

Case Study: Ross and Sue Duncan

ON FARM IRRIGATION ENERGY EFFICIENCY CASE STUDY

Ross and Sue Duncan. Chertsey, Mid Canterbury.

Consulting engineers: Aqualinc Research Ltd., Plains Irrigation Ltd.

BACKGROUND

Irrigation is a large user of energy and the current area and expected growth of irrigation across the country is a significant component of electricity demand. Efficiency of energy use on farm has not traditionally been a focus of irrigation service suppliers or farmers. There have been very few on farm energy use efficiency investigations. This lack of data has meant there was not enough evidence, of the opportunity and costs, to give confidence to the irrigation or energy industry to carry out a proposed industry wide energy efficiency program.

During the 2013/14 irrigation season Irrigation New Zealand carried out 14 irrigation energy efficiency on farm audits across Canterbury and Otago. The audits were part of a pilot project funded by EECA¹ and the lines companies of North Otago and Canterbury. Each of the audits covered the two aspects of irrigation efficiency:

1. Motor, pump and delivery system (Headworks, Mainline and irrigators) Efficiency & Performance
2. Seasonal irrigation scheduling/operation efficiency.

This case study documents the audit results and subsequent changes carried out on the property of Ross and Sue Duncan in the Mid Canterbury region.

Ross and Sue Duncan, Chertsey

Ross and Sue farm a 292 ha arable farm at Chertsey south of Rakaia.

The irrigation system had three pumps operating in parallel to serve a ring main network with several branching sub-mains. A single, fixed, Zimmatic centre pivot, two towable (Zimmatic & Pierce) centre pivots and a Roto-Rainer provided the method for distributing irrigation water. The ring main system was originally designed for Roto-Rainer and the distribution method has been altered with the addition of the fixed and towable centre pivots over the years.

Water is sourced from two bores and a reservoir located on site that is supplied by the Acton Irrigation Scheme taking water from the Rakaia River. The supply has also been added to over time from the original one main bore with the addition of a second bore and surface water supply. Both the addition of the pivots and the increased supply points had been done with minimal changes to the original underground pipe network other than to tee into it.

Design considerations

An IRRICAD² analysis was done on the design and came up with a number of issues to address. The main points were

1. Two of the three pumps consistently not operating at or near their BEP³ due to pumps fighting against each other to push water into the main lines. The 'Acton' pump most frequently operates between 50 to 60% of the capacity flow which is approximately 30% below the BEP of 57 l/s. The 'Acton' water supply was not being utilised fully as the pump was not being allowed to pump the full amount supplied. The contract to take water meant that this water was being paid for regardless of whether it was used or not. Underutilisation was up to 25% which represented almost \$10,000 of the annual charges.
2. 25 l/s overall supply deficit. To function efficiently whilst under maximum load (all four irrigators operating), the system demands 189 l/s but is only supplied with 164 l/s. This supply deficit reduces the overall system pressure affecting the overall system efficiency and the distribution uniformity of the irrigators.
3. Pressure losses in the mainline due to inadequately sized and less than optimal configuration.

1 Energy efficiency conservation authority.

2 Irrigation design software.

3. Best efficiency point.

Changes made

Once the initial investigation had been completed the information was taken to Plains Irrigation Ltd, the company used by Ross and Sue, for a second opinion and to gauge their thoughts on the proposed changes. After many follow up discussions and sharing of information a plan was finalised to upgrade the irrigation system. This involved further changes that went beyond the scope of the original investigation but which has ultimately ended with a better system.

The changes on farm were:

1. Replacing sections of the mainline that were undersized and creating excessive friction losses. Some of the original redundant mainline was dug up and reused where possible.
2. A towable pivot were replaced with a ½ circle 10 span centre pivot watering 90.8 Ha. The towable pivot spans were reused to keep the cost down.
3. Reconfiguring the supply to the irrigators by installing new and discontinuing other sections of mainline to better match the new irrigator configurations. The new ½ circle pivot supply In the reports is solely from the Acton water now fully utilising the quota and the pumps energy used. The pump is now not fighting against the other pumps and is operating as it is designed. There is provision in the new configuration to use the alternative water sources if necessary
4. The Roto-Rainer was renozzled to better match the supply and improve the distribution uniformity.
5. The other three irrigators (fixed 10 span with Z arm pivot, a Pierce 5 span towable pivot and Roto-Rainer are now all supplied from the existing two wells and pumps, one with a VSD⁴) do not operate at once, two of the three irrigators operate together. This maintains correct pressures and flows to each.

The costs to change the system can be broken into two components:

1. The alteration and upgrading of the distribution system. Approximately \$90 per irrigated hectare with a lot of the work performed by the on-farm staff and utilising existing redundant mainline .
2. The new pivot at \$2022 per hectare utilising the old pivot.

The results from these changes are;

- Improved energy efficiency of the Acton pump now operating at its designed duty.
- Pumps not fighting against each other to supply the mainline.
- Better utilisation of the Acton water money spent.
- Improved performance of the irrigators.
- The new ½ circle centre pivot infilled some area so a larger area is able to be irrigated.
- Less labour requirement to operate the system.

Ross and Sue are extremely pleased with how the new system is operating. They stress the key was using the information provided and taking a bigger picture look at the system as a whole to come up with the optimal solution. The energy efficiency investigations certainly kick started the whole improvement of the system and has resulted in better utilisation of both water and energy and improved productivity on the farm.

4. Variable speed drive.