Optimising bankless channel irrigation systems

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- Developed in the Riverina in the 1990s, bankless channel irrigation systems were designed to improve water management and production performance in rice-based farming systems and are now used for row crop production in many parts of Australia
- Evaluation and optimisation of water application efficiency is a well defined procedure for most surface irrigation systems – however they cannot be applied to bankless channel systems
- Research at Griffith seeks to develop an evaluation method for bankless channels, which then enables design and management guidelines to be established to assist designers and irrigators optimise the performance of current systems and improve the design of new systems

Surface irrigation systems are the most widely used form of irrigation in most parts of the world. In Australia, 60% of irrigated land is irrigated using surface irrigation systems. On appropriate soil types surface irrigation systems can be operated to achieve high water application efficiency and distribution uniformity. Unfortunately, this level of performance is often compromised through inappropriate field design and/or irrigation management.

Measurement tools and techniques, computer models and evaluation procedures provide the resources needed to improve conventional furrow irrigation system performance. However, these techniques cannot be readily applied to all forms of surface irrigation.

Bankless channel irrigation

One form of surface irrigation currently under investigation through the Cooperative Research Centre for Irrigation Futures (CRCIF) is bankless channel irrigation systems (BCIS). While similar to drain back level basins developed in the United States in the late 1980s, BCIS in Australia feature reverse grades, higher flow rates and typically larger bays and are being installed on heavier soil types than their US counterparts.

Developed in the 1990s, Australian BCIS were designed to improve water management and production performance in rice-based farming systems. These adjustments not only provided cropping alternatives but also increased operational and labour efficiencies while decreasing occupational health and safety risks and, anecdotally, water use. Beds were subsequently added to the system enabling row crop production in rotation with rice-based production crops. The system has now been adopted outside traditional rice-based farming areas and is being used exclusively for the production of row crops in Queensland and northern Australia.

Bankless channel irrigation systems consist of a series of terraced bays which, while irrigated separately, are connected by a bankless channel (Figure 1). Each bay is irrigated by backing up water behind a closed gate in the bankless channel, causing water to spill into the adjacent bay. Once irrigation is complete for that bay, the gate is opened allowing both supply water and drainage water from the bay to flow into the next bay in the series. This process is repeated until all bays in the series have been irrigated.

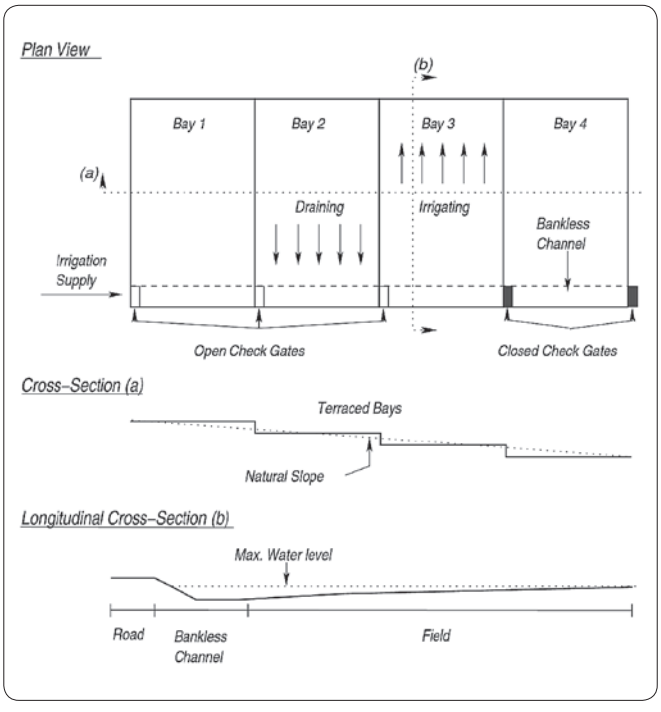

Figure 1. *Schematic of a bankless channel irrigation system (BCIS)*

The key advantages of BCIS over conventionally irrigated furrow systems which have led to their adoption outside traditional rice growing areas include:

- increased labour saving through the elimination of siphons
- improved machinery operation efficiency as a result of the elimination of rotor-bucks and the introduction of a drive-through head ditch
- improved irrigation performance of hard setting soils
- reduction in tailwater flows.

The system is not without limitations. Some recognised limitations include installation costs, unproductive land area and weed management issues on banks. In addition, current irrigation evaluation methods are not suitable for assessing the irrigation performance of the system. Consequently, published irrigation performance data for this system has relied on system scale evaluation. While these figures are comparable to conventional siphon irrigated fields, the distribution uniformity within each bay is arguably more important. With this information (and a method with which to measure performance), the system can be optimised.

Finding a way to measure BCIS performance

Optimising the water application efficiency of most surface irrigation systems makes use of well defined procedures. However, for BCIS these procedures are not well developed. Current irrigation optimisation procedures are compromised by some of the operational aspects of BCIS, such as the presence of reverse grade slopes and inter-bay hydraulic influences. Furthermore, without an appropriate evaluation method, design and management guidelines for optimising the irrigation performance of the system cannot be developed.

Cooperative Research Centre for Irrigation Futures PhD student, Michael Grabham, is currently working to identify evaluation, design and management practices to improve the irrigation performance of BCIS. Identification of these elements will lead to improved operation with benefits for both the irrigator, community and the environment.

Michael's research seeks to develop an evaluation method for BCIS and to subsequently identify and validate hydraulic simulation models capable of modelling these systems. With these capabilities, design and management guidelines can then be established to assist designers and irrigators to optimise the performance of current systems and improve the design of new systems.

The first challenge for Michael has been to identify how field slopes, inflow rates and time interact during an irrigation event and how these can be measured reliably and accurately. Michael is using Dopler flow meters at each regulator in the system, water depth probes and irrigation advance meters at appropriate points down selected furrows, comprehensive field surveys and individual furrow discharge measurements to understand the operational intricacies of the system. Data from 14 irrigation events over two summer irrigation seasons of cotton have been collected from the Commins' family property near Whitton, south of Griffith.

Findings from the 2008–09 season

It was anticipated that irrigation advance in each bay would be relatively even, as has been observed in bays with no beds.

Figure 2. *Results from field work show that irrigation advance can be quite variable in bankless channel systems, possibly due to the differences in elevation and evenness of slope within each furrow, more so than just the effect of wheel track rows.*

However, the results show that irrigation advance can be quite variable in these systems. While wheel track rows do contribute to some of this variability, it is hypothesised that differences in elevation and the evenness of slope within each furrow is having a greater impact. Analysis of information from this season will reveal the reasons behind this variable advance.

Another important observation from the data collected so far is the variability in water applied to each bay. Release of water from each bay is largely dictated by both observations of furrows to ensure all furrows a 'through', and time. Consequently, the amount of water applied to each bay is variable and, without measuring discharge at each bay outlet, it is difficult to assess when to release water to achieve an equal water application on each bay.

Data from the field trials suggests a combination of depth, flow and advance measurements within each bay will probably yield the best inputs for an irrigation event to be analysed and subsequently optimised using a simulation model.

These observations highlight the complexity of managing the system to achieve efficient water application. Perhaps more importantly it identifies the value of an evaluation methodology and computer simulation model which can enable various operational aspects of the system to be optimised.

Future research

Over the coming twelve months a simulation model being prepared by the University of Southern Queensland will be validated. Once validated, irrigation simulations will be conducted using the data collected from Michael's field work to optimise the irrigation performance of BCIS.

Further information

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