Injecting manure into growing cover crops can cut pollution, support corn crops

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A dairy manure tanker with shallow disk injectors used for injecting liquid dairy manure into no till farm fields. Credit: Sailesh Sigdel/Penn State

Nitrogen in the soil, where plants can readily utilize it, benefits crop growth and health. However, nitrogen leaving the soil—whether through leaching into the groundwater table, flowing with surface runoff into streams or escaping into the air as ammonia or in nitrous oxide emissions—is detrimental to the environment.

Nitrogen management is a concern for dairy farmers, especially those in Pennsylvania and elsewhere in the U.S. Northeast who use manure as a fertilizer and employ no-till agriculture for improved soil health, lower fuel and labor costs, less dust and erosion, and better water conservation.

To better guide these farmers, a team of Penn State agricultural scientists conducted a new study on dairy manure management strategies for ecosystem services in no-till crop systems. In findings recently published in the *Agronomy Journal*, they report a new strategy that achieves multiple conservation goals while maintaining corn yield: injecting manure into a growing cover crop in early spring.

"Applying manure early in the spring synchronized with a growing cover crop, when temperatures are cooler, can reduce ammonia and nitrous oxide emissions compared to later in the spring when temperatures are warmer, and the cover crop has been terminated," said first author Sailesh Sigdel, a doctoral degree candidate in agricultural and environmental plant science. "This practice offers a potential strategy to simultaneously achieve multiple conservation and agronomic goals."

Many no-till dairy farmers grow winter crops, such as cereal rye or annual ryegrass and red clover, between corn and forage crops grown for cattle feed, noted research team leader Heather Karsten, associate professor of crop production/ecology in the College of Agricultural Sciences.

A gas analyzer connected to a vented static chamber used in this study to measure nitrous oxide emissions from a research plot. Credit: Sailesh Sigdel/Penn State

"Cover crops are grown to increase soil organic matter and improve soil fertility by capturing excess nutrients after a summer annual crop is harvested," she said. "They also help prevent soil erosion, limit nutrient runoff, improve soil structure and can even help suppress weeds."

The surest way to prevent nitrogen loss as ammonia gas and nitrogen-laden runoff is to inject liquid manure below the surface of the ground, Karsten said, explaining that this approach is considered a best

management practice to lessen agricultural pollution in the troubled Chesapeake Bay watershed, to which Pennsylvania belongs. But it's not a perfect strategy.

"While manure injection typically conserves ammonia, we also know that conserved nitrogen can contribute to increased emissions of nitrous oxide—a potent greenhouse gas that is contributing to climate change—through a process in the soil known as nitrification and denitrification," she said.

"In 2022, about 75% of U.S. nitrous oxide emissions were from agriculture. So, our research focused on how to reduce those emissions."

In experiments conducted at Penn State's Russell E. Larson Agricultural Research Center, the researchers compared four dairy farming scenarios. They evaluated early spring surface broadcasting and liquid dairy manure injection for a growing cover crop, as well as with late-spring applications for a cover crop that was terminated by an herbicide.

"Our study found that when manure was injected into live cover crops in early spring, it reduced nitrous oxide loss by 55% while maintaining yields compared to the current recommended injection practice of applying manure after terminating cover crops before corn planting," Sigdel said.

"This approach offers a potential win-win manure and cover crop management strategy, achieving both agronomic and environmental goals."

More information: Sailesh Sigdel et al, Can manure application method and timing with cover crops reduce NH_3 and N_2O gas losses and sustain corn yield? *Agronomy Journal* (2024). DOI: 10.1002/agj2.21644

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