How the humble woodchip is cleaning up water worldwide

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Credit: University of Illinois at Urbana-Champaign

Australian pineapple, Danish trout, and Midwestern U.S. corn farmers are not often lumped together under the same agricultural umbrella. But they and many others who raise crops and animals face a common problem: excess nitrogen in drainage water. Whether it flows out to the Great Barrier Reef or the Gulf of Mexico, the nutrient contributes to harmful algal blooms that starve fish and other organisms of oxygen.

But there's a simple solution that significantly reduces the amount of nitrogen in drainage water, regardless of the production system or location: denitrifying bioreactors.

"Nitrogen pollution from farms is relevant around the world, from corn and bean farms here in Illinois to sugarcane and pineapple farms in Australia to diverse farms bordered by ditches in Belgium. We're all dealing with this issue. It's really exciting that bioreactors are bringing us together around a potential solution," says Laura Christianson, assistant professor in the Department of Crop Sciences at the University of Illinois and lead author on a new synthesis article accepted for publication in *Transactions of the American Society of Agricultural and Biological Engineers (ASABE)*.

Denitrifying bioreactors come in many shapes and sizes, but in their simplest form, they're trenches filled with wood chips. Water from fields or aquaculture facilities flows through the trench, where bacteria living in wood chip crevices turn nitrate into a harmless gas that escapes into the air.

This edge-of-field conservation practice has been studied for at least a dozen years, but most of what scientists know about nitrogen removal rates is based on laboratory replicas and smaller-scale experimental setups. The USDA's National Resource Conservation Service published a set of standardized bioreactor guidelines in 2015, based in part on Christianson's early field-scale work, and now more and more U.S. farmers are adding bioreactors. They're catching on in other countries, too.

The ASABE article is the first to synthesize the available data from full-size bioreactors on working farms across the world.

"After gathering all the data, the message is bioreactors work. We've

shown a 20-40% reduction in nitrate from bioreactors in the Midwest, and now we can say bioreactors around the world are pretty consistent with that," Christianson says.

She adds bioreactors, like all conservation practices, have their limitations, but nitrous oxide emissions aren't one of them.

"People are worried we're just transferring nitrate in water for nitrous oxide, which is a greenhouse gas. We don't know the full story on nitrous oxide with bioreactors yet, but we can say with good confidence they're not creating a huge nitrous oxide problem," she says. "They're just not."

Christianson says farmers frequently ask her about monitoring the water in bioreactors, so she and her co-authors detail the process in the ASABE article. She also partnered with the Illinois Farm Bureau to create a series of step-by-step videos explaining how to test the water.

"For monitoring, there are two parts. You have to know how much water is flowing through the bioreactor and how much nitrogen is in the water," she says.

The short videos, which are aimed at non-researchers such as farmers and water quality volunteers, break the process down into five steps. Christianson notes her students, postdoctoral researchers, and lab staff all pulled together to create the series.

The videos are available at www.youtube.com/playlist?list= … 4Di-8AnP8Q1MJkVVd91s .

Christianson, who may just be the world's biggest cheerleader for bioreactors, admits the monitoring guidelines and video series are a little self-serving.

"We included recommended monitoring approaches so that more people will build them, and then more people will monitor them. And then we'll have more data to show how well bioreactors work and how we can make them work better."

More information: Laura E. Christianson et al, Effectiveness of Denitrifying Bioreactors on Water Pollutant Reduction from Agricultural Areas, *Transactions of the ASABE* (2021). DOI: 10.13031/trans.14011

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