Insect Control. We have always had a policy of using the safest possible spray that will do the job reasonably well. We now use a Hardi MRY® knapsack mist blower instead of a conventional tank, pump, and boom. We can spray the same area with $^{1}/_{6}$ of the volume of spray. That is an 82% reduction.

SUMMARY

As a result of the above measures, the installation of a variable speed pump, and diligence, Heyne's Wholesale Nursery has been able to reduce the amount of irrigation water used (Table 1).

Table 1. Water use at Heyne's Wholesale Nursery.

Year	Water used (kL)	Saving since 1993/94
1993/94	89,500	
1994/95	81,000	9%
1995/96	64,000	21%

Our situation is unique, because of the adjacent wetlands, however on my recent trip to Fremantle (Western Australia) to the National Nursery & Garden Industry Association (NGIA) Conference, the amount of water recycling technology and the amount of assistance available now amazed me. NGIA development officers are available in every state. The technology is there for all to improve our irrigation techniques now and into the future.

Evaluating an Irrigation System Upgrade©

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INTRODUCTION

As part of a major irrigation system upgrade, Sunraysia Nurseries conducted a test of system efficiency under the Nursery and Garden Industry of Australia (NGIA) "Waterworks" program.

The program consisted of training in assessing existing system output and efficiency, and recommendations for improvements. There were two major areas that were examined:

- An existing shadehouse with overhead "B500" sprinklers on a 4.0 m × 4.5 m spacing.
- An existing group of polyhouses with overhead "Eindor" sprinklers on a 2.0 m × 3.2 m spacing.

METHOD

Catch cans were placed in a grid across the growing areas. Irrigation was allowed to run and the amount of water in each can was measured and analyzed using the Waterwork calculator supplied as part of the training package.

RESULTS

The results of multiple tests showed consistent results. The major issue with these old designs was the poor distribution patterns. The sprinkler heads were not located at the edges of growing areas, so significant numbers of pots (mainly at the edges) were not getting as much water in a given irrigation time. This necessitated longer irrigation times and frequent hand watering. Combined with the older high output sprinkler heads, we were ending up with large amounts of runoff water to process. After evaluating these areas and recognizing the problems, recommendations were made on system alterations to improve water-use efficiency. Major alterations made were:

- Shadehouse — Toro Waterbird sprinklers on a 4.67 m ×4.5 m spacing
- Polyhouse — Toro Waterbird sprinklers on a 5.4 m × 5.2 m spacing

There were also modifications to the pumping and control valves to minimize pressure variation within each section. The irrigation controller and pump were upgraded to incorporate a variable speed drive, which allows multiple sections to be irrigated simultaneously while maintaining pressure at optimum levels. New control valves incorporated adjustable pressure regulators to further ensure stable system output.

Table 1. Results of irrigation system improvements.

	Shadehouse		Polyhouse	
	Old irrigation design	New irrigation design	Old irrigation design	New irrigation design
Mean application rate (mm/h)	14.5	10.7	21.1	9.7
Coefficient of uniformity	79.7%	88.5%	71.0%	82.5%
Scheduling coefficient	2.3	1.2	4.0	1.4

So, after all this, just how much water is being saved? It is clear that the design modifications have lowered the mean application rates, and improved distribution patterns. But what is the actual amount of water being saved?

A single shadehouse irrigation event on a standard irrigation section is typically 4 mm of water. On the old design, this would require 16 min of irrigation, plus an additional 20 min to fully irrigate the driest part of the irrigation pattern, a total of 36 min. On the new design, it would require 22 min, but just 4 min to irrigate the driest part of the irrigation pattern. This is 10 min less pumping time on each section, or about 18,000,000 L total of water in a year.

Likewise in the polyhouses, to apply 4 mm of irrigation with the old design would take 45 min. With the improved coverage, it takes 34 min, 11 min less on every irrigation, which equates to about 250,000 L of water saved in a year.

OVERVIEW OF THE NEW SYSTEM

In the year following the expansion, the nursery had used 13% more water to irrigate 85% more plants. The reduction in output is a saving in applied water costs, and also a reduction in the amount of run-off which needs to be dealt with. The new pump and controller allow more flexibility in planning irrigation. A pressure sensor and auto switch allow irrigation water to be used for hand hoses and tractor filling points, rather than more expensive "town water." Temperature sensors allow for automatic cooling in heat waves, and frost protection in winter.

We have learnt that making savings in water use requires an approach beyond just designing a new irrigation system. The lower output heads of the new system are more prone to wind drift, and on particularly windy days, the distribution pattern still lacks excellent coverage. As yet, hand watering of dry spots is still required, though on calm days is much reduced.

Overall, saving water is a complex process of planning and requires an integrated approach to design and the requirements of the crops being produced.

Water Disinfecting Techniques for Plant Pathogen Control©

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Water for irrigation is becoming harder to get and more expensive. In addition, the environmental performance of industries, including nursery production, is under public scrutiny. Water recycling addresses these issues but introduces challenges to embrace technologies and procedures to ensure plant-safe water reuse. The provision of disease-free water is part of this challenge.

INTRODUCTION

Many water sources for plant production need some form of treatment before the water can be reliably used for irrigation. Water treatment includes avoiding algal blooms, preventing precipitation of solid particles, controlling iron, and water disinfestation.

Water disinfestation is a treatment to reduce the risk of introducing disease via irrigation water and to control bacterial growth in the system. Many disease-causing organisms are easily transported in irrigation water from diseased plants to healthy ones. For example, *Fusarium* and the root rot causing fungi, such as *Phytophthora*, are readily spread.

PRETREATMENT

There are a number of disinfestation techniques available and their effectiveness is affected by different aspects of water quality. Disinfestation will be a lot easier, effective, and generally cheaper if the water is "clean" before treatment. It is a good idea to pretreat the water so that it is free of heavy sediments, floating material, fine colloidal clays, and organic matter. Beardsell and Bankier (1996) provide further detail on monitoring and treatment of recycled water for nursery production.

Heavy Sediments (Sands and Gravel). These can be removed in a sediment trap at the end of open drains. Water passes through a pool and the velocity that is carrying the sand and gravel along is reduced. This makes the sediments fall to the bottom of the pool. The trap needs regular cleaning to remain effective.