Alternative irrigation systems

By **LANCE PENDERGAST**

Centre Pivots/Lateral Moves (CPLM)

Centre pivot and lateral moves (CPLMs), have been around since the 1950s, and used by American cotton growers from the late 1960s Their design was still relatively basic when first introduced to the Australian cotton industry in the early 1970s. Early experiences with CPLMs were often poor.

Typically early Australian system designs, based on American experience, were incapable of delivering the application rates required by cotton growing under Australia conditions, a problem exacerbated by the relative lack of knowledge regarding peak crop water use. They operated at high pressure using overhead knocker sprinklers and were prone to poor hydraulic design. Operating costs were high, water use efficiencies low and a great deal of time was spent just keeping the systems going.

Much has changed since those early days. Pressure on water availability and environmental sustainability, as well as economic and political factors, have contributed to increasing attention to the viability of CPLMs. Raine, Foley and Henkel (2000) found less than 4% of Australian cotton grown under CPLMs. A study currently underway will no doubt record a significantly greater area irrigated with CPLMs today.

Design and operating protocols have come a long way in the past decade. Systems capable of operating efficiently over a wide range of soil types and environmental conditions now efficiently irrigate an increasing area of cotton.

BE AWARE OF

- CPLM are capable of profitably producing cotton.
- Their design needs to be site-specific.
- They should only be considered when the potential performance of any existing system (e.g. furrow) has been adequately assessed.
- When assessing the viability of CPLM investments the following need to be considered: Yield and prices risk, the extent of water savings and risk of water availability, likely impact of changing energy costs, and availability of labour.

Swing arm pivot in operation.

Before replacing a current surface irrigation system with a CPLM system you should assess the performance of the existing system. This will ascertain potential improvements before considering the alternative irrigation systems. Optimisation of an existing furrow system could significantly reduce potential gains expected from investment in an alternative system.

It is not possible to make a 'rule-of-thumb' statement that the investment in CPLMs is or is not profitable – every farm business differs and so do the water savings and yield benefits for the many crops that can be grown with these machines.

A 'with'and 'without' scenario analysis approach with support from a suitably qualified agri-business financial advisor, is a robust method to assess the economic and financial performance of investment in CPLMs. This approach involves the following steps:

- Prepare a steady state profit analysis at the whole farm scale for the current farming system (the 'without' scenario) and the one with the CPLM investment (the 'with' scenario).
- Undertake a financial analysis over the life of the investment for the 'with' and 'without' scenarios.
- Complete an economic analysis to calculate and compare the Internal Rate of Return and the Net Present Values for the 'with' and 'without' scenarios.
- Perform a marginal analysis to calculate the marginal return and payback period for the CPLM investment.

Growers considering purchasing CPLMs should look, listen and learn from those with experience with these machines. One of the most consistent messages is the importance of obtaining a 'site specific' system design – CPLM designs must be tailored to match the environment (e.g. soil characteristics) in which they will be operating. Field by field considerations often result in system design varying considerably between machines operating in close proximity to each other.

A well designed CPLM should:

- Maximise the amount of water placed into the crop root zone from water pumped.
- Distribute the water uniformly across the field.
- Be capable of meeting peak crop water use.
- Have minimal energy and labour inputs.

Fortunately the industry has matured since its early days when disappointment could often be traced back to inappropriate designs sold and built by overly "optimistic" providers. Growers can now access providers with a proven track record of delivering machines that perform as promised. A range of tools has been developed to assist growers' initial decision making process, to verify system performance, and to plan ongoing machine operation. These are now available through the Cotton Catchment Communities CRC and other industry bodies.

Useful resources

- The cotton industry publication WATERpak provides a useful discussion of alternative irrigation systems, including CPLMs.
- A comprehensive CPLM training package, developed and delivered by the National Centre for Engineering in Agriculture (NCEA) with funding from CRDC and the CRC-IF.
- A Centre Pivot and Lateral Move one day workshop available through Growcom.
- Water Use Efficiency extension officers, funded by Australian Government's Water for the Future Program and the Rural Water Use Efficiency 4 project, can provide assistance to access information.
- OVERshed – an on-line CPLM management tool for visualising soil moisture deficits and irrigation scheduling options.

Subsurface drip irrigation

BE AWARE OF

- SDI has more flexibility in design layouts than surface irrigation systems.
- Any decision to invest in SDI should be underpinned by many of the same considerations associated with investing in CPLM technology.
- As with CPLM the decision making process to invest in SDI needs to be supported by a 'with' and 'without' scenario analysis approach.
- More expensive than CPLM and requires a higher level of operator expertise if potential benefits are to be achieved.

Furrow irrigation remains the dominant irrigation method in Australia. Typically about 60–70% of the water that reaches the field is used by the crop, and the remainder is recycled as runoff or lost to deep drainage. Over recent years some operators have made considerable improvements in the efficiency of furrow irrigation in response to the increasing demand for limited water supplies. Significant improvements in water use efficiencies have been achieved through furrow optimisation evaluations using advance meters, siphon meters and SIRMOD. There has also been an increased adoption of CPLM systems. While irrigation efficiency for these systems is often higher (85–90%) than for furrow (about 75–85%), there is still the potential for losses due to evaporation and increased foliar diseases. Improved designs of both machines and sprinklers, and innovations such as the use of low energy precision applications have led to some operations increasing water use efficiency to exceed 90% (with associated improvements in application uniformity).

Sub-surface drip irrigation (SDI) is an alternative irrigation system for improving water use efficiency and has been successfully used by Australian cotton producers. SDI is the application of water below the soil surface through emitters with a discharge equivalent to crop water requirements – to meet the crop evapo-transpiration demand. It is a low pressure, low volume irrigation system that uses buried drip tubes. SDI tape is laid permanently and has been documented lasting for 10–15 years. Recent developments in SDI technologies and materials have increased system affordability and reliability with systems now capable of achieving irrigation efficiencies as high as 90–100%.

Capital investment and labor costs are, therefore, low compared to surface drip where tape needs to be placed, removed and then replaced after each crop. It has a number of potential benefits over furrow irrigation:

- Water savings, control of runoff and deep drainage, increased rainfall capture, and reduced soil surface evaporation.
- Reduced incidence of disease and weeds.
- Enhanced fertiliser efficiency.
- Reduced labor demands.
- Field operations possible even when the irrigation is turned on.

As was the case with CPLM, historically SDI irrigated cotton systems provided disappointing results. Their failure to produce the anticipated improvements in yield and water use efficiencies (which had been critical components in the initial decision to outlay the considerable required installation capital) may be attributed to a range of factors. Again, as with early CPLM installations, poor design or adherence to design at installation, and insufficient operator expertise, so often associated with application of any new technology, did little to produce expected outcomes. Just as a high performance engine behaves atrociously when out of tune, SDI systems perform poorly if not operated correctly, even if their design is excellent.

Trials conducted by the Cotton Catchments Communities CRC, in collaboration with a tape manufacturer and three

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irrigators on three sites, (see Table 1.) showed a range of yield impacts of drip irrigation on cotton. The average yield decreased with the use of drip at one site (although here drip out-yielded furrow irrigated cotton in the first year of installation), and increased at the second (a 10% yield increase on average over furrow irrigation with 1m drip) and third sites (where yield increases ranging from 20 to 34% for drip over furrow irrigation where recorded). The average reduction in applied irrigation for drip irrigation over furrow irrigation ranged from 15 to 31% across the three demonstration sites.

TABLE 1.
Impact of drip irrigation on Water Use Efficiency Indices (bales/ML) on three Darling Downs drip irrigation demonstration sites.

	Gross Production Water Use Index (GPWUI)		Irrigation Water Use Index (IWUI)	
	Furrow	Drip	Furrow	Drip
Site 1 (1m drip) (2m drip)	0.84 0.84	1.11 1.04	1.58 1.58	2.60 2.41
Site 2 (solid) (skip)	1.22 1.32	1.30 1.50	2.20 2.19	2.80 2.66
Site 3 (60") (skip)	1.13 0.92	1.82 1.15	1.66 2.24	2.69 3.17

The impacts of the yield increases and reduction in water use, as captured in the Water Use Efficiency Indices (IWUE – bales/ML), showed significant improvements in water use efficiency from the investment in drip irrigation. However, for an increase in profitability from the installation of drip the water savings must be significant enough to enable an expansion in cotton area and an increase in yield sufficient to increase profits over the existing furrow irrigation system.

It is also important that there is reliability in water supply from year to year to justify the significant capital investment. It is critical that best management practices in design, installation, management and maintenance of drip irrigation systems are followed – if not, then profitable investment in these systems is unattainable.

Useful resources

CRDC funded, NCEA produced publication: Alternative Irrigation Systems for the Australian Cotton Industry by Raine, Foley and Henkel remains a very informative reference for both SDI and CPLM. Ask your local cotton or water use efficiency extension officer for access to a copy.

More Profit Per Drop (http://moreprofitperdrop.wordpress.com) website has a range of articles discussing SDI.

Articles discussing SDI can also be accessed at http://www.cottonandgrains.irrigationfutures.org.au including WATERpak provides a useful discussion of alternative irrigation systems, including SDI.

Bankless irrigation systems

By **Nikki Pilcher,** DEEDI

BE AWARE OF

- Bankless channel irrigation systems are a new system being utilised within the industry.
- The major benefit and motivator for change to this system is reduced labour requirements.
- Efficiencies of these systems still need to be assessed.
- Expensive to convert an existing irrigation system to a bankless system.

Bankless channel systems are designed to remove the need for siphons, with the field split into bays. The field is designed to be watered at a high flow rate with all furrows in a bay irrigated at once

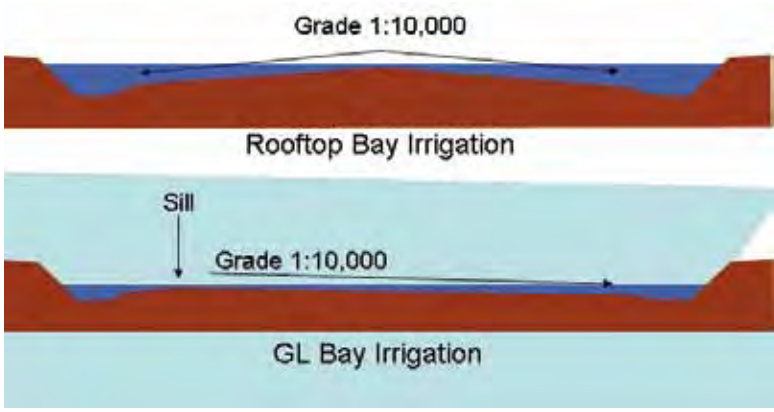
There are several types of bankless channel systems in use in Queensland and NSW. The original bankless channel system is the 'roof-top' system. In the roof-top system the bay is graded from both ends on a reverse slope forming a peak in the centre of each bay. Innovations in design are being made with this design with the most recent version in the St George area eliminating the roof top configuration.

Currently there is work in NSW measuring the efficiencies and variability of bankless channel systems. In the 2011–12 season the DEEDI Irrigation Extension team intend building on past research in the St George area by developing a strategy to assess the efficiency of the bankless systems in that district.

Bankless irrigation systems are being used by broadacre irrigators seeking to improve farm efficiencies. The main motivation is the labour savings that can be made with such a system.

Pros

- Reduced labour requirements through removal of siphons.
- Improved machinery efficiency – no need for



Two different bankless channel field designs – GL Bays have superseded the rooftop on a property near St George.
(Source: GL Irrigation)

traditional management operations such as rotobucking and drive through ditches for spraying and harvesting operations.
- Ability to better manage crop water use in response to hot, dry weather and pending rainfall events.
- Limited maintenance – tail drains are graded every 2–3 years but no need to do head ditches.

Cons

- Not suitable for paddocks with varying soil types.
- Current efficiency and uniformity evaluation methods not suitable to assess bankless systems.
- Need suitable slopes.
- Installation costs – suited to properties in the developmental phase as opposed to converting old siphon fields to bankless systems.

For more information contact: nikki.a.pilcher@deedi.qld.gov.au
Ph: 07 4620 8109, Mob: 0428 114 810.

Looking down the furrows on a bankless channel bay near St George.

Check gates being removed between bays at a property near St George on a bankless channel system.

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