Bankless channels: Irrigation without siphons

By Michael Grabham, NSW DPI Griffith and David Williams, NSW DPI Dubbo

The invitation to investigate a surface irrigation system which doesn't rely on siphons was too good to miss for a group of cotton industry representatives in November 2004. The NSW Department of Primary Industries (NSW DPI) arranged for the group to tour "bankless channel" surface irrigation systems in the Riverina.

Three farms were visited over two days to see the system in operation on row crop maize and talk with irrigators and designers on the merits and weaknesses of the irrigation system. The aim of the tour was firstly to raise awareness of bankless channel layouts in the cotton industry and secondly encourage discussion on the potential of the system as an alternative to conventional surface irrigation layouts in cotton production systems.

Bankless channel irrigation — what is it ?

Bankless channel irrigation layouts were first developed to improve water management and production performance in rice farming systems. For the past 15 years the system has been developed by irrigators and designers in southern NSW.

Five years ago a small number of irrigators began using and experimenting with the layout in row crops. The system is now common in the Riverina with the majority of new surface irrigation developments and redevelopments using bankless channel layouts.

The system's versatility has allowed it to become a true multicrop irrigation layout. It is now commonly used on a variety of crops in addition to rice — including canola, winter cereals and lucerne and increasing areas of maize, soybeans and agroforestry are being grown on the layout each year.

The aim of the bankless channel layout is to apply and drain water quickly using high flow rates. To minimise erosion a large flow rate with a slow channel velocity is required. This is achieved by constructing a supply channel that is wide and shallow. The supply channel runs down slope along the side of a field. The channel is excavated below the level of the field, but only has a bank on one side away from the field (Figure 1).

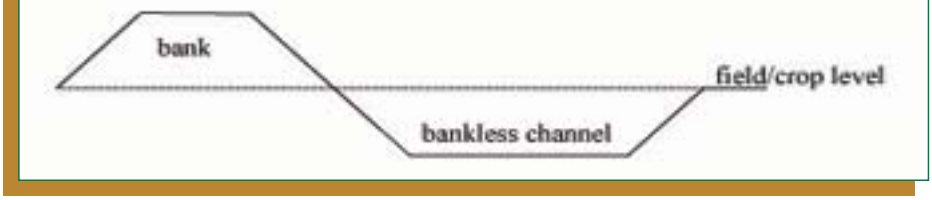
Automation is readily available to allow the doors to open at a set depth, simplifying the irrigation process. This unit is portable to other culverts.

Straight check banks are then constructed across the slope on the contour at regular intervals forming bays. Any number of bays can be constructed down the slope of the field.

Bays are typically levelled, forming terraced bays down the slope, although this was not the case in earlier layouts. Each contour bank has a control structure, usually a con-

58 ▷

FIGURE 1: Bankless channel cross section (not to scale)



Bays are irrigated without over-topping beds in five hours on a 450 metre run. This field has another channel at the other end, also irrigating 450 metres towards the camera.

Large capacity culverts are required to handle the high flow rates of combined supply and drainage.

Looking downstream on the large 200 x 500 metre bays. Culvert capacity is 60 megalitres per day of supply water plus drainage water from the upstream bay. Note the ease of access from the raised roadway to the culvert.

No siphons, no rotobucks, just doors.

crete stop, located where the bankless channel meets the contour bank (Figure 2).

To irrigate the field, a large flow is directed into the bankless channel, where it continues until it comes to the first closed stop. As the water level rises in the channel, it overtops the channel onto the field and starts to flow over the bay.

Once the bay has been irrigated to a sufficient depth, or for a suitable duration, the check is released. This allows draining water from the freshly irrigated bay into the next bay down the slope. This drainage water combines with the continuing supply water, increasing the flow rate to the following bays. This process of "fill then release" is repeated down the slope to the last bay.

Systems visited on the tour

The three systems that were visited were all planted to maize, but a variety of other crops are being grown with the system elsewhere on the properties.

On the first property, low labour availability was the motivation behind converting to bankless channel. Each 10 hectare bay (200 metres wide x 500 metres long) is irrigated in 5–8 hours. The flow rate applied to each field during irrigation was significant at 60 megalitres per day (equivalent to approx 150 x 63mm siphons).

When combined with drainage from other bays, the application rate would peak at about 90 megalitres per day. Reducing water velocity was also a priority, so large 'double stops' were introduced into the system to minimise scouring.

The second farm had control structures that had been automated using water level sensitive trip mechanisms. Once the water reached the desired level in the field the control structure released, allowing irrigation of the subsequent bay. The automated control structures were totally transportable and could be transferred once the structure had been activated.

The third farm visited focussed on the design of the system and reinforced the need for some investigation work on the system. This property had seen the development of six variations of the system with each version adjusted to improve certain parameters.

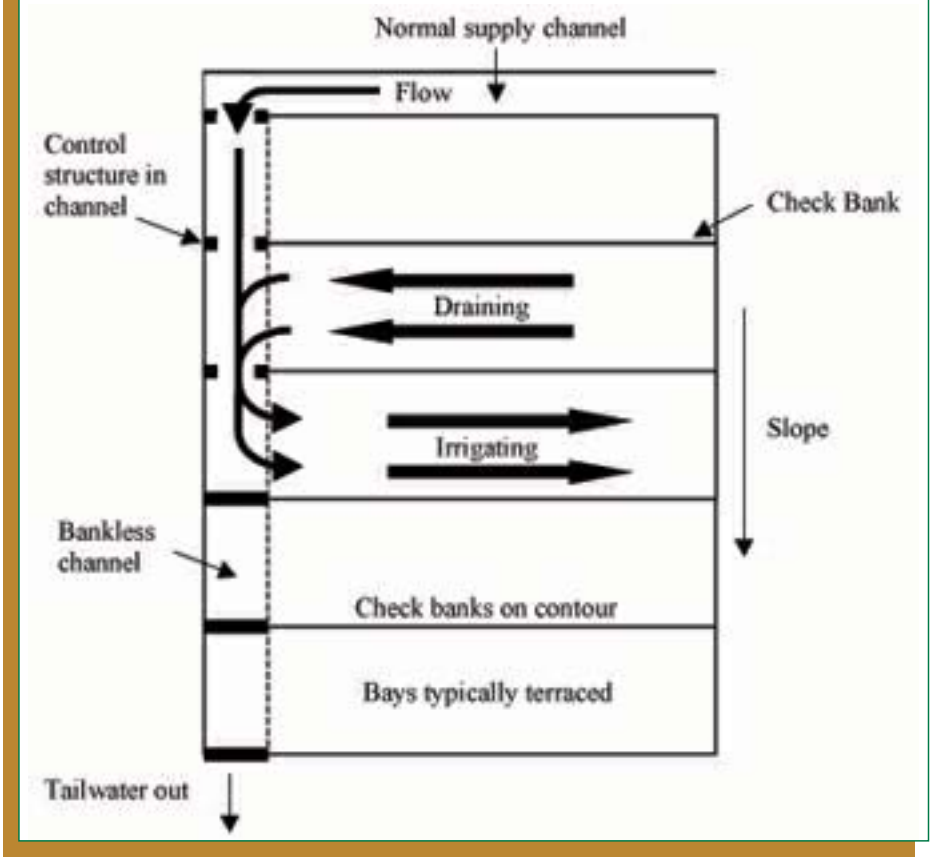
The owners of this property are in the process of converting all their farms to bankless channel layouts. Furthermore, confidence and realised benefits from the bankless channel system in this expanding enterprise are such that additional farms are also converted after being purchased. Questions as to the ideal length and width of bays, the step between bays and the necessary flow rates to operate the system were all discussed.

System pros and cons

All irrigation systems have advantages and disadvantages. The suitability of an irrigation system to an individual enterprise depends on the purpose for which it is to be used. Changing commodity prices and diversification mean opportunity and rotational cropping are essential elements of any system.

Bankless channel layouts offer versatility

FIGURE 2: Bankless channel layout



in crop rotations and significantly reduce labour costs over conventional surface irrigation systems providing a compelling case for further investigation of the system.

Low labour costs are achieved by the system through the elimination of siphons and rotobucks and by the potential for system automation. Significant resources are invested in starting and stopping siphons, especially if uniform applications are to be achieved, and in the removal and reformation of rotobucks for infield operations.

Operational requirements in bankless channel systems are limited to opening one easily accessible control structure per bay. Large control structures and wide supply channels ensure excellent trash management and therefore fewer system blockages.

Irrigation Efficiency (IE) and Distribution Uniformity (DU) are key performance indicators of an irrigation system. At this point, there are no objective measurements being taken to determine these factors. NSW DPI plan to investigate these parameters through a project proposed to specifically investigate the design and performance of the layout.

Well designed bankless channel layouts can rapidly irrigate a field, resulting in all parts of a bay receiving water in a shorter period of time than is achieved with conventional surface systems. Water drains quickly off the field in the same way.

No tailwater is released from the system until the last bay has been irrigated. When tailwater from the last bay exits the system it does so in a single large flow, improving tailwater efficiency.

A good operator aims to cut the supply early enough to allow the last bay to be irrigated with drainage water only. This results in no tailwater leaving the field at all for an irrigation event. As a result, high DU and high IE are anticipated due to quick advances and recessions and a relatively even infiltration opportunity time across the field. Investigations by NSW DPI over the next few seasons are expected to validate these assumptions.

Flow rates, the duration of irrigations and drainage are all controlled by one structure, allowing for easy infield water management. While this is a distinct advantage for better water control, fewer structures also means larger, and more costly structures — albeit a negligible cost increase over siphons.

The structures also have an overflow feature allowing excess water to be diverted to the next bay. This technique can be utilised when ponding in areas of poorer infiltration is required.

Bankless channel layouts have the ability to pond surface water to facilitate infiltration. This has positive implications for irrigators trying to manage hard setting soils which are difficult to sub.

Wheel track rows in this layout assist with the movement of supply and drainage water within the bay. Reduced infiltration in these rows is compensated by the adjacent non-wheel rows.

Scouring and erosion does occur in the system especially around the culverts. Installation of drop box structures and increasing the capacity of the culverts canalleviate this problem.

POTENTIAL FOR COTTON

What is the potential for cotton irrigation?

Bankless channel layouts are an established multi-crop system that shows some potential in cotton production. While it is unlikely at this stage for cotton irrigators to change existing furrow layouts to bankless channel, there are areas where the use of bankless channel layouts could be considered.

Any new development or significant redevelopment should look at the feasibility of the layout, focusing primarily on the suitability of the farm's soils, topography and labour costs. Areas with poor infiltration and subbing characteristics could benefit from the layout. Irrigators with these soil types now have the option of dovetailing bankless channel layouts into current systems to improve subbing on these soil types.

The demonstrated labour savings over siphons and tailwater containment within the crop are significant advantages of the layout. In addition, the versatility of the system to cater for varying rotations without the need for system change is significant. But the perceived but unverified improved distribution uniformity needs to be investigated.

There are two cotton properties in Queensland that are known to grow cotton on this layout. The authors were unable to visit these farms prior to publication in order to comment, but will do so in the coming months.

Representatives from the National Centre for Engineering in Agriculture (NCEA), Queensland Department of Primary Industries and Fisheries (QDPI&F), Australian Cotton Growers Research Association (ACGRA), Cotton Research and Development Corporation (CRDC), Australian Cotton Co-operative Research Centre (Cotton CRC), Co-operative Research Centre for Irrigation Futures (CRC IF) and private irrigation consultants made up the visiting group.