

# Bioreactors chip away at nitrogen pollution

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Contractors place concrete bioreactor liners into the trench. Credit: Michelle Soupir

Bioreactors are underground trenches filled with woodchips. They have been gaining traction as a tool to remove nitrogen from the water in

agricultural settings.

The [water](#) draining from fields is channeled into the bioreactors. Natural microbes living on the woodchips remove the [nitrogen compounds](#) in the water as it flows through.

Because it is the bacteria that do this water-cleaning process, it's called a biological process, hence the name [bioreactor](#).

The water exiting the bioreactors has much less nitrogen, making it healthier for the environment.

In a new study, researchers tested parameters that could help estimate the working lifespan of these bioreactors. The research was published in *Agrosystems, Geosciences & Environment*, a publication of the American Society of Agronomy and Crop Science Society of America.

"Our goal is to give farmers and other stakeholders a better understanding of how long these systems will last when they are used in the field," says Abby Schaefer, lead author of the study.

The study spanned two years. The researchers tested nine bioreactors. By the end of that [time](#), all the bioreactors were still effectively removing nitrogen from the water.

Removing nitrogen from the drainage water in agricultural settings is crucial because nitrogen can be a double-edged sword.



Natasha Hoover (left) and contractors (Con-Struct Inc) install the culverts to be used as sampling wells. Credit: Michelle Soupir

Crops need nitrogen to grow and produce food. But too much nitrogen in the wrong place can cause problems.

Excess nitrogen can contaminate groundwater and waterways. In these [aquatic environments](#), too much nitrogen can fuel harmful algal blooms.

The algae quickly use up all the oxygen in water bodies. This can lead to dead zones, which are areas with too little oxygen to support life.

Woodchip bioreactors are one way to reduce the amount of nitrogen entering waterways. The bioreactors have several advantages over other denitrifying techniques.

Bioreactors can consistently reduce 30-50% of nitrogen compounds from water. "Some bioreactors can achieve even higher reductions," adds Schaefer.

"Bioreactors require very little land to be taken out of crop production," says Schaefer. "Plus, they require very little maintenance."

The bioreactors also do not impact the effectiveness of farm tile drainage systems. This means water in fields can still be drained to help prevent flooding.

One challenge with woodchip bioreactors is the settling and breakdown of the woodchips. This affects how efficiently the bioreactors work.



Concrete linings are partially filled with woodchips during installation and monitoring wells are visible. Credit: Michelle Soupir

The researchers found that the woodchips closer to the entryway of the bioreactors settled and broke down faster than woodchips further inside.

That's an important finding. Woodchips near the bioreactor inlets can be replenished without having to excavate the entire bioreactor.

Additionally, the researchers determined that the first three-quarters of the bioreactors was where most of the nitrogen compounds were removed from water.

That means replacing the woodchips near the entry point of a bioreactor could prolong the lifespan.

The team also studied the amount of time any given drop of water spends within the bioreactor. This measurement is called the hydraulic retention time.

"Hydraulic retention time is one of the main criteria for designing denitrifying bioreactors," says Schaefer. "We wanted to understand the impact the retention time has on all facets of bioreactor performance."

The researchers tested three different hydraulic retention times: two hours, eight hours and 16 hours. Most changes seen in the bioreactors over time were similar for the different retention times tested.

However, woodchips decomposed faster when the hydraulic retention time was two hours. But those bioreactors still removed [nitrogen](#) compounds from water effectively.

Schaefer and colleagues are now aiming to have a better understanding of how the bioreactors work over even longer periods of time.

**More information:** Abby Schaefer et al, Impact of flow on woodchip properties and subsidence in denitrifying bioreactors, *Agrosystems, Geosciences & Environment* (2021). [DOI: 10.1002/agg2.20149](https://doi.org/10.1002/agg2.20149)

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