The true cost of irrigation modernisation

– the implications of water, energy & emissions

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- In surface water regions, pressurised irrigation systems will increase energy consumption and emissions, therefore their installation should be considered carefully in light of this.
- In groundwater regions, pressurised irrigation systems can reduce water use, energy and emissions, offering an excellent opportunity for irrigators to reduce resource use and costs.
- This study found that for all irrigation methods (including gravity fed), for surface and groundwater sources, as water application increases, energy use and emissions also increase.

Faced with climatic and political pressures, irrigators are experiencing a reduction in water availability, and are looking for ways to make the best use of their scarce water resources. One way of achieving this is to reduce on-farm water application by installing potentially more efficient pressurised irrigation systems.

The installation of such systems is supported through federal government schemes such as Sustainable Rural Water Use and Infrastructure funding (managed by the Department of Environment, Water, Heritage and the Arts). However, water is not the only factor that should be considered when thinking about converting to a pressurised system, as the energy costs for pumping and the associated emissions can be increased greatly, even as water use is reduced.

Energy costs of irrigation

In areas supplied by surface water using a gravity fed irrigation system, the energy costs to the farmer are essentially free. While there is energy embodied in any system, whether it is in channel and dam construction, bore drilling or pipes and infrastructure, the ongoing operational energy costs are minimal, if not free, in these situations. However, where groundwater is pumped and/or irrigation requires pressure for operation, there are ongoing energy costs in addition to the embodied energy.

Given the increases in energy costs in the past few years, and the uncertainty surrounding both diesel and electricity prices into the future, energy costs for pressurised systems should be evaluated before deciding on any changes to irrigation methods.

As well as the energy cost factor, there is a well established link between fossil fuel use and carbon emissions. The drive to reduce emissions across all industries could see significant impacts in the future for those who may increase their emissions by using more energy.

When making changes to irrigation systems, irrigators need to make sure they are making informed choices, and taking into account not only field scale water savings and capital costs, but also the ongoing associated energy costs.

This study was carried out to explore the impacts of converting traditional gravity fed systems to pressurised systems in surface and groundwater situations in terms of water and energy consumption and the emissions associated with crop inputs. The results can help inform irrigators about modernisation in light of the present climatic and political pressures.

What we did – method

This research project was undertaken on selected farms in the Coleambally Irrigation Area in NSW, and the south east of South Australia (Figure 1), to compare a predominantly surface water sourced region with a groundwater dependent area, respectively.

The farms were varied in terms of crops produced and irrigation methods used. Irrigators were surveyed to understand their crop production practices (eg machinery use, sowing practices), inputs used (eg fertilisers, pesticides) and water applied using their current irrigation method.

To explore the consequences of changing to a pressurised irrigation method, some assumptions were made about system operating requirements (ie pressure, pumping depth and so on) and water use, based on regional information and previous studies.

A model was developed, and this information was used to calculate total energy use and emissions on a per hectare basis using standard methods. The results were used to compare the total amount of water applied and energy consumed for different crops.

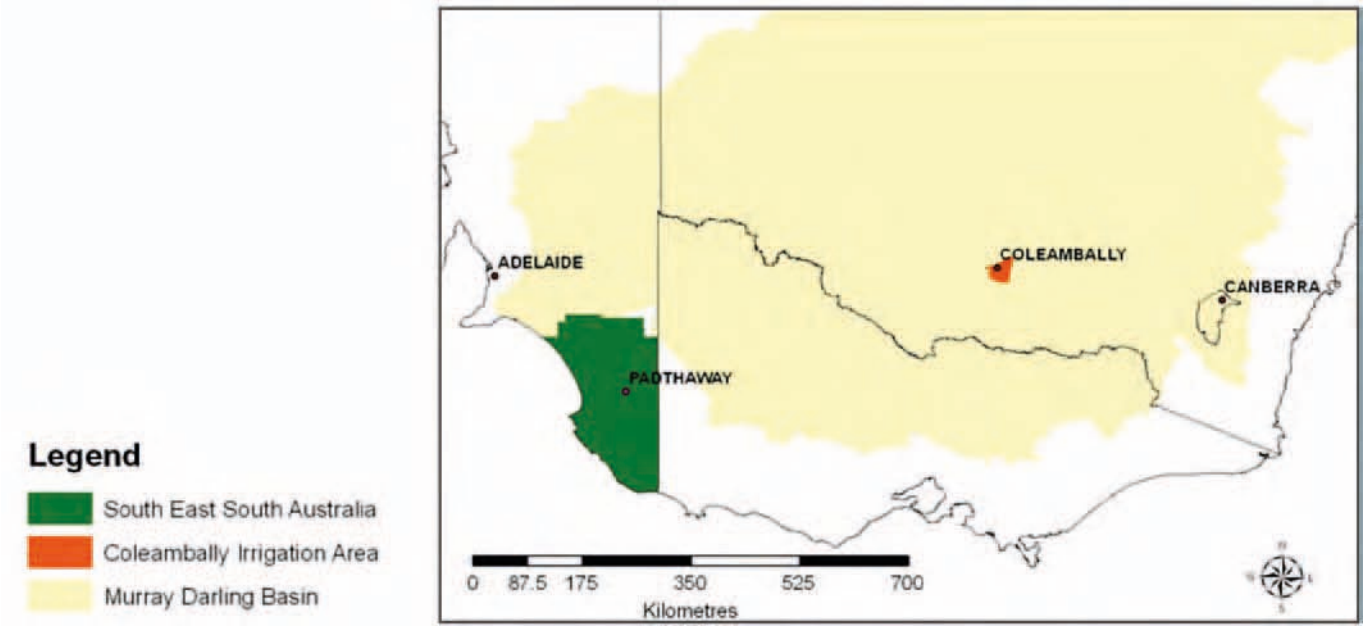

Figure 1. The research compared energy requirements of surface water irrigated farms in the Coleambally Irrigation Area with those of groundwater irrigated farms in south east South Australia.

What we found out – results

Water use

Using data from previous studies and on-farm observations, it was confirmed that water application at the field scale is reduced when pressurised irrigation methods are used, as would be expected due to their higher levels of application efficiency.

None of the case study farms in the Coleambally Irrigation Area had pressurised systems installed. Possible water savings at the field level due to pressurised irrigation in this region were assumed to be 10% for summer crops and pastures, and up to 60% for winter crops, based on a previous study by Dr Shahbaz Khan and his associates in 2008.

In the groundwater region of south east South Australia, several farms were using centre pivot systems, and one farm also had a drip irrigation system installed. In this region, it was observed that water use was approximately halved with the use of centre pivot systems compared to flood, and reduced by a further 32% where drip was used.

Energy use

There is a link between water use and energy consumption; as water application increases, energy use also increases. This is true in both surface and groundwater regions, as shown in Figure 2 (based on observed data).

In the surface water region studied (Coleambally), energy consumption increased greatly with the use of pressurised systems. This is because when gravity fed systems are used, energy use is essentially free. The installation of a pressurised system adds an energy component to the crop production total that was not previously there. These results suggest that total energy consumption could be increased by between 25% and 163% per hectare.

In contrast, in the groundwater region (south east SA) there was a potential to reduce energy use by using pressurised irrigation systems. The large savings in the amount of water applied were enough to reduce energy consumption by between 12% and 44%, despite the need to pressurise the system. There was larger energy savings using drip irrigation, due to less water applied and lower operating pressures, compared to centre pivot systems.

Emissions

As there is a link between energy consumption and emissions, when energy use based on fossil fuel increases or decreases, emissions also follow the same pattern. When accounting for input based emissions, the fuel source used has a major effect on the amount of emissions generated, particularly in the current Australian situation. In most states of Australia (apart from Tasmania), electric pumps have greater emissions than diesel pumps for the same volume of water pumped, due to the electricity generation methods used (ie coal fired power generation). For example, the emissions from one megajoule

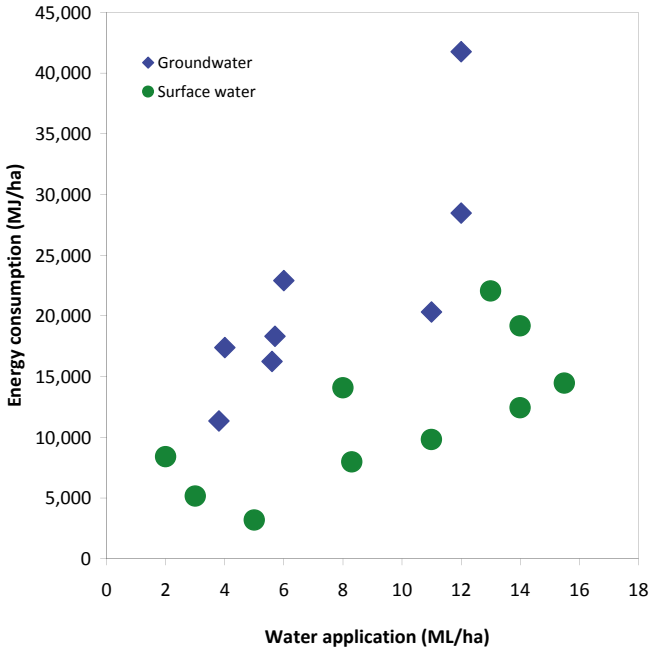

Figure 2. The data collected from case study farms showed that as more water was applied, more energy was consumed. This trend held for both surface water and groundwater application.

of diesel are 75.2 grams of carbon dioxide equivalent (gCO^2-e), and from one megajoule of electricity in NSW are 295 gCO^2-e and in South Australia 272 gCO^2-e (based on Department of Climate Change data, 2008).

What does this mean for irrigators?

While results for individual farms differ, there are general trends that emerge.

In general, as water application increases, energy use and emissions also increase; this is true for all irrigation methods (including gravity fed) and for surface and groundwater sources.

In surface water regions, pressurised irrigation systems will increase energy consumption and emissions. Their use should be carefully considered in light of this.

In groundwater regions, pressurised irrigation systems can reduce water, energy and emissions, offering an excellent opportunity for irrigators to reduce resource use and costs.

Other energy costs

Energy for pumping where systems are pressurised and/or groundwater is used is a dominant energy cost. As well as the quantity of water applied, the design of an irrigation system is very important, as changes to operating pressure and flow rate can greatly influence the quantity of energy consumed. Correct operation and maintenance of all components of the system (including pumps, motors and irrigation system) are essential to minimise energy consumption.

Other important sources of energy inputs include fertiliser (in particular nitrogen), agro-chemicals, machinery diesel inputs and soil improvements. The relative importance of these components depends on the crop selected and the production system in place. The choice of irrigation method can also impact on their use. Therefore, there is a possibility of offsetting potential increases in energy consumption and emissions associated with a pressurised system by managing these inputs.

Other benefits

In addition to water savings, landholders have identified several benefits associated with the use of pressurised irrigation systems.

Yield increases of up to 25% were documented in the south east of South Australia, as well as improvements in total yield and yield quality for some crops; this has also been observed in previous studies.

Additional benefits associated with the use of pressurised irrigation systems include the potential to irrigate more than one crop with mobile centre pivot systems, and increased arable area when on-farm supply channels are eliminated.

There is also evidence to suggest that a reduction in fertiliser use is possible when crops are irrigated with groundwater compared to surface water, although this was not recorded in this study.

A reduction in labour requirements was reported in the groundwater dependent region, and this has also been reported in a study of the Murrumbidgee Irrigation Area (MIA), where 50–80 labour days were saved per year.

Other benefits identified by landholders in both South Australia and the MIA after the installation of pressurised irrigation systems include a reduction in weed management costs associated with less agro-chemical use and less cultivation.

Consider more than water savings

As with any decision, there will be systems that are more suitable than others for a given situation for a variety of reasons. Irrigators may still choose to convert to a pressurised system even though they know that energy costs will increase. The important thing is to be aware of the consequences of conversion by considering more than just water use.

Further information

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The use of pressurised irrigation methods can reduce the water applied at the field level, however, energy costs for pumping and the associated emissions should also be considered.