

CO-DIGESTER FACT SHEET¹

What is an anaerobic digester (AD) and how is it different from a co-digester?

- ADs use microorganisms, heat, and oxygen-free conditions to break down organic material in order to stimulate methane production.
 - The additional methane produced by ADs is trapped and used as either heat or energy from the farm (biogas) or is refined for use as a substitute for natural gas (biomethane or renewable natural gas).
- In the context of farms, most ADs take only animal manure. These are called manure-only digesters.
- On-farm co-digesters mix manure with a number of inputs from outside the farm including food waste which can include various types of institutional food waste (expired food from grocery stores, scraps from schools, nursing homes, prisons and more) and industrial food manufacturing waste (pet food manufacturers, food processors, slaughterhouses, breweries, and more).²

What is digestate?

- Digestate is the waste product from ADs. The content of the digestate will vary depending on the inputs used during the digestion process.
- If a technology called a “screw press” is used, the digestate can be separated into dry and liquid fractions.³
 - Liquid digestate- kept in lagoons until used for irrigation water on fields or immediately used on fields as a source of additional agricultural nutrients
 - Solid digestate- kept as solids in a separate building to be stored until it can be used as animal bedding or spread on fields

How can digestate and biogas production negatively impact the water, soil, and air in my community?

Water Contamination

- Nitrogen- “Much of the nitrogen in raw manure is converted from its organic form to ammonium. Ammonium can be transformed to either ammonia or nitrate... Nitrate can be leached through the soil and may eventually reach groundwater. Field application and management to reduce nitrogen losses may be more demanding for digester effluent than for untreated liquid manure.”⁴ This means that nitrate pollution in groundwater can be more of a problem with digestate because it becomes more water soluble.
 - Consuming nitrate in drinking water may increase the risk of pregnancy complications, blue baby syndrome, thyroid disease, as well as breast, colorectal, and bladder cancer.⁵
- Phosphorus- if agricultural fields have elevated phosphorus levels, the additional phosphorus in digestate can increase the risk of agricultural runoff into neighboring bodies of water including lakes, streams, and rivers.⁶
 - Phosphorus runoff promotes eutrophication of bodies of water which suffocate aquatic wildlife.⁷
- Pathogens- Digesters reduce some, but not all of pathogens.
 - Researchers in Wisconsin found that ADs eliminated some pathogens, but other harmful pathogens such as E.coli and Salmonella routinely survive the digestion process.^{8,9}

¹ For any questions or inquiries related to this fact sheet, please contact Dr. Sarah D’Onofrio at sarah.e.donofrio@gmail.com

² <https://www.epa.gov/anaerobic-digestion/anaerobic-digestion-facilities-processing-food-waste-us-2020-2021#FoodWaste>

³ <https://www.epa.gov/sites/default/files/2014-12/documents/agstar-handbook.pdf>

⁴ Penn State Extension. 2023b. <https://extension.psu.edu/anaerobic-digestion-biogas-production-and-odor-reduction>

⁵ Ward, Mary H., et al. 2018. doi: 10.3390/ijerph15071557

⁶ Horta, C., & Carneiro, J. P. (2021). doi: 10.1007/s11270-021-05382-y

⁷ <https://www.epa.gov/national-aquatic-resource-surveys/indicators-phosphorus>

⁸ Burch et al. 2018. <https://doi.org/10.2134/jeq2017.07.0285>

⁹ Wang and Panday. 2017. <https://www.topicsoncivilevironeng.com/paper/ICETI/ICETI45.pdf>

- Digesters do not eliminate antibiotic resistant pathogens.¹⁰
- Researchers in Ireland found over a dozen types of pathogens in digestate, many including several that were concerning for human health including *Cryptosporidium parvum*, *Salmonella*, norovirus, enteropathogenic *E. coli* (EPEC), *Listeria monocytogenes* and *Campylobacter coli*.¹¹
- Food waste also introduces additional pathogens into co-digesters and includes many of the same pathogens found in digestate that were not eliminated by on-farm ADs such as *Clostridium* and *Salmonella*.^{12 13}

Soil Contamination

- **Microplastics**- plastics in food packaging leach into the food waste itself and bioaccumulate in soils.¹⁴
 - “Food itself is also a source of microplastic particles...Plastic contamination rates in purely food waste streams may be higher, as available evidence indicates plastic contamination levels in food waste streams may be higher than that of other organics waste streams, such as yard waste.”
 - “Due to their highly stable chemical structure, most conventional petroleum-based plastics are resistant to total degradation and may persist in the environment for centuries (Ali et al., 2021). Through time, plastics may accumulate in soils (Y. Yu & Flury, 2021), with macroplastics fragmenting into microplastics or even nanoplastics due to physicochemical and biological degradation (Ali et al., 2021). This partial degradation can release additives and impurities that may be harmful to human and ecosystem health (Rillig et al., 2021).”
 - Microplastics can build up in soil crops and reduce crop yields by decreasing the ability of the plant to photosynthesize and blocking nutrient and water absorption.¹⁵
- **PFAS**- found in food packaging, cookware, and food processing equipment and transfer to food waste
 - “PFAS are extremely persistent in the environment, and they are generally more water-soluble than other persistent organic pollutants...PFAS cause widespread contamination in soils and groundwater and can be found even in rural regions, far from potential PFAS sources (Brusseau et al., 2020).”¹⁶
 - In March 2024, a global study identified 61 PFAS chemicals in food packaging that are not authorized for use in such products.¹⁷
 - Consumer Reports tested multiple samples of 118 packaging products and found that PFAS was detected in half the food packaging tested. Almost a third had very high PFAS levels.¹⁸

Toxic Air Pollution

- **Volatile organic compounds (VOCs)**- Zheng et al. (2019) detected 49 different types of VOCs emitted from digestate.. Almost a third (32.77%) of the VOCs were hazardous to human health: 8 of the compounds were carcinogenic and 14 were known to cause organ damage in humans.
- **Ammonia**- Holly et al. (2017) found in their study of digestate in Wisconsin that in storage, ammonia emissions increased 81%.¹⁹ Exposure to ammonia can cause, “...eye, nose, and throat irritation, headache, nausea, diarrhea, hoarseness, sore throat, cough, chest tightness, nasal congestion, palpitations, shortness of breath, stress, drowsiness, and alterations in mood (Schiffman and Williams, 2005; Wing and Wolf, 2000).”²⁰

¹⁰ <https://www.frontiersin.org/journals/microbiology/articles/10.3389/fmicb.2022.965132/full>

¹¹ Nag, Rajat et al. 2020. [doi: 10.1016/j.scitotenv.2019.136297](https://doi.org/10.1016/j.scitotenv.2019.136297).

¹² Karanth et al. 2023. [doi: 10.3389/fmicb.2023.1198124](https://doi.org/10.3389/fmicb.2023.1198124)

¹³ Burch et al. 2018. <https://doi.org/10.2134/jeq2017.07.0285>

¹⁴ <https://www.epa.gov/system/files/documents/2021-08/emerging-issues-in-food-waste-management-plastic-contamination.pdf>

¹⁵ <https://www.frontiersin.org/journals/plant-science/articles/10.3389/fpls.2023.1226484/full>

¹⁶ O'Connor, James, et al. 2022. <https://doi.org/10.1016/j.envpol.2022.118860>

¹⁷ Phelps, Drake W., et al. 2024. <https://pubmed.ncbi.nlm.nih.gov/articles/PMC10993423/>

¹⁸ <https://www.consumerreports.org/health/food-contaminants/dangerous-pfas-chemicals-are-in-your-food-packaging-a3786252074/>

¹⁹ Holly, Michael A., et al. 2017. [doi: 10.1016/j.agee.2017.02.007](https://doi.org/10.1016/j.agee.2017.02.007).

²⁰ Wyer, Katie E., et al. 2022. <https://doi.org/10.1016/j.jenvman.2022.116285>