Cornell University

Dairy Manure Storage & Greenhouse Gas Mitigation Opportunities

Information Sheet #2 OVERVIEW

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Fast Facts

- **Trends**: Due to increasing farm size and water quality requirements, more farms are storing manure in order to apply valuable nutrients to cropland during the growing season.
- **An imperative to act:** Stored manure is often anaerobic (low oxygen) and produces methane, a greenhouse gas (GHG) that is 34 times more potent than carbon dioxide (CO_2) over 100 years (86 times more potent over 20 years). If methane is combusted it greatly reduces farm GHG emissions.
- **A concern for implementation:** Stored manure also produces N_2O (a potent GHG 298 times more potent than CO_2) and other gases such as hydrogen sulfide (H_2S) that can impact health.
- **An opportunity for proactive change:** Many carbon-trading programs recognize methane destruction; methane can also be used to generate useable energy on and off farms.

Introduction

Society increasingly expects agriculture to produce food in a manner that maintains environmental quality. In the past, daily spreading of manure, with the potential to contaminate surface waters, was common particularly during fall or winter when crops are not growing and frozen ground increases surface runoff of nutrients to streams (Williams et al., 2011, Wightman & Woodbury 2016). To address water quality, manure is stored in a solid stack (less often) or in a liquid storage facility (more often) for many months so manure can be spread on dates closer to when crops can take up the nutrients, reducing the potential for pollution of surface and groundwater. However, these improvements for water quality may have drawbacks when considering greenhouse gas (GHG) emissions.

Environmental Concerns

Methane (CH_4) and nitrous oxide (N_2O) are potent GHG and should be considered when evaluating manure management. For more general information about GHG in agriculture, see Information Sheet #1. Dairy manure is about 90% moisture and 10% solids (ASABE, 2006), with a portion of those solids being carbon compounds called volatile solids (VS), and also various nitrogen (N) compounds. Some of the VS are precursors for CH_4 and some of the nitrogen compounds are precursors for N_2O. More anaerobic (low oxygen) manure management conditions, as found in liquid storage, cause more CH_4 production. More aerobic (high oxygen) manure management conditions, such as daily spreading or composted solids, prevent CH_4 production. The opposite pattern is true for N_2O: when manure-N is stored more anaerobically, N will not convert to N_2O (and has great benefit for reducing synthetic N fertilizer needs during spring planting); when manure-N is stored under aerobic conditions (e.g. composted solids), more N_2O is released. These two gases are important because CH_4 is 34 times more potent as a GHG than CO_2 while N_2O is 298 times more potent over 100 years. This is potency is referred to as the Global Warming Potential or GWP; see Information Sheet #1. To note, there is significantly more VS than N in the manure, so while N_2O is a more potent GHG than CH_4, there is significantly greater potential to produce more CH_4. Besides GHG, other emissions including ammonia, hydrogen sulfide, and other odor causing compounds are often released from manure storage. In high concentrations these toxic gases can cause damage and even death to humans and other animals.

Summary of Regulations of GHG Emissions

Policies and regulations, such as Concentrated Animal Feeding Operation (CAFO) permitting, Total Maximum Daily Load (TMDL) requirements for certain watersheds, and other watershed protection efforts throughout NYS, have led to more storage capacity on farms to facilitate better management of manure for water quality. There are no regulations of GHG emissions from agriculture in NYS.

Goal

This Information Sheet is intended to help dairy farmers and their advisors navigate meaningful methods for reducing GHG emissions from manure management systems. Three major opportunities are summarized below.

Summary of Potential GHG Reduction Practices from Manure

Description of Strategy	Opportunities	Considerations
Optimized animal feed	• Reduce nitrogen in animal feed to reduce N_2O emissions from manure storage. • Improve diet efficiency to reduce total inputs, reduce VS in the manure, and potentially reduce the enteric emissions of CH_4 from the cow. Other benefits: Feed efficiency saves money.	• Requires animal diet planning and testing of diet and manure.
Manure storage with cover and flare for methane destruction	• Methane capture with a cover + combustion with a flare reduces the GWP of CH_4 from 34 to 1. • Documented and verified CH_4 destruction can qualify for carbon credits. • State and federal agencies offer competitive funding for manure cover and flare systems. Other benefits: Manure covers exclude rain reducing storage size. Excluding rainfall can reduce hauling costs. A cover prevents rainfall from causing overflow of storages. Covers can control storage odor and improve neighbor relations.	• Covers + flares cost money, require labor & maintenance. • Covers last ~10-20 years and will need to be replaced. • Carbon markets are not mature. • CH_4 is a highly flammable gas requiring new safety considerations. • Storing manure can produce hydrogen sulfide (H_2S), a deadly gas. • Manure solid/liquid separation is required.
Anaerobic Digestion System (ADS) methane destruction + energy generation	• Methane capture and combustion for generating electricity reduces the GWP of methane from 34 to 1. • AD can be used to generate heat and power on farm, reducing fossil fuel emissions. • Grants are available for ADS-electricity • AD may qualify for carbon credits and/or renewable energy credits if documented and verified. Other benefits: ADS can control odors from storage and spreading, reduce electric costs, and improve neighbor relations.	• ADS intentionally produce additional methane, which if not properly combusted in an engine, boiler, or flare can cause increased farm GHG emissions. • AD systems are expensive to construct and require regular maintenance. • CH_4 is a highly flammable gas requiring new safety considerations. • Storing manure can produce hydrogen sulfide (H_2S), a deadly gas. H_2S can also corrode equipment; corrosion is reduced by proper design. • Capital costs may not be recouped from sale of electricity.

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