Shepparton Irrigation Region case study: irrigation system assessment saves energy and stress

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Following a recent assessment of a centre pivot irrigation system, modifications were made to improve energy efficiency by approximately 20%.

This equates to potential cost savings of $2,664 per season, or $40,000 over the life of the system.

In 2020 an irrigation system check was conducted by Agriculture Victoria on a centre pivot irrigation system located at Kyabram in Northern Victoria. The centre pivot irrigated approximately 42 ha to grow maize.

The centre pivot was over 15 years old and had been designed and installed when electricity was much cheaper. An oversized pump had been fitted to allow operation of an end-gun without a booster pump. This meant the operating pressure was excessive, resulting in high energy consumption and operating costs. Energy consumption was found to be 245 kWh/ML.

Following the irrigation system check the farmer removed the end-gun, which reduced the irrigable area from 42ha to 36.2 ha. However, because the pump was not fitted with a variable speed drive, the pressure of the system could not be reduced and electricity costs remained high.

Improved energy efficiency

The solution was to take advantage of the oversized pump by increasing the system capacity of the pivot. This lowered the system pressure, reducing the energy required to run the pump and therefore the electricity costs.

To increase system capacity, the grower replaced 36 nozzles and 15 regulators at a total cost of around $300. The system capacity was increased from 10 mm/day to 15.7 mm/day. Flow rate increased from 4.3 ML/day to about 6 ML/day, while total head pressure dropped by 7 metres to 43.7m. This reduced the energy consumption from 245 kWh/ML to 203 kWh/ML.

This simple alteration lowered electricity costs because the system pressure was significantly less, and the efficiency of the pump was improved by operating closer to the pump's most efficient flow rate and pressure (Best Efficiency Point).

Improved system capacity

The designed system capacity of the centre pivot was originally 10 mm/day. The recommended system capacity for growing maize in northern Victoria is 14 mm/day. The farmer had previously managed the limited system capacity by sowing about half the irrigable area. Even then it was difficult to meet maize water demand in the middle of summer.

Changing the nozzles and regulators led to an increase in system capacity from 10 mm/day to 15.7 mm/day. This reduced the required operating hours, meaning crop water demand could easily be matched, greatly reducing both crop and farmer stress levels. It also enabled more operating hours with off peak electricity further reducing energy costs.

Improved application uniformity

The system assessment identified two ways to improve application uniformity: replacement of the static plate sprinkler pack and removal of the end-gun.

Sprinkler pack

As an older system this pivot was fitted with static plate sprinklers, which are not uncommon in the Goulburn Valley. Static plate sprinklers (see Figure 1) emit several constant streams of water, which means the application rate and depth is very high at the spots where the individual streams hit the ground. This results in poor application uniformity and the high point application rates can cause soil crusting and infiltration problems. The distribution uniformity of this machine was 69%, which means higher application areas were receiving 2.2 times the application rate of lower application areas.

Modern moving plate sprinklers (see Figure 2) randomly scatter droplets over a much larger area, dramatically reducing application rate and improving distribution uniformity. A moving plate sprinkler pack, (an “accelerator pack’) was fitted to the pivot. Another assessment will be undertaken in the future to confirm the anticipated improvements in distribution uniformity. Anecdotally, the farmer found he could apply a much higher application depth without causing runoff, which is indicative of a better application uniformity.

Figure 2: Static plate sprinkler nozzle.
(Picture source IAL CPLM course manual, 2010)

Figure 1: Moving plate sprinkler nozzle.
(Picture source IAL CPLM course manual, 2010)

End-gun

End-guns have notoriously poor application uniformity. This means some areas of the paddock were receiving much more water than others. The end-gun on this pivot was no exception. The inner half of the end-gun was only applying 12.5 mm, while the outer half was applying 20 mm (60% more water), compared to the 14 mm average for the rest of the system. Removal of the end-gun improved the application uniformity of the system, making irrigation scheduling easier, as well as reducing electricity costs of every megalitre of water pumped.

Electricity cost saving assumptions

The changes made to the centre pivot as a result of the irrigation assessment resulted in an energy saving of 42 kWh/ML. If electricity costs 0.25 c/kWh, this equates to a saving of $10.50 per ML. If the whole area of the pivot (36.2 ha) was irrigated at a rate of 7 ML/ha, this equates to a saving of 10,648 kWh or $2,664 per season or almost $40,000 over a 15 year system life.

SYSTEM CHECKS

The Agriculture Victoria irrigation services team is currently offering system checks on Centre Pivot and Lateral Move (CPLM) irrigation systems in northern Victoria. The system checks assess the uniformity of irrigation water application, pump performance and the design of the system.

This service helps irrigators to:

- use their irrigation water more efficiently,
- improve crop yields,
- increase energy efficiency and
- reduce operating costs.

If you are interested in participating in the assessment program or would like to discuss the proposed design of your planned irrigation system, contact Agriculture Victoria Irrigation Services Nick O’Halloran on 03 5833 5222.

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