



Towards real-time control of surface irrigation

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in a nutshell

- A new real-time control system could mean improved water use efficiency in furrow irrigation systems
- The system combines infiltration information and only one advance point, measured around the mid length of the furrow, to determine the optimum cut-off point for the current irrigation event

Surface irrigation, especially furrow irrigation, is one of the most commonly used methods for irrigating crops and pastures in Australia and around the world. Well-designed and well-managed surface irrigation systems can have application efficiencies of up to 95%. But many commercial systems have been found to be operating with lower and highly variable efficiencies. For example, recent research shows that in sugar and cotton fields application efficiencies for individual irrigations range from 14 to 90% and average efficiencies over the season range from 31 and 62%.

The application efficiencies of surface irrigation are influenced by field design, soil infiltration characteristic and the irrigation management practice. Once a crop is established the soil infiltration characteristic is the most crucial factor affecting application efficiency; and to improve application efficiencies, we need to know what the infiltration rate is so that irrigation cut-off times can be set when irrigation events are underway.

Real-time measurement

Real-time control of surface irrigation involves using infiltration information from the current irrigation event to set the cut-off time. This would allow considerable water savings to be made by reducing surface run-off and deep drainage losses. The problem with measuring infiltration, to date, has been that infiltration varies across the field and over time, and that infiltration estimation methods are data intensive and hence information on which to make irrigation decisions is not available until after the event.

In this article we outline a system for real-time control of surface irrigation, which is based on a model infiltration curve and a scaling technique developed by Kanya Khatri and Rod Smith from the National Centre for Engineering in Agriculture, University of Southern Queensland, Toowoomba. The work is part of an extensive program of research carried out by the Cooperative Research Centre for Irrigation Futures. The success of the system opens the door to real-time control of surface irrigation systems and the resultant increase in application efficiency.



Figure 1: Kanya Khatri in a cotton crop grown at Dalby



Figure 2: Real-time control of surface irrigation systems has the potential to reduce water applications, and reduce surface run-off and deep drainage



The basis of the system is a new method, Real-time Estimation of Infiltration Parameters (REIP) for predicting the soil infiltration characteristics for individual furrows. The REIP method requires minimum field data, inflow and only one advance point measured – around the mid length of the furrow. Using one advance point results in huge savings in labor and equipment costs, and substantial reductions in the data acquisition burden on the part of irrigators; and it enables the implementation of real-time control.

The underlying hypothesis for the method is that the *shape* or pattern of the infiltration characteristic for a particular field or soil is relatively constant (across the field and with time), despite variations in the magnitude of the infiltration rate or amount.

Evaluation of the system

To evaluate the REIP method, two cotton fields (T & C) were selected, from which irrigation water balance and advance data were available for a total of 42 furrow irrigation events (ie data selected from measurements taken for multiple furrows and multiple irrigation events for cotton farms across Queensland). A furrow was selected as the model furrow for each field, and the REIP method applied.

Measurements were taken so that the actual irrigations for each furrow could be simulated. The simulated irrigations were then used to assess the performance of the real-time control.

The results revealed that the scaled infiltration curves produced by the proposed method were of similar shape (Figure 3) and hence gave a distribution of cumulative depths of infiltration for the whole field that was statistically equivalent to that given using the complete set of advance data for each furrow, which gave the actual infiltration curves.

The advance water trajectories predicted by the proposed system (the scaled trajectories in Figure 2) also favourably matched the measured advances (the measured trajectories in Figure 4).

The simulation results using the proposed system showed that the scaled infiltration gave predictions of the irrigation performance similar to the actual performance. They also indicated that by adopting the REIP method a simple real-time control system (which determines cut-off times)

would have increased irrigation application efficiencies from 76% and 38%, to 85% and 72% for the fields T & C, respectively.

Increased efficiency

Real-time control of surface irrigation systems has the potential to considerably improve application efficiencies. This produces benefits on farm via increases in water productivity and decreases in deep drainage losses thus reducing the risk of waterlogging and salinity.

The REIP method proved successful in estimating infiltration based on inflow and one advance point measurement in a single furrow without significant loss of accuracy. This was the case in two fields with contrasting infiltration characteristics.

The scaling technique combined with the reduction in data requirements opens the door for the REIP method to be used in the field to provide real-time control of surface irrigation events.

In this example, use of real-time control of the irrigation event would have saved 20% and 60% of water applied to fields T & C, respectively, and reduced surface run-off and deep drainage losses. Across the two fields this amounted to a saving of 2.02 ML/ha. This would have been achieved by using the REIP method to estimate field infiltration rates and set cut-off times during the actual irrigation event. The end result is that application efficiency is improved, increasing water productivity and, decreasing off-farm impacts by reducing deep drainage and surface run-off.

The next step is to link the system for flood irrigation systems as well and replace furrow siphons with controllable water input technology as part of a totally automated irrigation program using real-time one point technology. [🌐](#)

Further information

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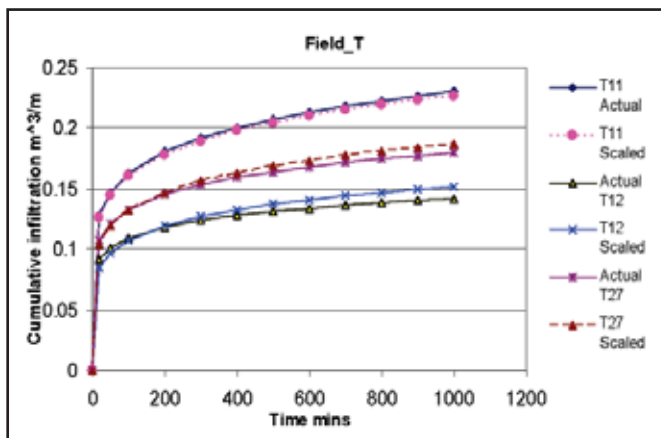


Figure 3: Example of scaled and actual infiltration curves from field T. Analysis was based on a total of 42 infiltration relationships established.

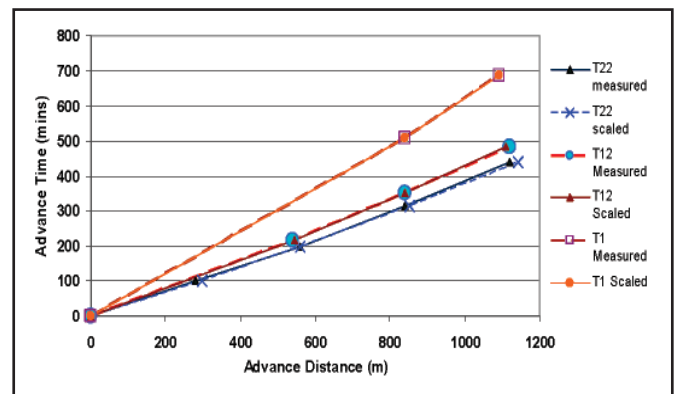


Figure 4: Example of measured and predicted water advance trajectories along the length of furrow. (It is interesting to note here that predicted advance using only one point is almost identical to actual measured advance which clearly establishes the suitability of new method).