

THE MANURE DIGESTER AND BIOGAS CONTROVERSY

SCIENCE BRIEF

Introduction

Manure digesters are a rapidly expanding and hotly debated technology. They work by capturing methane, a potent greenhouse gas, and converting it to a biogas that can be burned for energy. Manure digesters are touted by their proponents as a climate solution, a renewable energy source, and an economic boost for farmers. Opponents argue that manure digesters are a form of greenwashing that distracts from actual climate solutions, worsens air and water pollution, and adds to the health and economic burdens borne by rural communities.

This brief is a summary of an in-depth review, *Deconstructing the Livestock Manure Digester & Biogas Controversy*, in which authors from the Johns Hopkins University assessed the scientific evidence surrounding claims about manure digesters and their impact on rural communities and climate change. The full study is available in the November issue of *Current Environmental Health Reports*.

Manure digesters in United States agriculture

Industrial livestock operations, the largest of which are designated by the United States (US) Environmental Protection Agency as Concentrated Animal Feeding Operations (CAFOs), house thousands of animals in dense confinement. Most operations in the US don't use manure digesters, but the number has been growing. Most US digesters have been installed on operations raising either dairy cows or pigs. Manure from these animals is typically drained or flushed into liquid cesspits or "lagoons," where it is stored prior to being applied on nearby fields.

Manure digesters vary in their design, but they typically trap methane and other gases inside covered lagoons where microorganisms break down or "digest" manure and other organic materials, producing biogas. An additional uncovered lagoon stores the leftover "digestate," a slurry that is applied to nearby fields as a fertilizer, with the solid portion sometimes used as animal



Photo of a covered manure lagoon. Source: US Environmental Protection Agency.

Because of economies of scale, high up-front construction costs, and managerial complexity, manure digesters are typically only viable for larger livestock operations. Manure digesters may only be economically feasible if operators receive government funding for construction costs and subsidies for biogas. These policy incentives, combined with added revenue from manure biogas, have prompted concerns that the economics of manure digesters may be accelerating industry consolidation—the trend toward larger operations alongside the loss of smaller farms.

Manure digesters and public health

Even in the absence of manure digesters, industrial livestock operations are documented sources of harmful gases, particulate matter, odors, pathogens, nitrates, drug residues, and other chemical and biological hazards that can contaminate air, water, and soil. Living near and working in these operations has been associated with elevated risks for adverse health effects, including respiratory conditions and antibiotic-resistant infections, while exposure to nitrates in groundwater has been associated with cancer, birth defects, and thyroid problems. More than just a bad smell, noxious odors interfere with daily activities, quality of life, social gatherings, and property values while contributing to stress and elevated blood pressure. Low-income communities and communities of color are in many cases disproportionately impacted by these harms.

How does the addition of a manure digester affect the health risks associated with industrial animal agriculture? The review of the evidence found that they potentially lessen some impacts while perpetuating or exacerbating others. For example:

- **Odors.** Digesters have been found to reduce odors from stored manure, both through chemical changes that occur during digestion, and by capping lagoons.
- **Air pollution.** Emissions of ammonia (a harmful gas) from operations with a manure digester have been reported as being higher, lower, or similar compared to operations without a digester, depending on the study and the digester system. Studies also warned against “pollution swapping” where digesters reduce levels of some pollutants, such as methane, while increasing others.
- **Pathogens.** Manure digesters reduce levels of pathogens, but the size of those reductions is not consistent. Even with reductions, most of the remaining pathogens end up in the liquid part of the digestate, the fraction typically applied to farmland—a practice that can contaminate crops and ground and surface waters.
- **Soil and water pollution.** Nutrient pollution and other chemical hazards from operations with a manure digester have been shown to be either comparable to or worse than operations without a digester.
- **New community and occupational health concerns.** Manure digesters may also introduce new public health risks. Burning biogas, for example, releases an array of harmful compounds. Toxic gas releases, fires, and gas explosions have also been documented at biogas facilities and infrastructure, resulting in injuries and deaths among workers.

Critically, this evidence must be considered in the context of how manure digesters incentivize growth in an industry with well documented harms to rural communities. Impacted populations have faced uphill battles fighting to protect their health, and their advocates have called for more transparency and participation in permitting processes for new digesters.

Manure digesters and climate

Without curbing livestock’s greenhouse gas emissions, global temperatures are projected to exceed scientific targets designed to avoid the most destructive climate scenarios. Compared to operations without a digester, studies have found that manure digesters provide a net reduction in greenhouse gas emissions. Most of those reductions are from preventing methane releases from stored manure, with additional climate benefits from displacing fossil

fuel use with manure biogas. There are, however, important caveats and potential consequences:

- **Small reductions in overall agricultural emissions.** The share of US agricultural greenhouse gas emissions that manure digesters could potentially address is only 11%. Other major emissions sources, including cattle burps, feed crop production, and manure from grazing animals are not addressed by manure digesters. Livestock industry narratives overstating the climate benefits of manure digesters may mislead policymakers, consumers, and other audiences.
- **Methane leaks and elevated nitrous oxide emissions.** The potential for manure digesters to reduce emissions is partially offset by methane leaks and increased emissions of nitrous oxide, another potent greenhouse gas, from digestate storage and farmland application.
- **Role in energy transitions.** If the energy grid transitions off fossil fuels and towards green energy (wind and solar), the climate benefits of producing biogas from manure digesters would be dampened. Greenhouse gas reductions from displacing fossil fuels with biogas can only happen if there are fossil fuels to displace.

Reducing greenhouse gas emissions from livestock is urgent, but the role of manure digesters is overstated, and the technology may further entrench the very industries that are driving the climate crisis.

Conclusions

Manure digesters are at the center of contentious debate over their roles in multiple public health, environmental, and economic outcomes. The review of the evidence suggests manure digesters offer modest reductions in some pollutants while exacerbating others and thus are not the solutions they are often touted to be.

Critically, further investments in industrial livestock operations, manure digesters, and associated infrastructure risk entrenching and expanding an industry that runs counter to public health and environmental goals, while delaying transitions to more sustainable alternatives.

Learn more:

<https://clf.jhsph.edu/projects/biogas-rural-communities-and-climate>