Overhead irrigation in the Australian cotton industry

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About 5300 hectares of cotton is currently irrigated using centre pivots and lateral move machines in Australia. This represents approximately four per cent of the irrigated cotton crop in an average year — significantly more than is irrigated by drip irrigation systems (3100 hectares).

While centre pivots have been used in the Australian cotton industry for more than 20 years, recent interest in the performance and operation of both centre pivot and lateral move machines resulted in the Cotton Research and Development Corporation commissioning a scoping study to better understand the issues surrounding the use of these. The study was conducted during 2001 and involved a face-to-face survey of more than 80 per cent of the 36 cotton growers using centre pivots and lateral moves.

Using low energy precision application (LEPA) socks to irrigate cotton.

INDUSTRY OVERVIEW

Centre pivots and lateral moves are currently installed in each of the major cotton producing areas from Emerald in Queensland through to Hillston in NSW as well as in experimental areas in other states. The majority of machines used in the cotton industry are centre pivots (76 per cent) while the remainder are lateral moves. The average size of the centre pivots is about 70 hectares while the average size of lateral move machines is 165 hectares with the largest single machine irrigating 267 hectares.

TABLE 1: Typical characteristics of centre pivot and lateral move machines

Centre Pivot	Lateral Move
Circular layout	Rectangular layout
Higher capital cost (about 10–15 per cent)	Lower capital cost
Low labour requirement	Higher labour requirement (>50 per cent)
Pipeline supplied	Can be channel supplied
Driest ground always immediately in front of machine	Driest ground typically at opposite end of field from machine
Very high instantaneous application rates at outer end of machine	Uniform instantaneous application rates across the machine

Centre pivots and lateral moves in the cotton industry have been commonly installed on cracking clay (61 per cent) and clay loam soils (27 per cent). Half of the growers surveyed obtain all of their water from surface supplies while 35 per cent use only groundwater.

Over 40 per cent of the machines operate with a supply pressure of less than 30 psi while another third of the machines operate at between 30 and 40 psi. Nearly all growers (96 per cent) used static plate sprinklers for germination but about half of the growers (48 per cent) then used low energy precision application (LEPA) emitters (either socks or Quadsprays) for in-season irrigations.

FIGURE 1: Increase in crop water use efficiency (in bales/MLirrig) for cotton irrigated by centre pivots and lateral moves compared to traditional surface systems

REASONS FOR INSTALLING MACHINES

The main reasons cited for installing the

machines were the potential for water savings (93 per cent), labour savings (85 per cent) and reduced crop waterlogging (73 per cent). These benefits were highlighted by one grower who said: “I’m saving a ‘cruiser every two years and two blokes’ wages compared to managing a furrow system.”

Another responded saying that: “Waterlogging is a thing of the past. If there is a front coming, I only put on one inch, instead of two inches and see what rain I get.”

Approximately two-thirds of growers indicated that improved uniformity of water application and the ability to automate the system was also important while approximately half the growers were interested in increased yield and either fertigation or chemigation opportunities.

Other issues, such as the elimination of the requirement for extensive surface irrigation earthworks, were also found appealing. Approximately two-thirds of the growers surveyed owned more than one machine and nearly all of the growers (93 per cent) used their machines to also irrigate other crops (normally grains or peanuts).

YIELD AND WATER USE EFFICIENCY

All growers reported an improvement in the crop water use efficiency (CWUE) using centre pivots and lateral moves when compared to their own traditional surface irrigation systems (Figure 1). The average CWUE was 1.9 bales per megalitre of irrigation using centre pivots and lateral moves compared to grower’s own traditional non-optimised surface irrigation of 1.1 bales per megalitre of irrigation — a 72 per cent improvement.

Yields per unit area were primarily influenced by management strategy and system capacity. All the centre pivot and lateral move growers surveyed applied less water per unit area with their machines than they applied using their own surface irrigation systems.

Growers reported applying on average 3.1 megalitres of irrigation water per hectare less than fully irrigated surface systems. But the survey results were strongly influenced by the large proportion of growers who were short of water. Growers who had plenty of available water and an adequate system capacity achieved yields per unit area similar to, or greater than, traditional surface irrigation.

Growers with limited available water achieved lower yields per unit area compared to traditional surface irrigation. But these growers would not have had enough water to fully irrigate the cropped area using surface irrigation. The average yield for centre pivots and lateral moves was slightly lower (0.5 bales per hectare or 6.4

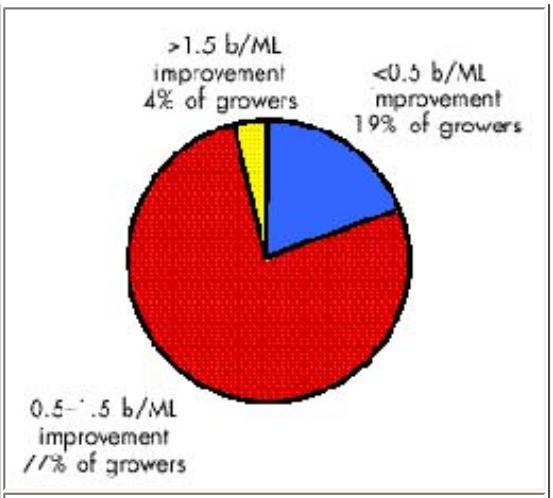

FIGURE 2: Difference in water applied by growers using centre pivots and lateral moves when compared to fully irrigated surface systems

Centre pivot fitted with LEPA socks.

per cent) than traditional surface systems.

CENTRE PIVOTS VERSUS LATERAL MOVES

The major drivers in machine selection are capital cost per unit area, the size of the area to be irrigated and the labour requirements. The average cost of lateral move machines was $1800 per hectare compared to $2000 per hectare for centre pivot machines. But anecdotal evidence reported by the surveyed growers who use both centre pivot and lateral move machines suggests that the labour requirement could be as much as 80 per cent higher for lateral moves compared to centre pivots.

One grower's response when asked why he would prefer not to choose a lateral move machine was: "You always need to have one eye on it, just to make sure that it is actually still going properly." Another responded by asking: "Do you like to sleep at night?"

While centre pivot machines often cost between 10 and 15 per cent more in capital costs than lateral move machines on a per hectare basis, growers indicated that the on-going savings in labour and management costs more than compensate for the extra capital cost.

Approximately half of the growers who irrigate with centre pivot machines were planting and cultivating in circles so that they could use LEPA emitters for in-season irrigations. Most commented that while the transition from 'square' farming wasn't easy, they now prefer farming in circles.

DESIGN ISSUES

Over half of the growers surveyed (56 per cent) indicated that they would like to make changes to the design of their machine for future installations. A wide variety of design issues were identified by growers ranging from problems with system capacity, operating pressures, field slope, soil type and sprinkler packages.

The broad perceptions of the performance of centre pivots and lateral moves in the Australian cotton industry are closely related to design and management problems associated with some of the first machines used in the industry. Early centre pivots were successfully sold to growers, particularly in central Queensland and northern NSW, with little understanding of the crop requirements and the necessary system capacities required for each region.

One grower claimed pivots were originally presented as 50 hectare machines, but in some instances up to three additional spans were sold increasing the irrigated area to 100 hectares without any change in pumping or system capacity. This sales technique significantly

reduced the cost per hectare, but gave growers little chance of crop success (when measured in bales per hectare) with system capacities at roughly half the local peak crop water use.

Unfortunately, many growers still have machines designed or managed with capacities substantially below peak crop water requirements. While cotton can handle continuing small deficits, other grain and legume crops that are commonly grown under these same machines need capacities to match the relevant peak crop water use.

More than three-quarters (79 per cent) of centre pivot and lateral move growers reported experiencing some wheel rutting problems, with most indicating that it was only a problem in the first few years of operation due to inexperience and poor machine design.

The majority of growers indicated that wheel rutting and bogging were no longer major problems in their irrigation management. A wide range of machine modifications and management practices are currently being used by growers to successfully reduce the incidence of wheel rutting and bogging.

AGRONOMIC ISSUES

Development costs

A significant number of growers (83 per cent) installed machines onto new country without levelling or drainage — representing a significant cost saving over traditional surface irrigation systems.

Reduced waterlogging

The ability to apply smaller volumes of water in a single irrigation and so make better use of in-crop rainfall was also cited as a major benefit of these machines. One third of growers typically applied less than 15 mm in a single pass while another third of growers applied less than 30 mm.

The lack of irrigation-induced, temporary waterlogging often associated with traditional surface irrigation practices means that crops under these machines are not often held back as much as surface irrigated crops. This is believed to be the main reason for approximately 20 per cent of centre pivot and lateral move growers experiencing excessive rank growth.

So irrigation schedules and application volumes can and should be modified to maintain a desired level of crop stress when using these machines. Where the crop has been encouraged to grow without either moisture or waterlogging stress, growers have reported the ability to finish crops earlier with significant reductions in the amount of chemical used late in the season.

Applying chemicals and fertilisers

Chemigation through centre pivots and lateral moves was routinely conducted by 14 per cent of growers. These growers reported success using Gemstar with one grower also using Dipel. One grower indicated that the only chemicals used in producing a seven bales per hectare crop were Gemstar applied through the machine and Tracer applied normally. Significant improvements in the efficacy of Gemstar were reported when cotton was regularly chemigated at rates as low as five per cent of label rate with 10 millimetres of irrigation water.

Almost one-third of growers (31 per cent) indicated that the use of these machines changed their insect management strategies. An increasing number of growers are showing interest in setting up their machines with the capacity to chemigate through separate spray systems that are hung underneath the main trusses of the machine.

In these cases, growers are specifying high-speed electric motors and gearboxes with large diameter tyres so that they can obtain high machine speeds and an ability to apply the chemicals quickly with their machine over the entire field.

Forty-five percent of growers had applied fertiliser through their machine with 38 per cent reporting a decrease in the total fertiliser applied to the crop compared with applications for traditional surface irrigated fields. More than two-thirds of growers (69 per cent) indicated that they had decreased their pre-season fertiliser application.

Growers also indicated that irrigating with a centre pivot or lateral move provided an increased ability to time the application of fertiliser, improving both the management of labour, machinery and water as well as the efficiency of fertiliser uptake.

OTHER ISSUES

Other issues covered in the full report include:

- Sprinkler and LEPA systems;
- Design and managed system capacities;
- Wheel rutting and bogging;
- Field drainage;
- Crop germination;
- Scheduling and crop management;
- Economics of centre pivots and lateral moves.

Copies of the full report can be obtained from Helen Dugdale, CRDC on ph: 02 6792 4088.