

# Woodchip Bioreactors for Agrochemical Removal from Recycled Irrigation Water

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Great Lakes Expo

December 10<sup>th</sup>, 2024

## Introduction

Traditionally woodchip bioreactors have been used to reduce nitrate in agricultural runoff water. Our previous research expanded the use of bioreactors to removing phosphate and pesticides from runoff water. Our current research is investigating bioreactors for use in recycling irrigation systems to remove pesticides but retain valuable nutrients. The key challenge is to remove as much of the pesticides as possible while retaining the most nutrients possible. We have additional projects investigating removing both nutrients and pesticides for the instances where water will be released from a production facility.

## How They Work:

1. **Water Flow:** Irrigation return water flows through a tank filled with woodchips. The tank size and water flow rate can be modified to achieve a specific hydraulic retention time (HRT). HRT measures how long water stays inside a treatment system before leaving it.
2. **Microorganisms:** As the water passes through, naturally occurring microorganisms (bacteria, fungi, etc.) living in the woodchips break down harmful agrochemicals.
3. **Filtration:** The woodchips act like filters, trapping particles and providing a habitat for microorganisms to do their work. Over time, the pollutants are cleaned out of the water.

## Why They're Useful:

- **Cost-Effective:** Once set up, they are low-maintenance and can help manage water runoff without needing expensive chemicals or equipment.
  - The 300 gallon bioreactor treats over 15,000 gallons of water per day
  - The 600 gall bioreactor treats over 25,000 gallons of water per day
  - Cost is the price of a water holding tank and the woodchips to fill them, less than \$1,000 for the 600 gallon bioreactor.
  - Small footprint, thus easily sited in production facilities. Larger (taller) tanks can be used for greater treatment volumes with minimum additional space.
- **Eco-Friendly:** Woodchip bioreactors use natural processes to clean water, helping protect the environment by preventing pollution from reaching rivers and lakes.
- **Sustainable:** They can last for several years (up to 15 years), and the woodchips can be replenished or replaced when needed.

## Research Overview

In Experiments 1 and 2, simulated runoff continuously runs. It contains nitrate, phosphate, and the pesticides acephate, atrazine, bifenthrin, chlorpyrifos, cyazofamid, oxyfluorfen, sulfoxaflor, and thiophanate-methyl. Experiments 1 and 2 are laboratory-scale.

### Experiment 1: Seeding New Bioreactors

Woodchips collected from an established bioreactor were used to seed new bioreactors at varying percentages (0%, 5%, 10%). The new bioreactors are evaluated at three hydraulic retention times (HRT): 4HRT, 14HRT, and 24HRT.



### Experiment 2: Two-Stage Systems

These experiments utilize two-stage bioreactors, with some treatments consisting of the first stage unaerated and the second aerated. In contrast, other treatments consist of the first stage aerated and the second unaerated. The evaluation is also done at

4HRT, 14HRT, and 24HRT.

### Experiment 3. Commercial-Scale Bioreactor

Experiment 3 uses a two-stage system but has been scaled up to use 300-gallon and 600-gallon bioreactors to treat recycled water for irrigation at a wholesale Michigan greenhouse.



Funding provided by

