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Beneficial Manure Management Practices to Mitigate Greenhouse Gases

Manure management – handling and storage of manure – is one of the largest sources of agricultural greenhouse gas (GHG) emissions. Methane (CH_4) is the most important GHG associated with liquid manure management. Methane emissions during slurry storage contribute to more than 90% of total GHG emissions from untreated dairy cattle manure.

Manure methane emissions occur as a net result of microbial production and consumption of CH_4. 'Wetter' (less oxygen) conditions favour the production of CH_4, while drier conditions (such as in a manure crust) result in CH_4 consumptions. Management practices to avoid optimal conditions for CH_4 production and/or to provide favourable conditions for CH_4 consumption are beneficial in mitigating GHG emissions from dairy manure. The Dairy Livestock and Crop Systems Project identified the following promising management practices to help reduce CH_4 emissions from dairy manure.

Applying a straw cover on the liquid manure surface has the potential to reduce CH_4 emissions during storage by up to 15%. The thickness of the cover should be at least 15 cm to achieve this suggested reduction as thin straw covers have been found to increase CH_4 emissions. The straw cover reduces CH_4 emissions by providing an environment with enough oxygen for the microbes that break down CH_4 and by reducing transport of gas produced in the bottom of the tank to the atmosphere. Applying a straw cover comes with many other benefits; they are simple to put into practice, inexpensive, adaptable and immediately usable, decrease ammonia emissions, and reduce odour and hydrogen sulfide production. However, straw covers are susceptible to wind and rain damage. Although straw has limited buoyancy time, it can be made more durable by providing floating supports.

Complete emptying of liquid manure storage tank in the spring eliminates the inoculum or aged manure remaining in the tank and reduces the CH_4 emissions from the newly loaded manure in the following months by up to 40%. Benefits can also be realized when a small amount (5%) of manure is left in the tank compared to leaving 15%. Downstream effects on field manure application with complete emptying have to be taken into account, but overall this is a practice with a lot of potential for GHG reduction at the dairy farm level.

Anaerobic digestion of liquid manure reduces CH_4 emissions from the tank storage component by up to 60%. In this process, CH_4 producing bacteria use volatile manure solids ("food") to produce CH_4 under enhanced environmental conditions in a digester, which leads to lower CH_4 production during storage of digestate, the liquid portion of anaerobically digested manure, due to lack of "food" for CH_4 producing microbes. The CH_4 produced during anaerobic digestion is captured and used as an energy source. This practice also offers many other benefits such as odour control, conversion of organic nitrogen to inorganic nitrogen and production of homogeneous effluent. Capital costs for installation of anaerobic digestion systems are high but the associated GHG benefits are substantial.

Separating solids from the liquid manure and composting the solid fraction shows the potential to reduce overall CH_4 emissions by about 30%. Emissions from the liquid portion are reduced because volatile solids, the substrate for methane-producing microbes, are reduced by 60-80%. Caution has to be exerted because storage of the solid fraction could increase ammonia emissions; however, by supplying sufficient oxygen in manure heaps and implementing good composting practices, these emissions can be reduced and lower overall emissions can be achieved.

Cost and trade-offs with other environmental benefits have to be considered for each of these practices, but applying a straw cover, complete emptying tanks to eliminate inoculum, producing biogas using anaerobic digestion and separating solids have shown to have significant reductions in greenhouse gas emissions from dairy farms.

This project is funded by Agriculture and Agri-Food Canada under the Agricultural Greenhouse Gases Program.

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