Anaerobic Digestion on Poultry Farms

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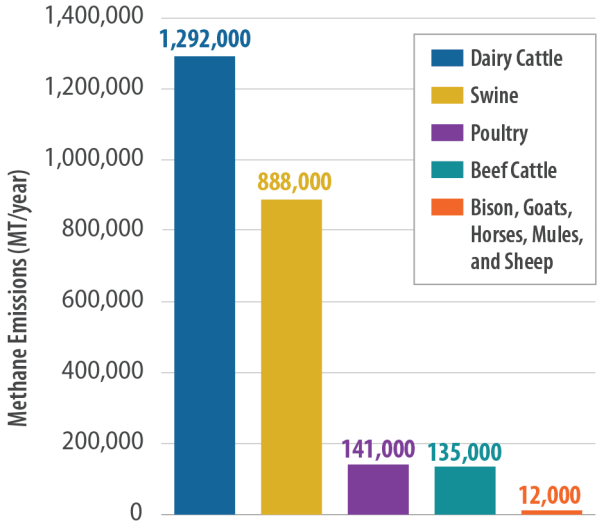
Anaerobic digestion (AD) of poultry manure in the United States (U.S.) has many environmental and economic benefits, including renewable energy production and reduced greenhouse gas emissions. Poultry manure is the nation's third largest source of methane from livestock manure management (see Figure 1).

Figure 1. Total Manure Management Methane Emissions in the United States, 2018



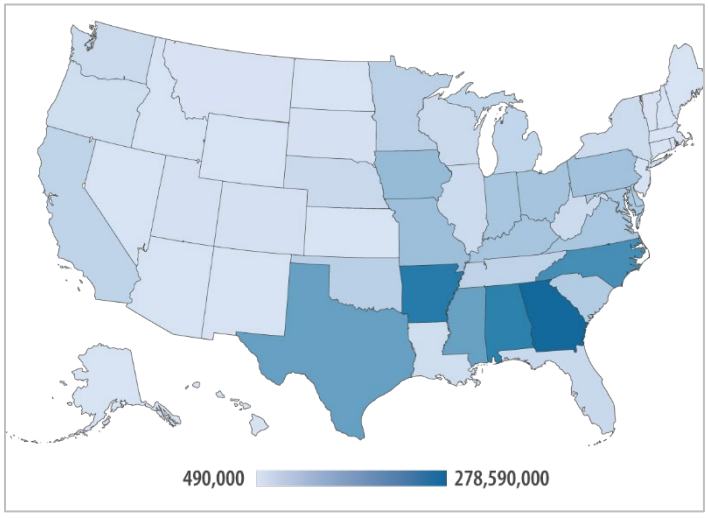
Source data: U.S. EPA GHG Inventory of Greenhouse Gas Emissions and Sinks: 1990-2018.

As of April 2021, there are eight known AD systems accepting poultry manure in the U.S. These systems annually reduce approximately 66,800 MT CO_2e.[1] That's equivalent to planting over 1.1 million trees![2] However, there is potential to expand poultry manure AD capacity.

Where Poultry Farms Are Located

U.S. poultry populations are concentrated mainly in the Southeast, with a large percentage (over 41 percent) located in Georgia, Arkansas, Alabama, and North Carolina. Texas, Mississippi, Iowa, and Missouri are the next most populous states for poultry, together making up about 20 percent of the U.S. poultry population. Figure 2 presents the U.S. poultry population by state.

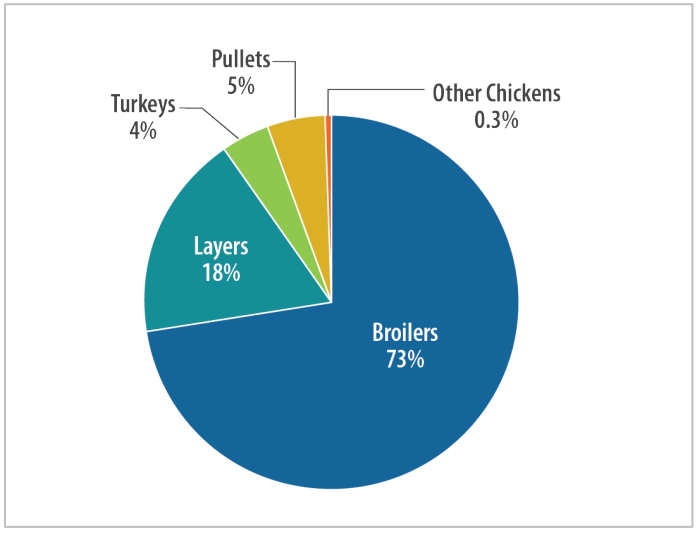
Figure 2. U.S. Poultry Population, 2018



Source data: USDA *Quick Stats;* U.S. EPA GHG Inventory of Greenhouse Gas Emissions and Sinks: 1990-2018.

Figure 3 presents the breakdown of poultry population by bird type. Broilers are chickens raised for meat purposes, layers are raised for egg production, and pullets are hens that have not laid an egg (for this graph, pullet populations are estimated as hens under one year of age). Other chickens include roosters and other males.

Figure 3. U.S. Poultry Population by Bird Type, 2018



Source data: USDA *Quick Stats;* U.S. EPA GHG Inventory of Greenhouse Gas Emissions and Sinks: 1990-2018.

[1] AgSTAR Anaerobic Digester Database. This value includes direct methane reductions from the manure emissions as well as indirect reductions from the avoided use of fossil fuels.

[2] Greenhouse Gas Equivalencies Calculator.

Current Manure Management Practices

Operators on large poultry farms use two primary systems to house birds:

- Birds may be raised on **bedding** that is spread over the floor of the housing facility. This type of housing is common for pullets, broilers, and turkeys.
- Birds may be confined to **cages** situated above slotted or perforated floors. This type of housing is most common for layers.

Bedding consists of absorbent materials such as wood shavings, rice hulls, chopped straw, or peanut hulls, and when mixed with manure, it is referred to as *poultry litter.* Litter may also include feathers and spilled feed. Litter is removed from facility floors at a frequency determined by the operator. Because the litter is managed in dry conditions (not wet, anaerobic conditions), it produces minimal methane emissions and therefore this type of management system is not conducive for AD.

Young broilers raised on bedding.
Photo credit: USDA.

For poultry raised in high rise houses, cages are raised, and manure collects into deep stacks in a well-ventilated lower level. These types of houses are not commonly being built, but many are still in use. In other caged bird houses, cages are suspended over a shallower space, and scrape, flush, or belt systems collect the manure more frequently. **Scrape and flush systems** remove manure mechanically by scraping or hydraulicly by flushing. **Belt systems** collect deposited manure on a belt that runs continuously under the cages to a spreader for immediate disposal or storage. Belt systems are more common than scrape and flush systems, and nearly all newly constructed layer houses use belt systems.[3]

Operators may store liquid or slurry poultry manure in **anaerobic lagoons**—earthen structures which look like farm ponds. For poultry operations, anaerobic lagoons are commonly used for layers in the South and Central U.S., often on operations that include egg washing. Anaerobic lagoons produce much more methane than dry manure management systems.

For more information about manure management system types, see Chapter 9 of the USDA Agricultural Waste Management Field Handbook or visit the Livestock and Poultry Environmental Learning Center's (LPELC) Manure Collection and Handling Systems website.

Current Use of Anaerobic Digestion Systems

AD systems in the U.S. process manure from about 2 million birds at eight sites in Kentucky, Maryland, Mississippi, Ohio, Pennsylvania, and South Carolina. **Complete mix tanks** are the most common design among these systems, although **covered lagoons** and **plug flow systems** are both used as well. At least half of these systems codigest other organics along with poultry manure.[4]

Market Trends

U.S. poultry production has expanded over the last decade due to increased domestic and foreign demand.[5] Although small farms and family businesses have been instrumental in market growth, most growth is driven by large-scale operations.[6] Often, large companies referred to as "integrators" provide poultry stock under a contract to growers who house and manage the birds.

Most AD projects in the poultry sector are now developed through partnerships between integrators and project developers, utilities, and other stakeholders. For example, Perdue Farms recently entered a partnership with Bioenergy DevCo to implement AD systems at their Delaware facility. These partnerships provide multiple benefits to the partners, including energy generation and fertilizer production.

Currently, all poultry-based AD systems in the U.S. generate electricity; however, several new projects planned or under construction will produce renewable natural gas (RNG). This shift in biogas use is primarily due to economic factors, as discussed in the "Barriers" and "Solutions" sections below.

[3] LPELC Exposure: Layer Hen Housing and Manure Management
[4] *Market Opportunities for Biogas Recovery Systems at U.S. Livestock Facilities*
[5] USDA Economic Research Service: Poultry Sector at a Glance
[6] Global Poultry Industry and Trends

Barriers

AD remains an uncommon manure management practice in the poultry industry due to technical and economic challenges. AD systems are not easily incorporated into typical poultry manure management practices without significant changes. When bedding is used, the infrequent removal cycles result in a substantial loss of organic matter from manure, resulting in reduced biogas production potential. Also, poultry manure is high in nitrogen, which creates ammonia and inhibits the AD process.[7]

Financing an AD system is a challenge for small poultry farms and family businesses. These farms typically have narrow profit margins, which means they are less likely to invest in practices beyond what the farm needs to function. A farmer may be aware of the benefits of AD (e.g., environmental stewardship, odor control, emission reductions, energy generation), but if the cost is perceived to outweigh those benefits, there is limited incentive to pursue AD. Hiring additional staff to operate the AD system and meeting additional regulatory or permitting requirements may also be costly.

Despite these barriers, current AD projects in the poultry sector have been able to take advantage of some of the solutions offered below.

Solutions

Solutions to the technical and economic challenges of developing poultry manure-based AD systems include:

Education and Outreach. It is important that operators interested in a poultry AD system work with trusted advisors with poultry AD experience to ensure success.

Market incentives for biogas. Tax credits, renewable energy credits, carbon offsets, and other incentives offered through federal or state renewable or low carbon fuel standards (LCFS) are a potential source of revenue or cost savings. At the federal level, the Renewable Fuel Standard provides market-based monetary value for renewable fuels, including RNG.

Market trends for renewable/low carbon fuels have made RNG more valuable than electricity. If a project can demonstrate that RNG is used as transportation fuel and meets appropriate requirements, RNG can also generate Renewable Identification Numbers or LCFS credits. Because of this, most poultry projects currently in development plan to produce RNG.

Strategic Partnerships. Biogas producers that partner with an organization to purchase the gas could potentially achieve greater revenues. Many companies and utilities are willing to pay a premium for renewable energy or carbon offsets to reduce their carbon footprint.

Third party build/own/operate models. These models can lower the financial risk and responsibilities for the grower, while still providing benefits like odor reduction and improved public image. Brightmark Energy, for example, owns, operates, and maintains the covered lagoon AD system at Pilgrim's Pride's poultry processing facility in Sumter, South Carolina.

Codigestion. Depending on the AD system, food waste or other organics may be codigested with poultry litter to increase biogas production, which can increase revenue from energy sales. Charging a tipping fee for the disposal of other parties' wastes is another possible source of income. Mac Farms, a broiler operation in Campellsville, Kentucky, attributes its AD system's profitability in part to tipping fees.

Nutrient concentration. Creating nutrient fertilizers from poultry manure digestate could add to revenues or directly reduce nutrient management costs. For example, digestate from Mac Farms' AD system is certified as a fertilizer with the Kentucky Department of Regulatory Services and used onsite for the farm's crops. Additionally, the Bioenergy Devco project in Delaware plans to use digestate to create compost for offsite sale and use.

Federal, state, or local funding. Federal, state, or local direct financial assistance for feasibility studies and/or up-front costs can reduce financial barriers. The Project Planning and Financing page on the AgSTAR website includes a table of resources to help identify funding opportunities.

AgSTAR is a collaborative program sponsored by EPA and USDA that promotes the use of biogas recovery systems to reduce methane emissions from livestock waste.
https://www.epa.gov/agstar

[7] Funding the Future: Ductor and Leyline Renewable Capital Partnership