Science Societies

Fugitive methane escapes from farms via anaerobic digesters

By Megan Sever

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Anaerobic digester. Source: Wikimedia Commons/Vortexrealm.

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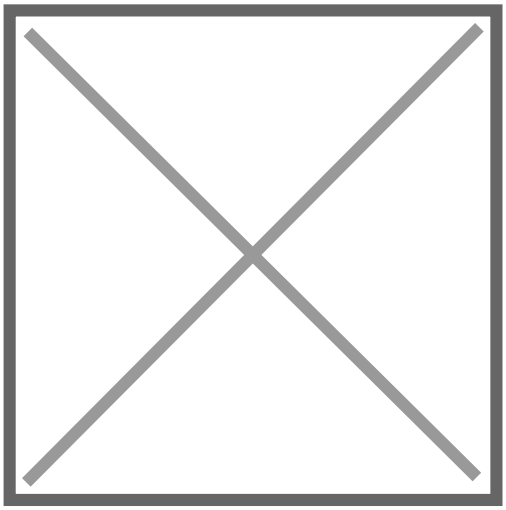
- Each year, farms, especially dairy farms, produce tons of methane, a potent greenhouse gas.
- Some farms have started to capture some of the methane they would otherwise release using systems reliant on anaerobic digesters.
- Since these systems don't capture all of the gas produced on a farm, new research in the Journal of Environmental Quality was conducted to determine how much methane is leaking—and thus whether these systems are as environmentally net positive as thought.

It sounds like a tagline from a high-stakes action movie: Fugitive methane escapes from farms via anaerobic digesters. The reality is certainly high stakes. After all, methane is a potent greenhouse gas that has proved hard to fully measure. Scientists know that farms, especially dairy farms, produce tons of methane each year. Some farms, however, have started to capture some of the methane they would otherwise release and to use it to produce electricity, using systems reliant on anaerobic digesters. These systems don't capture all of the gas produced on a farm, and some that they do capture still escapes. To determine how much methane is leaking—and thus whether these systems are as environmentally net positive as thought—scientists tracked these so-called fugitive emissions at a dairy farm over five years. Their results, published in the *Journal of Environmental Quality* (**https://doi.org/10.1002/jeq2.20052**), showed a surprisingly clear trend that fugitive emissions increase or decrease based on the types of waste material used in the digestion process.

Manure, especially on large dairy and hog farms, is a sizeable source of atmospheric methane. Some of that methane production can be reduced, however, by the installation of anaerobic digester systems (ADs), which use the methane to produce electricity.

Anaerobic digester systems are generally good for the environment, says ASA member Ray Desjardins, a micrometeorologist and principal research scientist at Agriculture and Agri-Food Canada in Ottawa, Ontario, who was not involved in the new study. There's no question that ADs remove and use methane that would otherwise leak out into the air, he says. They also produce electricity that would otherwise have to come from somewhere else, potentially reducing fossil fuel use.

But previous studies had indicated that fugitive emissions can be significant, says ASA and SSSA member Claudia Wagner-Riddle, an agrometeorologist at the University of Guelph in Guelph, Ontario and co-author on the new study. So she and her team, master's student Zachary Debruyn and research scientist Andrew VanderZaag of Agriculture and Agri-Food Canada, wanted to track background emission concentrations from a dairy farm, which would include fugitive emissions, to see how they changed over time—through the seasons with varying weather and as the farm used different materials in the AD system.



The wind speed measurement tower is shown in the foreground (right), and the air sampling tower is shown to the left with the anaerobic digester as well as part of the dairy barn and generator building in background (from l to r). Source: Claudia Wagner-Riddle.

The team partnered with a local dairy farm with about 150 cows, about an average farm size in Ontario, Wagner-Riddle says. Prior to the AD system being installed, she and her colleagues set up 4.5-m-tall towers around the farm to track concentrations of methane every half hour around the clock. The area of prime interest was near the 30-m-diameter cylindrical holding tank for the manure. The reactors were installed a little over a year after the team started tracking methane. The system now involved the AD reactors where manure and off-farm food waste were mixed and held at a constant temperature to promote biological activity as well as the tank where the byproduct digestate (a nutrient-rich slurry that can be used as fertilizer) was stored after leaving the reactors.

The team tracked methane concentrations at four heights on the towers (from 0.25 m above the tank surface to 4.5 m) around this system for the next several years. They found fugitive emissions at all times during the study, revealing that although ADs do produce electricity, some of the methane produced was also released to the atmosphere. More importantly, Wagner-Riddle says, the measurements also revealed a very clear trend: More methane escaped when more food waste materials—especially chicken and beef processing waste—were used in the digester.

Methane concentrations were very similar for the storage tank prior to installing the AD system and after, only markedly increasing once larger amounts of off-farm food waste started being added.

Off-farm materials like food waste are added to ADs to increase electricity production and make the system more economical, Wagner-Riddle says. “The trick is to make sure that there are no leaks in the system so that production and capture are maximized.”

The team found that weather and seasonality played little role in emission concentrations. It was all about the materials put into the tanks. Changing the feedstock, as the farmer did throughout the study, was bound to affect the methane concentrations, Desjardins says. “You have to have a steady-state system,” he says, “or else you'll see large fluctuations in the concentrations of methane like they did in this study.”

Feedstock “matters enormously,” Desjardins says.

Although the fugitive methane concentrations were much higher for the food waste than just manure, Wagner-Riddle says, a life cycle analysis the team performed but hasn't published yet shows that it's still a net positive: Emissions are still less than they would be if the food waste were instead put in a landfill. So big picture, it's still

beneficial.

But it does bring home the idea that we must carefully manage AD systems, she says. In order to maximize energy production and minimize methane losses to the atmosphere, scientists need to provide support and information to farmers and producers to help them get the most out of their systems.

Anaerobic digester systems could change the greenhouse gas picture for farms around the world. They're used sparingly in Canada right now but are widely used in Europe, Wagner-Riddle says. In the U.S., there are 254 operational ADs on livestock farms, mostly dairy and hog farms, according to the USEPA/USDA program AgSTAR. In 2018, those farms reduced greenhouse gas emissions by 4.33 million metric tons of carbon dioxide equivalent and produced 1.13 million megawatt hours equivalent.

But more than 5,400 swine and 2,700 dairy farms in the U.S. are great candidates for an AD system, according to AgSTAR. The best candidates—those most likely to see a positive financial return on investment—are dairy farms with more than 500 cows and swine farms with more than 2,000. If those all were to install ADs, they could generate 16 million megawatt-hours of energy per year, reducing greenhouse gas emissions significantly.

Dig deeper

Check out the original *Journal of Environmental Quality* article, "Increased Dairy Farm Methane Concentrations Linked to Anaerobic Digester in a Five-Year Study," at **https://doi.org/10.1002/jeq2.20052**.

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