May 2021

Manure Monday

Join us on May 10th at noon for a discussion on Anaerobic Digestion. We'll review some AD basics, cover some of the policies initiating renewed interest in digestion technologies, and look at some economic modeling to understand what it takes to reach economic feasibility.
You can find more information and sign up here.

Anaerobic Digestion for Odor Control

Everyone poops. An elephant makes a big poop. A mouse makes a tiny poop. And so, the story goes. No matter who is doing the pooping, how we manage it is critical.

Anaerobic digestion was brought to the forefront in the news recently as the Iowa State House passed House File 522, a bill related to anaerobic digesters. First, what is the purpose of the bill? This bill is about odor control. It offers anaerobic digestion as an alternative means to meet odor control requirements that apply to the largest livestock farms in Iowa. Previously, these farms had to aerate their manure or use solid manure systems. Should aerobic digestion count? The research sure says so; biologically processing potentially odorous compounds into the odorless methane is effective, reducing odor by 75 ± 23%.

More importantly, this bill inspired a conversation on anaerobic digestion - both the good and the bad. Anaerobic digestion is the breakdown of organic material without oxygen. While this process happens naturally in every liquid manure storage or saturated soil, we typically refer to a controlled system where the generated biogas is captured and used when talking about anaerobic digestion.

So why use anaerobic digestion? Taking animal manures, human waste, and food waste and organically breaking them down can play an essential role in developing solutions to the challenging issues we face in Iowa and around the country:

- Capturing methane and converting it into Renewable Natural Gas (RNG), rather than letting it go into the atmosphere, reduces our carbon footprint.
- It offers a low energy method to clean up industrial waste streams, generate potential revenue for cities and municipalities, and improve nutrient separation from treated wastewater.
- Creating a distributed source of renewable and dispatchable power for the grid can be tapped into high usage times to help existing wind and solar power.
- Provide new revenue sources from RNG, nutrient credits, and carbon credits through the Low Carbon Fuel Standard (LCFS) and developing carbon credit.

Digesters are complex systems – they require high capital investment, time, commitment, and effort to succeed. History has shown us digesters are challenging. They aren't always simple to operate. Digesters aren't something that you set, place, and ignore, and they aren't cure-alls. Finding success will take committed partnerships – farmers, cities, municipalities, and a new industry devoted to helping these systems function. Climate credits, advanced gas cleaning systems, and lessons learned from previous attempts have led to improved success opportunities.

Anaerobic digestion is hard – economics, science, and hard work have to come together to make it successful. But can the benefits outweigh the costs? The long-term sustainability and viability of agriculture are critical. We believe anaerobic digestion can be part of a holistic solution that helps reenvision Iowa agriculture and redefine the Midwest landscape. Digestion isn't alone in addressing this issue. But it is a piece of a larger puzzle to keeping Iowa vibrant, helping feed and clothe the world, and fostering a greener tomorrow.

How does Anaerobic Digestion Impact Manure Nutrient Management?

With interest again increasing for anaerobic digestion, it is a great month to review how using anaerobic digestion would impact a farm's nutrient balance. Anaerobic digesters conserve N, P, and K values in the digestion process – what you put in, comes out. The goal is to turn organic matter in the manure into methane, so, in theory, the nutrients stay in the manure. Nutrient conservation is at least reasonably accurate, though there are a few caveats. In manure, we often discuss nitrogen availability, with swine manure estimated at 90-100% first-year available and poultry litter being 50-60% available (see table 1 in PMR 1003 Using Manure Nutrients for Crop Production). Running manure through an anaerobic digester increases the organic matter (relative to storage in a manure tank), releasing more of the nitrogen from proteins and amines into an ammoniacal-nitrogen form and increasing initial availability at the time of manure application.

In addition to more available nitrogen in the manure, typically, the pH of the manure increases (more basic). These changes make ammonia in the manure slightly more vulnerable to volatilization during storage and subsequent land application. More than that, manure solids destruction during anaerobic digestion reduces the likelihood of the manure forming a crust and increases ammonia volatilization. What happens during anaerobic digestion needs to be considered at a system level and how it impacts the other components of the digestion system.
Digestion also impacts phosphorus; the higher ammonia concentrations and more basic pH leads to higher opportunities for precipitation of dissolved reactive phosphorus (DRP) into mineral forms. These changes can reduce immediate phosphorus loss from the first rainfall event after application. Injection, controlling soil disturbance, managing soil test phosphorus, and preventing erosion are critical for phosphorus control and have a more significant impact.

In general, the digestion of animal manures generally has only a slight effect on farm nutrient cycles, altering the loss mechanisms of nitrogen and the phosphorus forms in the manure slightly. The addition of crop residues with manures doesn't change the total amount of organic manures but modifies flows within the farm by changing availability and application timing. Dedicated energy crop digestion or adding new substrates from off-farm adds to organic nutrients to be managed. In this regard, a paper to check out and consider is Effects of anaerobic digestion on digestate nutrient availability and crop growth: A review.

There are a few other items to consider: odor control, pathogens, nutrient consistency, and organic matter.
Odor control: Digesting manure turns volatile organic compounds into carbon dioxide and methane, both of which are odorless. Some extra nitrogen is converted into ammonia, which, while an odorant, tends to have lower odor intensity than amines, which is what they otherwise would be. Similarly, sulfur is converted to hydrogen sulfide, but this tends to have lower odor intensity than many organic sulfur compounds.
Pathogens, viruses, and microbes: We usually see a two order of magnitude reduction. If well digested (often with higher temperatures and thermophilic conditions), a three order of magnitude reduction in these pathogens. Importantly, going from anaerobic to aerobic conditions typically promotes more significant decreases in bacteria and pathogens in the soil than what we'd see from manures that haven't undergone anaerobic digestion.
Nutrient consistency: Digestion of the manure generally helps remove intermediate-sized particles (broken down and digested) and converts them into soluble forms. These changes reduce solid settling and, in some cases, make agitation and mixing easier. More consistent manure is easier to manage in that it encourages confidence in provided fertility.

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Organic matter: Anaerobic digestion reduces the amount of organic matter that gets applied. The best reviews I've seen suggest that 12-14% of the organic carbon in the manure becomes stable soil organic matter for manures. I assume this number is slightly higher for anaerobically digested substrates. However, there is little information supporting or refuting this.

So, where does that leave us? AD should help noticeably with odor, bacteria, and pathogens but has a limited impact on nutrient cycles. In some cases, cattle and poultry manure N availability will increase. This would be minimal for swine manure; there are opportunities for more significant N loss during storage due to a higher pH, greater N in the ammonia form, and reduced solids content of the manure. The reduced solids content tends to make the manure slightly more consistent. If additional treatment, like solid-liquid separation, is used, it may alter the N:P ratio and allow other application methods, like irrigation.

Odor Mitigation: Manure Application Method

The application method selected when applying manure can have an impact on odor control. By utilizing incorporation or injection methods, there is the potential to reduce odors and conserve nutrients.

After broadcasting, incorporating solid manure within 24 hours using a disc or harrow can lead to a 20% - 90% reduction in gas emissions and odors. If incorporation occurs within 6 to 12 hours after application, emissions can be reduced by 60% to 80% with liquid manure. A reduction of up to 90% can be seen when liquid manure is injected. To read more about how this practice helps with nitrogen conservation, head over to the Manure Scoop.

More information about application methods and other odor mitigation methods can be found on the Air Management Practices Assessment Tool (AMPAT) website.

Events

May 10th, 2021
Manure Monday Webinar
Anaerobic Digestion

June 24th, 2021
Iowa Swine Day

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