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Dairy Environmental Systems Program
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GREENHOUSE GAS FROM DAIRY MANURE MANAGEMENT AT THE FARMSTEAD

Part 7: GHG FROM SOLID STORAGE SYSTEMS

August 2017

Some dairy farms have adopted a manure management system to limit the handling of liquid manure and to include the storage of the manure under the same roof as the animal housing. A bedded pack system typically uses additional bedding or waste feed to mix with the manure as it is deposited daily. Management includes adding bedding frequently and in enough quantity to adsorb the manure moisture so the animals can lay on the surface without getting excessively soiled. The amount of additional bedding material varies depending on stocking density, animal diet and the weather.

Composted bedded packs are similar but can use less bedding as the manure and bedding are aerated (often with cultivating equipment) once or twice a day to encourage composting. The composting creates heat and that and the stirring increases evaporation that reduces the need for as much added bedding. In all cases, liquid wastes that are not included in the solid manure storage system need to be collected, stored, treated and/or recycled to the land base. The portion of manure collected and stored in a liquid system would need to be subtracted from the solid storage greenhouse gas (GHG) production.

Typically both the bedded pack and composted bedded pack systems do not have a separate storage for solids. Farmers remove the pack manure periodically when it is appropriate to recycle it back to the land base. However if additional solid manure storage facilities are used they may be managed as a static pile which has a relatively low global warming potential (GWP). Pack manure may be composted in open windrows or piles if additional treatment is used. More sophisticated compost facilities under a roof may also be part of these manure storage/treatment systems. Additional composting will result in additional GHG production. Using Equation 1.2 from Fact Sheet 2 and Equation 1.3 from Fact Sheet 3 along with their respective Tables, 1.2 for methane contributing factor (MCF) and Table 1.3 emission factor (EF_3) for N_2O emissions will give the combined GWP for each of these manure management systems as shown in Table 1.7.

Advantages

Advantages in handling and storing manure as a solid may include use of existing solid handling equipment, less odor (bacterial action producing odorous compounds is reduced at lower moisture contents), less runoff potential, relatively high nutrient retention and less risk of a catastrophic failure. The solids may be more attractive for off farm use or sales.

Considerations

This option may include more labor involved in manure runoff management from unroofed storage areas, and labor/equipment requirements (number of loads to haul and spread) for land application. More volume may result as additional amendments are used to reduce the moisture content of excreted manure in order to maintain the pack and/or for composting to occur. Additional volume will increase the inefficiency of manure spreading. If a liquid system is also needed then having two manure/wastewater processes on the farm can add both cost and complexity. Limited mixing of a compost system to minimize N_2O emissions may limit the marketability of the compost as it may not be homogeneous enough for use as a higher priced product. Composted bedded packs will have high N_2O emissions while both bedded packs will have as high of a MCF as a slurry/liquid without a crust.

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Table 1.7 Global warming potential (GWP) estimates[2] for liquid storage with and without a crust compared to a bedded pack and a composted bedded pack as manure management systems

MCF[1] (winter - summer)	EF_3[1]	Manure Management BMP	Annual GWP lbs. from CH_4 CO_2eq/cow/yr.[2]	Annual GWP lbs. from N_2O CO_2eq/cow/yr.[2]	Total Annual GWP lbs. CO_2eq/cow/yr.[2]
(17 – 35)	0	Liquid/Slurry without natural crust	9,213	- 0	9,213
(10 – 22)	0.005	Liquid/Slurry with natural crust	5,670	846	6,516
(17 – 35)	0.01	Bedded Pack	9,213	1,692	10,905
(17 – 35)	0.07	Composted Bedded Pack	9,213	11,845	21,058

[1]Source: IPCC (2006) and EPA (2016) [2]Calculated

Cost

Although the barn roof doubles as a roof on the manure storage, there is an additional cost for the walls to contain the pack. Also typically the area required per cow is larger than for freestall barns. The cost of the additional amendment needed bed cows and to reduce the moisture content sufficiently for solids handling, and the cost to move the additional mass needs to be considered.

Planning considerations

Plan for both the pack manure system and for any liquid or wastewater generated on the farm. Determine how much additional amendments are needed and their availability. Contact a Natural Resources Conservation Service office, the local Soil and Water Conservation District office, or a qualified professional for design assistance.

Table 1.7 shows the MCF, EF_3, and GWP as the carbon dioxide equivalent (CO_2eq) per cow per year for a both the bedded pack and the composted bedded pack compared with a liquid storage with and without a crust. Variations in these systems if a portion of the manure is stored as a liquid will change the GWP.

The assumptions used are that each manure management system that stores manure stores it for both the summer period and the winter period, the nitrogen content of the manure excreted is 0.99 lbs./ cow-day, the volatile solids (VS) in manure is16.9 lbs./cow-day (ASAE), and that for this example, summer ambient temperature is assumed to be 18°C (64°F) and winter is assumed to be < 10°C (< 50°F) so an average MCF value is used for the whole year. If the bedded pack or composted bedded pack have an area such as a feed area or holding area where the manure is collected as a liquid that portion of the manure will contribute GHG under that manure management system.

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Fact sheet series: 1 How are Greenhouse Gases Generated?, 2 Dairy Manure Management Impact on Methane, 3 Dairy manure management impact on Nitrous Oxide, 4 Combining Methane and Nitrous Oxide Emissions from Dairy Manure Management, 5 GHG Reduction from Crusts on Storages, 6 GHG Reduction from Limiting Summer Storage, 7 GHG from Solid Storage Systems, 8 GHG Reduction from Solid/Liquid Separation, 9 GHG Reduction from an Impermeable Cover, 10 GHG Reduction from an Anaerobic Digestion System.

References:

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Intergovernmental Panel on Climate Change (IPPC) Tier 2 method from the 2006 IPCC Guidelines for National GHG Inventories, Volume 4, Chapter 10: