The irrigation system and energy efficiency

All irrigation systems use energy. The design and maintenance of a system will determine how efficient it is at using that energy.

Correct design and installation and the regular servicing of an irrigation system can:

- reduce water use by 20 to 50%
- save thousands of dollars in water costs
- reduce plant death[i]
- reduce nutrient loss by avoiding over-irrigation
- reduce electricity use associated with pumping and water treatment
- maintain optimum performance, therefore influencing energy costs
- prolong the life of the components
- reduce maintenance costs.

This fact sheet looks at what makes a good irrigation system and the factors that can affect energy efficiency. It provides some simple principles to follow; however, to ensure your system is working at optimum performance, it is advisable to consult an irrigation specialist. The costs of a yearly service are usually returned within the year through reduced plant death.

Physical parameters

Does your application rate meet your crop irrigation requirements? If the application rate does not meet crop demand, both production and pump operation are affected. A poor or low application rate will not only create plant water stress but cause longer pump run times, using more energy. If the application rate is too high, excess water is used, wasting pump and water treatment energy, as well as leaching nutrients from growing media.

Does every plant get the same amount of water? An irrigation system with an incorrect operating pressure or flow rate will also affect plant yield and energy use. Incorrect pressures can alter flow rates, affecting the uniformity of application, which can cause water stress and crop growth variations as well as increase wear on the pumps and irrigation components. Increasing the stress and wear on pumps and irrigation components reduces system efficiency and increases energy use. The irrigation system performance should be adjusted to the operating requirements of the sprinklers or drip emitters being used.

Operating pressures and flow rates are also affected by pipe size. Systems that have been repaired, modified or extended in an ad-hoc manner with incorrect pipe sizes can cause operating pressures to fluctuate and increase friction, causing poor flow rates and damage to pipes or fittings.

How many leaks are there in the irrigation system? Leaking irrigation lines and faulty solenoid valves can significantly reduce the irrigation rate. Unfortunately, small leaks tend to go unnoticed until it is too late and the plants are showing signs of water stress.

A 60-drops-per-minute leak can waste up to 630 litres of water a month, or 7500 litres per year. Ten water leaks in one system can waste approximately 75,000 litres of water each year. This is not just a waste of water but also the energy used to pump and filter the water.

Figure 1: Excess irrigation water pooling in greenhouse

This problem can cause water to pool in the greenhouse, which can increase the greenhouse humidity and trigger climate control systems to expel hot, humid air to the atmosphere, increasing heating costs. Excess water also provides a growing environment for algae and pathogens that can affect water quality and worker safety. Reducing standing water will reduce water and nutrient waste, and the reliance on the climate control system.

Consult an irrigation professional when considering changes to the irrigation system.

Pumps

Water pumps are the most critical component of an irrigation system and can be one of the highest electricity-using devices on the farm. Inefficient or inappropriate pumps will affect the entire irrigation system, reducing the efficiency and uniformity of the whole system. Old pumps can cost more to run, as worn bearings or seals can increase friction and reduce pump efficiency by up to 50%.

Modern multi-stage pumps and variable frequency drives (VFD) are able to adjust flow rates, manage the pump duty cycle to reduce pump run times and reduce energy use by 20% or more.

Figure 2: Old belt drive irrigation pump sitting on ground, never serviced and in poor condition, pumping efficiency < 30%

Simply replacing sprinklers or emitters with new, highly efficient alternatives will not make up for an inefficient or inappropriate pump system. The pump needs to be matched to the type and design of the irrigation system, pipe sizes and crop irrigation requirements.

Figure 3: New twin pump set combining a small and large pump to provide various pressures

Engage a specialist to conduct a full pump efficiency evaluation and check your system. The specialist will be able to tell you how much energy the pumping system is using, what it costs to run and how much you can save if you upgrade to a more efficient system. In most cases, replacing an old inefficient pump will pay for itself in 2 to 5 years.

Irrigation controllers and climate control

Old irrigation controllers have limited options and will use more power than modern units. Modern, highly efficient irrigation controllers will allow various sensors (e.g. rain, soil moisture and solar radiation) to be connected for more precise irrigation control.

For greater control, installing a combined irrigation and climate control system can reduce energy use through more efficient operation and coordination of the various systems. These controllers are highly advanced and will require training to use the full capacity of the programming, but they provide a more accurate control and integration of irrigation and the growing environment. They reduce energy and water use as well as labour time used in adjusting the independent climate systems.

Energy savings of 20% or more can be achieved with a modern control system when programmed correctly[ii].

Water quality and storage: filtration, fertigation and disinfestation

Poor water quality can cause blockages or corrosion in the distribution system and reduce the efficiency of the whole irrigation system. Maintaining good water quality will reduce electricity use by reducing the level of filtration required. High turbidity, water weeds or trash can reduce intake flow rate, increasing pump stress and run time required to transfer water. This will also increase filtration time, decrease filtration efficiency and increase filter service requirements.

Passive water filtration systems (e.g. slow sand/media filters or bio-filters) rely on the irrigation or transfer pump power during operation; therefore, well maintained and efficient pumps will also improve filtration. For these systems to work properly the pumps, pipe size and filtration times need to match the filter system requirements.

Some water sources will require more sophisticated filtration systems, such as reverse osmosis or ultra-filtration, to remove contaminants. Maintaining these systems to manufacturers' specifications will not only ensure consistent water quality but will also reduce operation times, and in turn will reduce electricity use.

Disinfestation and fertigation systems are also affected by poor water quality. High levels of organic matter, nutrients or other agri-chemicals in irrigation water can cause a chemical imbalance that reduces the effectiveness of sanitizing chemicals or alters the nutrient ratios of the fertigation solution. This will cause an increased use of disinfestation chemicals or run times and a greater addition of nutrients to compensate the imbalance. Each system can use a variety of pumps, mechanical stirrers or injection units that will consume energy and require more regular calibration or servicing.

Figure 4: Algae growth on dam indicating high nutrient content and poor water quality.

In modern greenhouse facilities, an irrigation system is more than just a way of applying or moving water. It is integrated with several systems that it can influence or be influenced by; therefore, the operational and energy efficiency of an irrigation system should be addressed in a whole-of-farm approach. Maintaining and servicing all components regularly and ensuring each system is operating to manufacturer specifications will not only reduce energy costs but will also prolong the working life of each component.

For more information and tips on simple ways to reduce energy use, visit this website:

https://sites.google.com/site/greenhouseenergyefficiency/

---

[i] Hunt, D. 2008. Increasing adoption of innovative irrigation and water recycling technologies in Australian nurseries: Final report. Nursery and Garden Industry Association, Epping, NSW.

[ii] Aaslyng, J.M., Lund, J.B. & Ehler, N. 2003. IntelliGrow: A greenhouse component-based climate control system. *Environmental Modelling and Software,18*(7). Available from: http://www.sciencedirect.com/science/article/pii/S1364815203000525#fig5 [Accessed: August 23, 2011].