

# Integrating Bioreactors into Substrate-Based Berry Production

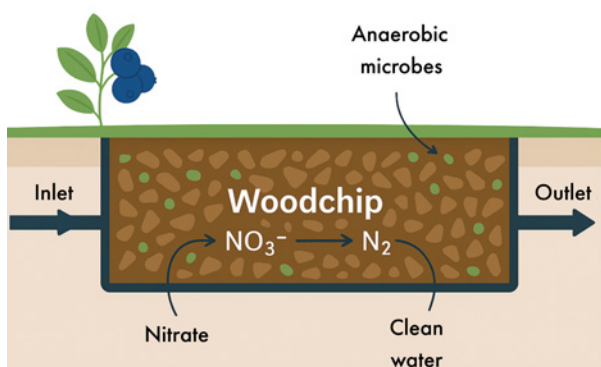
Melinda Simpson, Blueberry Development Officer NSW DPIRD

Nutrient runoff is a significant challenge for berry growers using substrate systems. As part of the NSW Storm and Flood Industry Recovery Program, NSW DPIRD, in collaboration with Berries Australia, is trialling bioreactors as a practical mitigation strategy for nitrate runoff in raspberry production systems.

Substrate berry farming provides many agronomic benefits, however there are concentrated nutrients in the drainage water which if left unmanaged can cause environmental issues such as algal blooms, oxygen depletion, and fish kills in nearby waterways.

## Bioreactors

Bioreactors use the natural process of denitrification to remove nitrate from drainage water; the most used material is woodchip. In this process, microbes consume the carbon in woodchips and convert nitrate ( $\text{NO}_3^-$ ) into nitrogen gas ( $\text{N}_2$ ), which is safely released into the atmosphere (Figure 1).



**Figure 1. Schematic of a Denitrifying Bioreactor**

## How Bioreactors Work

- Drainage water is directed into a trench or tank filled with carbon-rich media (typically woodchips)
- Under low-oxygen (anaerobic) conditions, denitrifying bacteria thrive
- As water flows through the bioreactor, bacteria use the carbon as an energy source and convert nitrate into nitrogen gas

## Trial Implementation in Corindi, NSW

Over the last two years, trial work looking at the nitrogen removal of bioreactors compared to reed-beds has been running at Wollongbar Agriculture Institute. This work has shown that that under the right conditions, the bioreactors can remove around 95% of nitrates in runoff water.

To evaluate the effectiveness of bioreactors in a commercial farm setting, a unit was installed on a large-scale raspberry farm on the NSW Mid North Coast. Raspberry pots were drained into a gutter capture system, which directed runoff into the bioreactor.

There are limited options for collecting run-off in field for such a large area. In this situation the corflute channel system was chosen but there are also other options for blueberries such as the Garden City Plastics (GCP) new capture system for their 28L round pots.



**Figure 2. Raspberry pots were drained into a gutter capture system (A) to direct runoff into the bioreactor (B) Piping installation transferring runoff to the bioreactor**

Photo credits: Gaius Leong, Melinda Simpson

## Bioreactor installation

The installation of the bioreactor took 1.5 days to complete and was built to handle run-off from 4,200 raspberry pots. The bioreactor is 25m long x 4m wide x 0.6m deep and holds 60m<sup>3</sup> of hard wood chip (Figure 3, 4). A phosphate filter was also installed; this is 0.7m deep, 2.4m long and 1.25m wide, and contains 2m<sup>3</sup> of dolomite (Figure 5).



**Figure 3. Construction of the bioreactor involved digging a pit 25m long x 4m wide x 0.6m deep (A) and lining it with thick black plastic (B) to prevent seepage of the runoff**

Photo credit: Melinda Simpson



**Figure 4. The pit was filled with hard wood chip (A) and enclosed with the thick black plastic (B)**

Photo credit: Melinda Simpson



**Figure 5. A second pit 0.7m deep, 2.4 m long and 1.5m wide was dug and filled with dolomite to create a phosphate filter (A). Both the bioreactor and phosphate filter were covered up with top soil to allow the grass to regrow (B)**

Photo credit: Melinda Simpson

## Measurements

To measure the performance of the system, water samples will be collected from three locations across the system; the common inlet, the outlet of the bioreactor and the phosphorus filter. The water samples will be tested for total nitrogen, ammonia, nitrate + nitrite, total phosphorus and phosphate.

Temperature, pH, redox potential\* and dissolved oxygen measurements will be completed in the field, such that the result is reflective of the conditions within the treatment system.

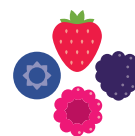
\*Redox potential (also known as oxidation or reduction potential) is a measure of the tendency of a chemical species to acquire electrons from or lose electrons to an electrode and thereby be reduced or oxidised respectively. Redox potential is expressed in volts (V). In this context, it helps assess the oxidising or reducing agents present in water, such as chlorine or oxygen.

## Next steps

The successful implementation of a nitrate-removal bioreactor for raspberries highlights the viability of using denitrification as a practical farm solution. With the support of industry and the continued development of extension tools and demonstration sites, bioreactors can become a key part of nutrient management in Australian berry production.

## Acknowledgements

This project was funded under the Storm and Flood Industry Recovery program, jointly funded by the Australian and NSW governments through the Disaster Recovery Funding Arrangement. It is a collaboration between the NSW Department of Primary Industries and Regional Development and Berries Australia.



**berries**  
AUSTRALIA