Lateral move towards improving water use efficiency

By Tom Breen[1] and Mitchell Carter[2]

Ben Stephen describing the Auscott Namoi system.

The impacts of drought and reductions in water allocations have been felt across the cotton industry in recent times. This has necessitated a move towards improving the efficiency of water use if cotton production is to remain both profitable and sustainable into the future.

Recent experiences at Auscott Namoi Valley Operations have demonstrated improvements in cotton yields, coupled with significant reductions in water use associated with lateral move irrigation.

Auscott installed the lateral move in season 2004–05, following encouraging results from growing cotton under laterals at their Gwydir Valley Operations, in which significant water savings were achieved. The machine was installed on land that had previously been developed for furrow irrigation, with the objective of assessing the difference in water use between traditional furrow irrigation methods and overhead irrigation with the lateral move.

FIELD DESIGN

Three fields (approximately 120 hectares each) were split in half, with one side of each remaining furrow irrigated, and the other halves undergoing further development for a lateral. Furrow irrigation was undertaken using a PTB outlet every 24 metres, so lateral development included the removal of these outlets and pushing in of all supply ditches.

Tail drains remained in place so that

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TABLE 1: Machine specifications

Width	720m
Length of run	2460m
Pumping capacity	15ML/day
Area developed	177 ha
Cotton area	118ha
Max application rate	12.7mm/day

TABLE 2: Yield comparison of lateral move vs furrow

Variety	Yield
Sicala 60BGRR (LM)	9.66
Sicot 71BGRR (LM)	11.48
Sicala 60BGRR (F)	8.66
Sicot 71BGRR (F)	10.44
Max application rate	12.7mm/day

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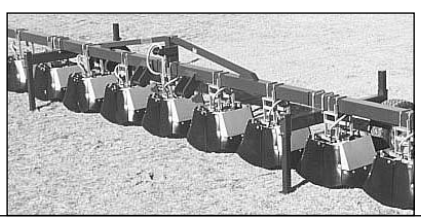

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field drainage could be achieved during high rainfall events. The lateral move was developed for a 2:1 cotton rotation, with two of the three fields in production for any given season.

The development was designed so that further lateral development could continue if the project was successful. In the first season, this allowed a direct camparison between cotton production under lateral move and traditional furrow systems.

With this objective in mind, the only difference in terms of crop management between the two systems was the method of irrigation. Two cotton varieties, (Sicala 60BGRR and Sicot 71BGRR) were planted in both systems. Neither system required irrigation at planting, with cotton establishment being achieved on full moisture profiles due to rainfall in the winter fallow period.

Irrigation scheduling was determined using capacitance probes. Mace flow meters were installed at the head and tail ends of the siphon irrigated fields to accurately measure both the amount of water applied and the amount of water leaving the field as surface runoff, therefore enabling irrigation water use to be measured. A Mace flow meter was similarly installed on the lateral move pump to accurately measure applied water during irrigation events.

Water was applied through the lateral move using low energy precision application (LEPA) droppers. This allows for water to be placed precisely in the furrow and minimises losses through evaporation.

This machine has droppers at one metre centres, although only every second dropper is operated during an irrigation event. Valves fitted to each dropper allow successive irrigations to be performed on alternate rows. This minimises surface runoff by utilising the soil's natural cracking characteristic which enhances infiltration. Irrigation events occurred over a 48 hour period allowing for an average application of 25mm. Table 1 outlines the lateral move specifications.

TABLE 3: Water use efficiency comparison of lateral move vs. furrow

	Furrow	Lateral	Difference	% Difference
Final yield (B/ha)	9.55	10.57	1.02	10.7%
Total water use (Ml)	5.4	3.38	2.02	37.5%
IWU index (B/Ml)	1.77	3.13	1.36	77.0%
Water saving (Ml)	0	238.7	238.7	
5 year water saving (Ml)	0	1193.5	1193.5	

CROP PERFORMANCE

Analysis of final yield results (Table 2) demonstrates an average yield increase of approximately one bale per hectare of cotton under the lateral move in comparison to the adjacent siphon irrigated fields, repeated across both cotton varieties.

An improvement in fibre quality was also experienced in the Sicot 71BGRR under the lateral move in direct comparison to the adjacent furrow irrigated Sicot 71BGRR. A percentage of bales produced under the furrow system attracted penalties for short fibre (34), but under the lateral move system all bales achieved at least base grade, with a small percentage attracting a premium for fibre length.

In terms of crop water use, five irrigation events were applied to the siphon irrigation system for a total of 5.4 megalitres per hectare. The lateral move made 14 passes for a total application of 3.38 megalitres per hectare. Total in-crop rainfall for the season was 485 mm. This result demonstrates a 37.5 per cent water saving by the lateral in comparison to the adjacent siphon irrigation system. This combination of increased yields and decreased water use under the lateral resulted in a 77 per cent increase in irrigation water use index (bales produced per megalitre of water applied). Table 3 illustrates the water savings and efficiency gains associated with the lateral move.

Improvements in the efficiency of water use under the lateral are directly attributed to four key factors:

- The application of smaller volumes of water per irrigation event minimises losses through surface runoff and deep drainage;
- Water applications using droppers results in incomplete saturation of the soil surface, thereby minimising losses through evaporation;
- The soil profile is rarely full, the lateral move system is in a better position to make effective use of rainfall; and,
- Increased yield due to less plant stress lifts the overall crop water use efficiency.

ECONOMICS

There are substantial costs associated with the development of new or existing land for lateral moves. Development costs for converting from furrow irrigation to a lateral move were in the order of $3000 per hectare and include purchase of the machine itself and all earthworks associated with the removal and installation of channels and structures, as well as the planning, design and surveying aspects of the project.

But the water savings achieved in combination with the increase in yield over the furrow system demonstrate the long-term potential of lateral moves. Budgeting on long-term water savings of 30 per cent in combination with a yield increase of five per cent, results that appear very achievable, the return on the initial investment

A Mace flow meter was installed on the lateral move pump.

suggest a payback period of 5-6 years. The life of the lateral move is assumed to be approximately 20 years.

Over time and with the further installation of more lateral moves, it is assumed that development costs can be significantly reduced, as we become more efficient in the earthworks component of the development. Similarly, survey and design costs should be reduced as we become more confident in the type of system we desire.

It was assumed that another significant cost associated with the lateral move would be in fuels and lubes. While the cost of fuels does increase, it is not as dramatic as first thought. This is due to a number of factors:

- The lateral was designed to be gravity fed after initial pumping of water at the river, so a second pumping event into farm storage is not required to supply a head to the lateral move field;
- The almost complete lack of tail water in the lateral move system eliminates the usual tailwater recycling costs; and,
- While the lateral move does need to pump water for application, the volume of water pumped during this process is less than that required to be lifted into storage for surface application

The net result is an approximate increase in fuel costs for the lateral move of $30 per hectare.

In terms of labour requirements, there is a significant reduction in the number of personnel required to irrigate a designated area. However, it should be recognised that irrigation personnel with a different skill set will now be required for the system to function at its maximum potential. There is also an increased mechanical requirement associated with the ongoing operation and maintenance of lateral moves.

So in terms of economics, while the development and energy costs may increase, these are offset by savings in labour and water, increases in yield and potential improvements to soil health and fertiliser efficiency.

ISSUES

Operation of the lateral moves in the current (2005–06) season has highlighted the importance of field drainage. The current crop was not planted in beds because of a number of perceived benefits associated with farming on the flat, but in hindsight this has created problems with field drainage.

The most important issue has been the inability to get infiltration at the point where water is dropped, leading to water entering into some of the lateral wheel tracks and causing problems with wheel slip later in the season. Crop variability is also greater this season as a result of some surface water movement before infiltration.

The lateral move produced a yield increase of one bale per hectare.

One metre beds will be implemented next season to maintain the irrigation of alternate furrows, subsequently maximising infiltration, minimising surface runoff and evaporation, and eliminating water in wheel tracks and the problems this creates.

Another positive observation has been the effect that lateral move irrigation has had on topsoil properties. After one season of operation, it was visibly noticeable that the structural properties of the topsoil under the lateral were in a better condition than the comparative furrow irrigated soil.

This is most likely due to the watering regime of the lateral move enhancing the self–mulching properties of the clay soils. The benefits of this finding include further improvements in infiltration and drainage and may lead to further increases in productivity and water use efficiency.

Extended periods of high temperatures and high daily water use in the current season have also highlighted the importance of ensuring a full soil moisture profile before hot weather and high crop extraction rates are likely. Although we are confident that we were able to supply enough water to the crop during these peak periods, it was imperative to come into these periods with a full profile to ensure that the lateral move with the current pumping capacity was able to supply enough water to satisfy the daily demand of the crop.

So in a season where winter rainfall has not been sufficient to fill the moisture profile, it should be recognised that the lateral move will need to start earlier to ensure that the demands of the crop can be satisfied during periods of peak water use. A dry winter which leads to a high water use pre-irrigation or water up is a situation where a lateral could save water as small applications could be used to establish the crop.

The level of inputs will also change under a lateral move irrigation system. The increase in fuel and lube costs and decrease in labour compared to furrow irrigation were previously mentioned, but there is also the potential to reduce inorganic fertiliser inputs.

The ability of the lateral move to supply smaller and more specific volumes will make it more feasible to grow rotation crops such as vetch, thereby reducing the requirement for inorganic nitrogen inputs. The likely reduction in deep drainage and virtual elimination of tailwater in a lateral system may also dramatically reduce nutrient losses.

In fact it may be possible for the combination of these factors and the additional benefits of this system to have a net positive impact on greenhouse gas emissions, which is a good news story for an industry facing increasing scrutiny for its environmental performance.

Preliminary experiences with lateral move irrigation at Auscott Namoi Valley Operations have demonstrated the potential to significantly reduce the amount of water used to produce higher yielding cotton crops. The costs involved in the conversion from furrow to lateral move irrigation are substantial, but the returns on the initial investment are promising. To be successful, the importance of detailed analysis of individual farm situations and careful management of the system must not be underestimated.

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