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Leading Edge, supported by the Society for Engineering in Agriculture and the Australian Centre for Precision Agriculture, provides a local and worldwide window on engineering and PA research.

This story is about a revolutionary type of irrigation management where a combination of theoretical modelling and simple real-time data can deliver very significant savings in water resources and environmental performance.

Smart irrigation will use REIP

Imagine a furrow irrigation management system achieving 80–90 per cent efficiency which can be controlled from your farm office or set to run on auto with repeatable precision.

This scenario has become more achievable with the development of an accurate simulation system using a simple real-time control system (RTCS).

A three year research program undertaken by PhD student Kanya Khatri for the Cooperative Research Centre for Irrigation Futures at USQ developed a new real-time infiltration prediction (REIP) system which will achieve this target.

Surface/furrow irrigation is set to lose its low efficiency, high-waste image using REIP.

Previous modelling techniques have been unable to accommodate both spatial (location) and temporal (time) variations in the critical soil infiltration characteristic of soils.

“The REIP system estimates the soil infiltration characteristics for individual furrows from an infiltration curve of known shape (the model-infiltration-curve) and only one advance point measurement is required,” Kanya said.

By placing advance sensing probes at approximately halfway down the selected

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SMART IRRIGATION WILL ‘LEARN’ AS IT GOES

Perfecting real-time control of irrigation events is just the first step in achieving better than 90 per cent water efficiency.

National Centre for Engineering in Agriculture Professor Rod Smith sees smart irrigation technology taking growers right out of the equation, if they wish.

“Apart from Kanya Khatri’s successful one-furrow modelling using a single advance point, we also have another PhD student looking at groups of 50 furrows with the same aim. These research activities will marry to provide predictive control in the field.

“We now have a good estimate of infiltration recognising temporal and spatial variation and know how much water is needed in a group of furrows to do the job most efficiently,” he said.

The ultimate vision, after field truthing these simulations, is to design and install a smart, hands-off irrigation control system.

This system would sense moisture deficit for a particular crop, apply the optimum amount of water to each group of furrows, and then stop delivery in time to ensure tail drain losses are eliminated.

The adaptive control program would ‘learn’ from each event and then store this experience in a memory bank for possible application to the next irrigation event.

Ideally each group of furrows with similar characteristics would be recognised and irrigated accordingly to achieve water use efficiencies of 90 per cent or better.

Before growers start thinking about buying a boat and going fishing instead of watching water run down furrows, Rod offers some entry level options for smarter irrigation systems.

“By using Irrimate, most growers will achieve an initial 20 per cent increase in irrigation efficiency.

"To achieve another 20 per cent, siphons go and controlled application technology is introduced as well as single-point advance sensing.

“For a start I envisage a grower pointing his palm pilot loaded with the right software at a mid-point advance sensor using an infra-red link. He would then read the calculated cut-off time and manually stop inflow,” he said.

Further up the technology and cost scales, a fully automated system would apply the required amount of water, remember the inputs and recognise changes in soil surface characteristics such as compaction and cracking.

Each irrigation event is discrete for each group of furrows. The smart system will recognise and react to the various inputs in each group in real time.

Two soil series T (a uniform black earth) and C (highly variable mixed alluvials) were used for the initial in-field data collection and testing. However Rod is confident smart irrigation technology can be applied to work successfully in any soil using various application options.

“Ideally the smart system will measure plant response then apply just the right amount of water to maintain optimum growth and yield potential,” he said.

furrows in the field to detect the arrival of the wetting front, the length of time to supply cut-off required to achieve field capacity without waste can be calculated and implemented.

Water input can be stopped precisely to ensure total root zone wetting at acceptable storage efficiencies without waste at the end of each furrow. Using one advance point results in huge savings in equipment and labour costs and significant reduction in data acquisition burden on the part of irrigators. This new method REIP opens the door towards real-time control and management of surface irrigated soils for achieving highly significant improvements in irrigation application efficiencies.

To evaluate RTCS, two cotton fields (T and C) were calibrated using irrigation water balance and advance data from 42 furrow irrigation events.

One furrow was selected as the model furrow and RCTS applied.

The SIRMOD, a leading surface irrigation simulation model, gave performance parameters — application efficiency, requirement efficiency and uniformity.

SIRMOD was then used with the scaled infiltration parameters (given by REIP) to assess the performance of real-time control, Kanya said.

Scaled infiltration curves produced by the proposed method were of similar shape (Figure 1 A and B) to actual field measurements. As well, advance trajectories predicted by REIP compared very favourably with actual in-field data.

He found scaled infiltration gave predictions of irrigation performance very, very similar to the actual performance.

Using REIP, irrigation application efficiencies improved from 76 per cent to 85 per cent (field T) and 38 per cent to 72 per cent (field C). Indicated reductions in total volume of water applied to the same two paddocks were 20 per cent and 60 per cent.

Correlation between final advance times for measured and simulated advance trajectories was over 95 per cent.

Comparison of irrigation application efficiencies under model strategies five and six for field T achieved a 99.69 per cent correlation (see Figure 2).

Strategy five is a simple real time control strategy in which the scaled infiltration parameters were used with a fixed inflow while varying/optimising only the cut-off time to achieve the best irrigation.

Strategy six is a simulation of the actual result of the real-time control strategy (five), using the actual infiltration parameters given by INFILT and the same inflow and cut-off time as used in strategy five.

The next step is to replace siphons with controllable water input technology as part of a totally automated irrigation program using real-time one point technology.

Prof Rod Smith (left) and PhD student Kanya Khatri.

FIGURE 1A: Measured and predicted advance (given by REIP method)

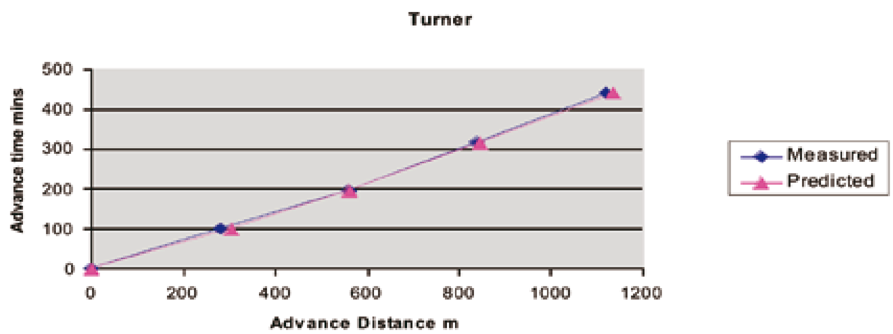

FIGURE 1B: Actual and predicted cumulative Infiltration plots (given by REIP method)

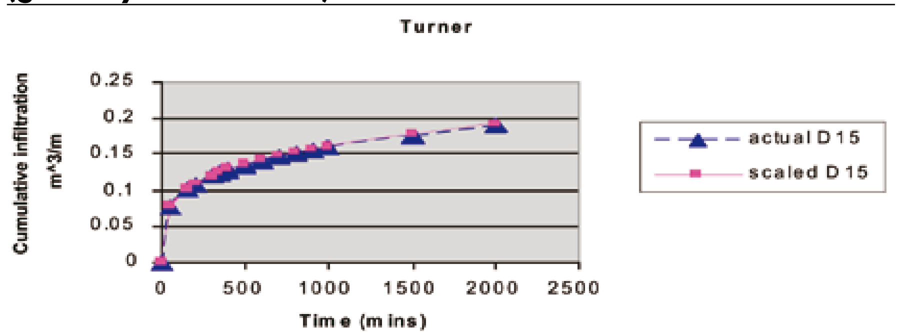

FIGURE 2: Comparison of irrigation performance simulation results (application efficiencies) under model strategies 5 (using full set of data) and 6 (using only one advance point by new method REIP) for a cotton field T