5.4 Bankless channel irrigation systems

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Key points

- Bankless channel irrigation systems are an alternative method of surface irrigation
- Bankless channel is appealing as it offers labour savings and machine operation efficiencies over traditional siphon irrigation
- Irrigation performance of bankless channel irrigation is difficult to measure and hence aggregated performance benchmarks have not been produced
- A simulation model is being developed to aid design and management of the system.

Introduction

Bankless Channel Irrigation Systems (BCIS) were developed in the 1990s in southern New South Wales with more recent modifications made to suit row-cropping enterprises in southern Queensland. While there are variations in the slopes and configuration of the systems, all of these systems operate by spilling water from a below-surface-level channel into an adjoining bay.

This section provides an overview of BCIS, the advantages and disadvantages of these systems and a guide to evaluating irrigation performance.

Why Bankless?

Irrigators who pioneered BCIS were seeking to reduce the labour cost associated with siphon systems without the additional energy costs associated with pressurised alternatives. In addition to the labour savings and a low energy requirement, BCIS also offered increased in-field machine efficiencies as the ability to drive through the bankless channel and turn on an adjoining roadway allowed for rapid re-entry to the field without the encumbrance of rotobucks.

The system also allows irrigation of a wide variety of crops including, for southern irrigators, the ability to include rice into a row-cropping rotation. Advantages and disadvantages of the system are highlighted in Figure 5.4.1.

System description

Two main design approaches are currently being used for BCIS. The conventional form of BCIS consists of a series of terraced bays with a vertical separation of between 0.1to 0.2 m. Bays typically have either a zero or very shallow positive (uphill) field slope of around +0.01% (1:10000).

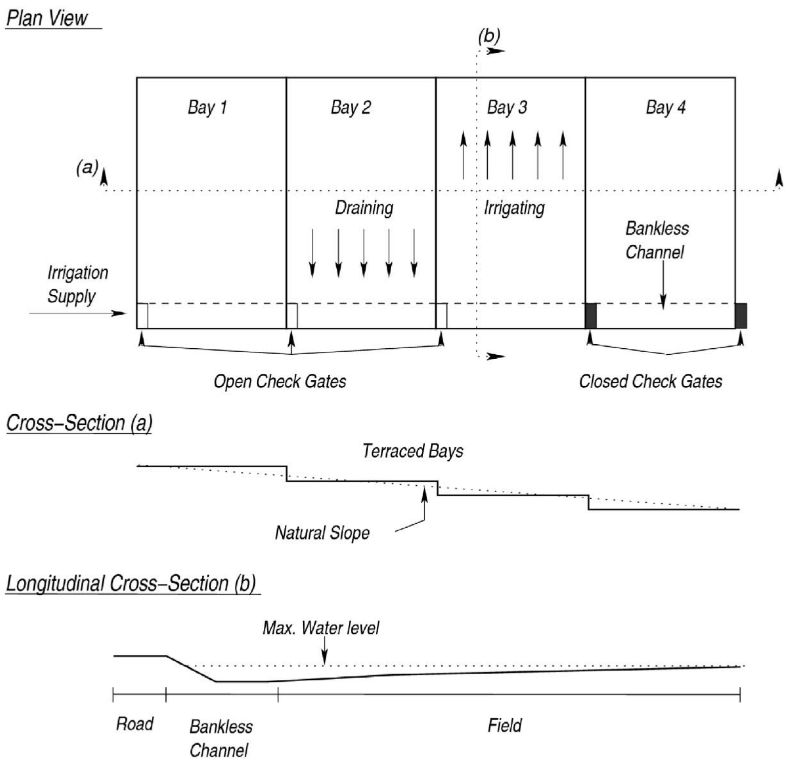
Bays must have no cross-slope and can be configured with beds or flat-planted. All bays are connected by a bankless channel (Figure 5.4.1). However, each bay is irrigated individually by backing-up water behind a closed structure in the channel, causing water to rise and spill into the adjacent bay. Once irrigation is complete for that bay, water is released through the structure, allowing both supply water from the channel and drainage water from the bay to flow into the next bay in the series. This process is repeated until all bays are irrigated.

The flow into each bay is augmented by the runoff from the accumulated surface storage volume in each preceding bay. This creates a higher discharge rate, which means fast advance rates can be achieved.

Table 5.4.1. Advantages and disadvantages over Siphon Irrigation

Advantages	Disadvantages
Labour savings	Larger footprint for a given area due to check banks and bankless channel
Machine efficiencies	Not suited to steeper slopes
Cropping options	Laser grading must be precise
No tailwater during irrigation	Development costs
Silt is minimised	Challenging to evaluate
Faster stormwater clearance	Management for uniformity can be challenging
Able to pond water for rice production	
Can achieve 4-6 hr changes	

Figure 5.4.1. Plan and cross section views of a BCIS showing flows during irrigation of the third bay in a series of four bays. Cross-section (a) shows the terraced bays with regards to the natural slope, while cross-section (b) shows a longitudinal section of the bay.



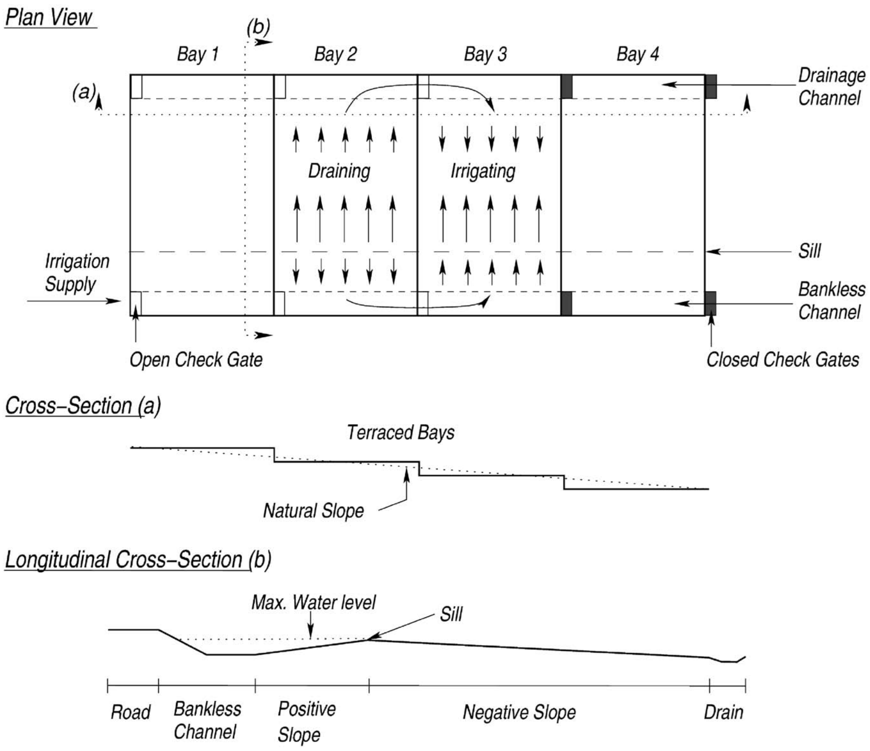
The second design approach of BCIS uses the same approach as the conventional form to deliver water to a bay in that water spills from the bankless channel into the adjacent bay. However, in contrast to the conventional form, approximately 20 metres from the bankless channel, the bay slope changes from a positive field slope to a conventional negative field slope, as show by the 'sill' in Figure 5.4.2.

The advantages of this design over the conventional design are shown in Table 5.4.2. A case study of this design approach is available online.

Table 5.4.2. Advantages and disadvantages of a silled system over conventional BCIS

Advantages	Disadvantages
Development costs less than rooftop Bay inflow/outflow	Unable to pond water such as for rice
Less field earthworks	Largely untested performance
Inundation time more consistent down the furrow	Not suited to hard-setting soils
Evaluation is easier	

Figure 5.4.2. Plan and cross section views of an alternative BCIS.



Performance Evaluation of BCIS

The purpose of evaluation is to understand the relative irrigation performance of a system and identify areas in which performance may be improved. Considerable discussion on irrigation evaluation and water efficiency is provided in WATERpak Chapter 1.2.

Unfortunately, some aspects of conventional surface irrigation evaluation methods cannot be applied to BCIS due to the positive field slope and the interconnected nature of bays within these systems. Consequently, few evaluations examining the irrigation performance of entire systems have been conducted.

However, recent evaluation methods suited to conventional BCIS have been developed following experimentation in the Murrumbidgee Irrigation Area on two field sites. Suggested field measurements, the information they provide and a collection method are described in Table 5.4.3.

Table 5.4.3. BCIS evaluation measurements and the information they provide.

Measurement point	Information provided	Collection Method
Bay inflow/outflow	Bay scale application depths and inlet hydrographs for simulation of irrigation within furrows.	Flow meters installed at bay inlets/ outlets
Furrow discharge	Infiltration parameters	Detailed measurement of furrow cross-sections, flow velocity and depth. Note: considerable care must be taken not to restrict discharge.
Furrow advance	Infiltration parameters	In-furrow advance meters
Furrow entrance elevation survey	Within-bay uniformity	Standard survey methods
Soil moisture	Change in soil moisture	Volumetric or calibrated capacitance measurement devices

The collection of these parameters provides sufficient information for estimates of irrigation performance to be determined with values for DU, Potential Application Efficiency and the Average Infiltrated Depth calculated.

The evaluation results indicated that variability in applied depths between the bays of BCISs may be greater than with-in bay variability. This suggests that careful management of irrigation timing and flow rates may allow the performance of a system to be improved.

Simulation of a field may be used to identify specific timing and flow rates which best suit a particular field. Simulation models enable parameters to be adjusted to reflect field conditions and may assist in identifying superior designs. A simulation model is under development which is capable of accommodating the design aspects of these systems. The model is being developed to simulate irrigation across an entire field. This means that the hydraulic interactions that occur between bays can be better managed to improve the performance of BCISs.

Until such models are developed, identification of suitable times and flow rates which improve irrigation performance will remain a challenge for irrigators. However, better understanding of evaluation methods suited to this system will enable further case studies to be conducted, providing a useful insight into the performance of these systems.