietermaritzburg, Kwa-Zulu Natal, South Africa*; [5] *Think Pink Hire, Home Hill, Queensland, Australia*

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Introduction

The digital revolution promises many advances in agricultural practices. Given that irrigated agriculture delivers 40% of the worlds food supply (Garces-Restrepo et al., 2007) and there are surmounting economic, and environmental pressures on water resources, it is imperative that agricultural enterprises look at new ways inspired by the digital revolution to save water, reduce runoff and increase yields at the same time. The first step in this process requires understanding crop evapotranspiration so the irrigation amount (mm) can be determined.

Crop evapotranspiration is dependent on many factors, one of which is climate - past, present and future. Other factors include crop type, location, farm management, irrigation inputs and soil characteristics. Crop models synthesize this information and estimate crop evapotranspiration and the irrigation required to meet crop water demand. Barriers to adoption of crop models are considerable and well documented (Hochman and Carberry, 2011, Thorburn et al., 2011). One reason for their low uptake is the time investment required by end-users to gain benefits from the information processed by the crop model. This is especially the case with irrigation, where irrigation events must be managed for multiple fields and at multiple times throughout the crop cycle. This means frequent data inputting processes are needed to continuously update the crop model so irrigation schedules can be generated throughout the irrigation season.

Much more popular amongst growers is automation. This is due to the many conveniences that automated irrigation offers. However, automation alone is not a solution for delivering improved irrigation use efficiency. Expert systems like crop models, are needed to deduce how much water should be applied to a paddock and when this should occur. For reasons outlined above there are many constaints which limit farmer engagement with crop models.

In this paper, the development of an integrated modelling approach involving the coupling of an automated irrigation system (WiSA) with an irrigation decision support tool (IrrigWeb, www.irrigweb.com) to improve irrigation management on a commercial sugarcane farm in north eastern Australia, adjacent to the Great Barrier Reef, is described.

Materials and Methods

An Uplink program was designed to connect the automated irrigation system (WiSA) to the irrigation support tool (IrrigWeb). Uplink allows seamless and effortless irrigation record keeping and data importing. To stream the irrigation schedule computed by IrrigWeb to WiSA, a Downlink program was created. The Downlink program adjusts the IrrigWeb generated irrigation schedule and allows the farmer to configure irrigation management rules to overcome practical constraints like pumping capacity, tariffs and crop priority. The Uplink and Downlink programs were connected via the Internet of Things. The Internet of Things uses technologies like sensors, actuators and communication devices to connect systems and *things*, like a crop model and an irrigation pump. A real-farm trial on furrow and drip irrigation was undertaken for a period of six months in the Burdekin sugarcane growing district of northern eastern Australia.

Results and Discussion

During the farm trial, the Uplink program saved the farmer a significant amount of time. Instead of the farmer manually entering records, Uplink uploaded irrigation and rainfall data directly into IrrigWeb. The Downlink program calculated and applied irrigation schedules automatically. This irrigation schedule was inclusive of practical real world constraints that sit outside the capability of the crop model. The farm trial results demonstrated the closed-loop system offers a number of advantages over more traditional irrigation approaches. Although the system could reliably manage the irrigation schedule during the trial, more testing is required to move the system to a state that is scalable and transferable.

Conclusion

The cybernetic closed-loop system outlined herein presented a unified framework for coupling an irrigation decision support tool with an automated irrigation system in a way that can help farmers save time, money, water, energy and reduce runoff to improve unique environmental systems like the Great Barrier Reef. Whilst still in an experimental phase, the system offers a platform to fuse multiple data streams like extra sensor data and downscaled climate forecasts into the system to improve the precision of the irrigation system. Science based systems that offer advantages to growers can deliver practical, profitable and environmental benefits to irrigated agricultural systems worldwide.

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