

Managing wetlands in intensive agricultural systems

Nursery industry

Water use efficiency and wastewater management drives innovative wetland treatment solution for a production nursery.

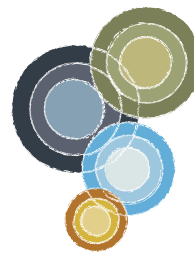
Managing wetlands in intensive agricultural systems

Rivers, creeks, lagoons, springs, ring tanks and dams are all wetlands. In fact, Queensland's beautiful coastline is also wetland.

Intensive agriculture relies on wetlands to support a range of production processes. For instance, wetlands regulate irrigation and stock water quality, provide flood management and erosion control and improve pest management (through wetland vegetation). Aside from their on-farm benefits, they are a place to fish, put the boat in, or swim.

Land use practices have the potential to impact both on-farm and downstream wetlands. To ensure wetlands remain functional, farm practices sometimes need to be adjusted. In some instances, building or modifying wetlands can help with nutrient removal, sediment control and water re-use, among others.

This case study is one of a series developed by the Department of Primary Industries and Fisheries (DPI&F) through the Queensland Wetlands Programme. It demonstrates the benefits of wetlands in improving farm management and incomes, and the farm practices that contribute to wetland health. The series can be viewed in the Managing Wetlands section of *WetlandInfo* (www.epa.qld.gov.au/wetlandinfo).



Queensland Wetlands Programme

The Queensland Wetlands Programme

The Australian and Queensland governments established the Queensland Wetlands Programme to protect wetlands throughout Queensland.

The Queensland Wetlands Programme is lead by the Australian Department of Environment, Water, Heritage and the Arts and the Queensland Environmental Protection Agency. A number of Australian and Queensland government agencies and organisations assist in the Programme's implementation.

The Queensland Wetlands Programme would like to thank Li and Belinda Chang, Damien Parker, John McDonald and David Huett and the following organisation for their contribution to, and support of this product:



Nursery & Garden Industry Queensland

www.ngiq.asn.au



Australian Government



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Queensland
Wetlands Programme

The nursery and its environment

Bau Farm is a 12 hectare production nursery between Lismore and Ballina on the New South Wales north coast. The nursery has extensive stock gardens, a modern propagation facility, outdoor and covered growing areas. It produces many Australian and exotic plants including azalea, camellia (japonica and sasanqua), gardenia, hydrangea, murraya, vireya and rhododendron. Certification under the Nursery Industry Accreditation Scheme was achieved in 1998.

Like many production nurseries, Bau Farm is in an area of mixed land use and relatively small lot sizes. Its location makes the challenge of meeting commercial as well as community objectives more difficult.

Vision for sustainable production

The owner's vision was to combine improved wastewater quality with better water-use efficiency and enhanced visual amenity.

Innovative solutions were implemented to achieve these objectives through a cost-effective, low-energy water treatment system that captures, cleans and recycles all nursery wastewater.

Two 150 cubic metre reed bed or horizontal flow constructed wetlands were installed to treat all the wastewater generated by the nursery.

Irrigation water was directed to a storage dam for holding nursery runoff and stormwater before being released into the treatment wetlands.

Financial assistance was given by the AAA Innovation Program (Australian Department of Agriculture, Fisheries and Forestry) and expert support was provided by Southern Cross University and NSW Department of Primary Industries.

Managing wastewater with Farm Management Systems and BMP

The Nursery Industry Accreditation Scheme Australia (NIASA) guidelines ensure businesses maintain a benchmark standard and commit to continuous improvement. In Queensland these form part of the Nursery and Garden Industry Farm Management System (FMS).

Bau Farm's NIASA accreditation has given them formal recognition of a commitment to best management practice (BMP) and continuous improvement.

Queensland's Nursery and Garden Industry Development Manager John McDonald recommends modern, professional production nurseries or growing media manufacturers use BMP as a foundation for business sustainability. He also indicates that FMS led by industry are flexible enough to allow producers to apply any or all of the programs.

All the programs address risk and support continuous improvement and on-farm change.

Nursery production FMS



The nursery industry Farm Management System (FMS) has three key programs designed for nursery production, supported by formal recognition and on-farm technical support.

The Nursery Production FMS embraces:

- NIASA—Best Management Practice Guidelines. *Nursery Industry Accreditation Scheme Australia. Nursery & Garden Industry 2003.*
- EcoHort™—Guidelines for managing the environment. *An environmental management system for the Australian nursery industry. Nursery & Garden Industry Australia 2006.*
- BioSecure HACCP—Property Biosecurity Program & Hazard Analysis Critical Control Point. *On-farm biosecurity for nursery production. NGIA & HAL 2006.*

The management approach

Wastewater issues

Production nurseries generate wastewater that typically contains nutrient levels above environmental guidelines. These nutrient levels are from applied fertilisers.

Excess nutrients in runoff degrade waterway and wetland habitats, causing algal blooms and reducing water quality. Unmanaged runoff can also expose nursery owners to legal action.

In this case, the owners chose to help meet community objectives for waterway protection by recycling wastewater. Recycling requires specific water quality standards to be met to promote healthy growth of plants.

Production nurseries need to maintain the pH of irrigation water at or near neutral (pH 5.5–6) but excessive nutrients in recycled water can increase the pH with implications for plant health. Plant root pathogens such as pythium and phytophthora reduce plant health. They are common in nurseries and are easily spread in recycled irrigation water. The efficiency of pathogen disinfection processes involving chlorination is reduced by pH levels greater than 7.0, jeopardising the health of nursery stock.

In addition, at high pH levels, pesticides precipitate from solution and settle in the bottom of the spray tank. Overall, high pH levels result in poor pest and disease management across the nursery.

Wastewater management using horizontal flow constructed wetlands

Constructed wetland treatment systems reduce levels of nutrients and pathogens in wastewater (sometimes called water polishing) using microbes, and submerged or partially submerged plants. The treated water can then be reused (Figure 1).

Horizontal flow wetlands use a bed of gravel or rock screenings as a substrate in which microbial organisms and wetland plants grow. Gravity causes wastewater to flow horizontally through the gravel substrate where it comes into contact with microbes that colonise the substrate and the plant roots.

Converted nutrients are released to the atmosphere, held in the wetland substrate or taken up by the plants. The above-ground portion of the plant biomass can be harvested annually (using a brush-cutter) to encourage re-growth and to allow continued nutrient uptake in the growing plants.

The quality of nutrient and pathogen treatment in a constructed wetland is directly related to the length of time the wastewater spends in the wetland system. This is known as **Hydraulic Residence Time** or **HRT**. A two-day HRT means the wetland is able to hold two days of wastewater generated by the nursery, a four-day HRT holds four days of wastewater.

Hydraulic Residence Time, along with a well-designed wetland capable of treating the quantity and quality of the influent water, are considered the two most important factors affecting the performance of the treatment system.

At Bau Farm, a 4.5 ML storage dam was installed to hold runoff water and stormwater, so inflow to the wetland could be regulated. Overloading wetland treatment systems reduces the HRT and treatment efficiency.

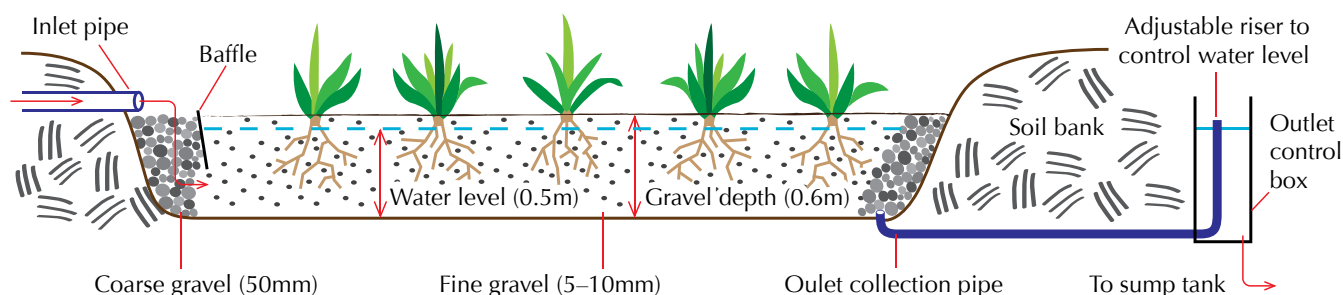


Figure 1: An irrigation runoff and recycling system configuration (reproduced with permission of Dirou et al, 2003¹).

¹ Dirou J, Headley T, Huett D, Stovold G, Davison L (2003). *Constructing a reed bed to treat runoff water: a guide for nurseries*. NSW Agriculture.

Benefits for irrigation

The system at Bau Farm can hold between two and four days of production area wastewater (i.e it has a residence time of two-to-four days). This reduces total nitrogen levels in the wastewater from 10 mg/L to less than 0.5 mg/L. Similar reductions in phosphorous levels can also be achieved. Keeping nutrients at low levels reduces algal growth and assists in maintaining near neutral pH of irrigation water.

Initially, the owners were concerned that the level of plant pathogens in the irrigation water would increase following wetland treatment. Monitoring at trial sites managed by the New South Wales Department of Primary Industries and at Bau Farm show that horizontal flow wetlands do provide some disinfection. In addition, the chance of irrigation water becoming re-infected is minimised by holding the treated water in tanks before re-use.

Bau Farm owners are confident that their wetland system provides some disinfection and have chosen not to continue using their ozone treatment system. However, the Nursery and Garden Industry of Queensland recommend disinfecting recycled water with the use of slow sand filtration (SSF), ultra-violet light or chlorine dioxide prior to irrigation.

Water use and energy efficiencies

Algal blooms caused by high nutrient levels in holding dams can clog pumping equipment with organic matter. This impacts on irrigation costs, as clogged equipment uses more energy and needs more maintenance.

The nursery requires an average of 250 kilolitres per day of irrigation water. Before the wetland was installed, 124 kilolitres of irrigation water (equivalent to 124 cubic metres) left the site daily as runoff.

Prior to establishing the wetland treatment system the nursery relied on bore-water and water extracted from a dam for irrigation. The nursery now captures all its wastewater which is treated by the wetland and stored in tanks for reuse. Other than evaporation and plant transpiration there are virtually no losses of water from the system, representing a significant saving of water, pump energy and maintenance costs.

Water saving systems such as treatment wetlands can help nursery managers achieve Water Efficiency Management Plans (WEMP) that are now required by many water suppliers and local governments in South East Queensland.

So what's the bottom line?

The AAA Farm Innovation Programme funded almost half of the \$130,000 project. Building the dam and setting up the site to capture the wastewater were the most expensive components.

Wetland Construction Manager and nurseryman Damien Parker suggests that most plant nurseries in South East Queensland are likely to have wastewater capture systems and holding dams already in place, which would significantly reduce set-up costs.

Damien believes producers should consider their surrounds, such as soil type and rainfall, when constructing wetland systems. His advice: "keep it simple...try to source the cheapest gravel screenings and wetland plants that are available".

While the wetland system helps provide clean irrigation water, which is good for the stock, it also provides excellent water-use efficiency outcomes. For example, a production nursery buying municipal water at commercial rates, and using a wetland treatment and reuse system, could potentially save thousands of dollars per year in water costs (depending on local government charges).

A cost-benefit analysis (Table 1) of the wetland treatment system at Bau Farm indicates the equivalent annual return is \$18,776 (over 20 years). This includes an annual maintenance cost of \$5,636 (labour and materials) which is comparable to other types of water treatment systems like ozone or slow sand filtration.

The analysis further indicates that the cost of treating nursery wastewater using the wetland system is \$1.21 per kilolitre. However, if the nursery bought water at commercial rates the cost for treating water with the wetland system falls to \$0.36 per kilolitre as a result of the water treatment and reuse capacity of the wetland system.

Production Manager Stuart Arnison says reduced water consumption and not having to worry about pump blockages and cleaning filters were the biggest benefits the wetland system provided.

Knowing that his irrigation supply is clean, has a neutral pH and is relatively pathogen-free gives Stuart confidence that the nursery stock will also be healthy.

Table 1. Estimated costs and benefits of horizontal flow wetland to treat nursery wastewater for irrigation reuse.

| | | Cost per KL |
|---|------------------|---------------|
| Total amount of water used by nursery per year | 34,968 KL | – |
| Amount of water saved per year using a treatment wetland (Assumes 50% reuse of captured and treated irrigation water) | 17,480 KL | – |
| Amount of nutrients (N&P) removed from irrigation wastewater per year | 115kg | – |
| Annual cost of treating wastewater using wetland over 20 years (includes capital establishment and maintenance) | \$18,776 | \$1.21 |
| Estimated saving in water costs per year* (If an additional 17,480KL from a commercial water supply is required). *(\$0.85 = average cost per KL for commercial supply of municipal water obtained from 5 SEQ water providers) | \$14,861 | \$0.85 |
| Net annual cost of wetland treatment system (annual cost of wetland system less savings from water reuse) | \$3915.00 | \$0.36 |

DPI&F have developed an electronic spreadsheet—Wetland Economic Assessment Tool (WEAT)—to help users calculate treatment performance and financial outcomes. WEAT will generate outcomes based on your construction costs and treatment values.

WEAT can also generate the costs and benefits of using a wetland to treat nutrients. This can help nursery managers in making water treatment decisions and develop funding applications.

To access WEAT, information on wastewater management and wetland treatment systems contact your local Nursery and Garden Industry of Queensland representative.

Sustainable outcomes for nursery water management and natural wetlands

Bau Farm owners say the overall improvement in the condition of the site and visual amenity has to be good for any business. Importantly since the installation of the artificial wetland site runoff has been virtually eliminated, a positive for the natural wetlands adjacent to the site. By reducing nutrient and sediment loads, the farm is contributing to better catchment water quality and biodiversity.

The wetland treatment system at Bau Farm is a good example of how artificial wetlands which mimic the processes of natural wetlands, along with best practice irrigation and drainage management, can be linked to industry Farm Management Systems and accreditation schemes to achieve profitable and sustainable outcomes.

For more information on how to protect or rehabilitate wetlands, visit Managing Wetlands at www.epa.qld.gov.au/wetlandinfo



Acknowledgments

Li and Belinda Chang—Bau Farm

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David Huett—New South Wales Department of
Primary Industries

Other Products

Managing wetlands in intensive agricultural systems—
cane production

Managing wetlands in intensive agricultural systems—
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or contact:

DPI&F Business Information Centre
on **13 25 23** (weekdays 8am to 6pm)

Email: callweb@dpi.qld.gov.au

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