METHANE EMISSIONS DURING DAIRY MANURE MANAGEMENT: CURRENT ISSUES AND OPPORTUNITIES

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ABSTRACT

The New Zealand's greenhouse gases inventory currently uses a country-specific methodology to compute methane emissions occurring during farm dairy manure management. Unfortunately, this methodology is mathematically flawed and based on highly uncertain and potentially irrelevant data. These errors and uncertainties have contributed to a perception that the amount of methane emitted during manure management is negligible in comparison to enteric emissions, and this perception is at the foundation of New Zealand investment strategy for mitigating the carbon footprint of its dairy sector. Our research instead demonstrates methane emissions during manure management, which are technically easy to mitigate, are indeed significant.

KEYWORDS

Anaerobic ponds; Dairy; Manure; Methane; New Zealand Greenhouse Gas Inventory

1 INTRODUCTION

Farm dairy effluent (FDE) is generated when manure, urine and other wastes are washed-down during milking. In NZ, most dairy farms treat or store FDE under anaerobic conditions promoting the generation and atmospheric release of methane, a potent greenhouse gas. In addition, an increasing amount of manure is collected from feed, stand-off and wintering pads and the contribution of these organic waste streams to methane emissions is currently ignored. The current NZ inventory thus estimates that the amount of methane released during manure management (19.96 Gg in 2011) represents 'only' 2% of the total emission from dairy farming. Based on this perceived low significance, there has been little incentive to mitigate emissions during FDE management in New Zealand. Our research has however identified significant flaws and inaccuracies in the methodology and input data used by the NZ greenhouse inventory (Chung et al., 2013; Pratt et al., 2014a).

2 METHODS

The methodology and data sets used in the present analysis are described in the literature (Chung et al., 2013, Laubach et al., 2014, Pratt et al., 2012; Pratt et al., 2014a; Pratt et al., 2014b). Given the current NZ methodology for quantifying methane emissions during FDE management is flawed and based on uncertain data, an adapted Tier 2 IPCC 2006 methodology was used as described in Laubach et al., (2014). In brief, methane emissions from manure management (M) were computed as:

$$M = B_0 \times \sum_{month} FDM_m \times \sum_{treatment} MS_t \times MCF_t \qquad (1)$$

Where M is the total amount of methane emitted in the year considered (kg CH_4), B_0 is the ultimate biochemical methane potential of dairy manure (m^3 CH_4 kg FDM^{-1}); FDM_m is the monthly "faecal dry-matter output" of lactating dairy cows (kg FDM); MS_t is the fraction of FDM_m treated in each treatment system considered, and MCF_t represents the methane conversion factor associated with each treatment system considered (e.g. 0.74 at 15°C for anaerobic ponds, IPCC 2006).

FDM_m can be obtained from the current NZ Inventory (MfE, 2013). The B_0 value of dairy manure can be derived from the value of 0.24 m^3 CH_4 kg VS_{manure}^{-1} representative of the Oceania region (IPCC 2006). The values of MS_t and MCF_t can be obtained from national survey and IPPC default values (Laubach et al., 2014; Ledgard and Brier, 2004; Luo et al., 2013). Advantageously, this methodology also allows estimating CH_4 emissions from non-manure wastes entering anaerobic ponds (Chung et al., 2013).

3 CONCLUSIONS

Based on the extensive monitoring of 4 farms (Pratt et al., 2012) and additional data, we have established that the NZ inventory has considerably underestimated methane emissions during FDE management (Figure 1) and that this category actually represents 6-10% of the total emissions from dairy farming (Chung et al., 2013*;* Pratt et al., 2012; Laubach et al., 2014). Furthermore, pressures to improve nutrient and water management cause NZ dairy farmers to increasingly adopt farming practices contributing to further increase the magnitude and relative importance of methane emissions during FDE management (Laubach et al., 2014; Ledgard and Brier, 2004; Luo et al., 2013).

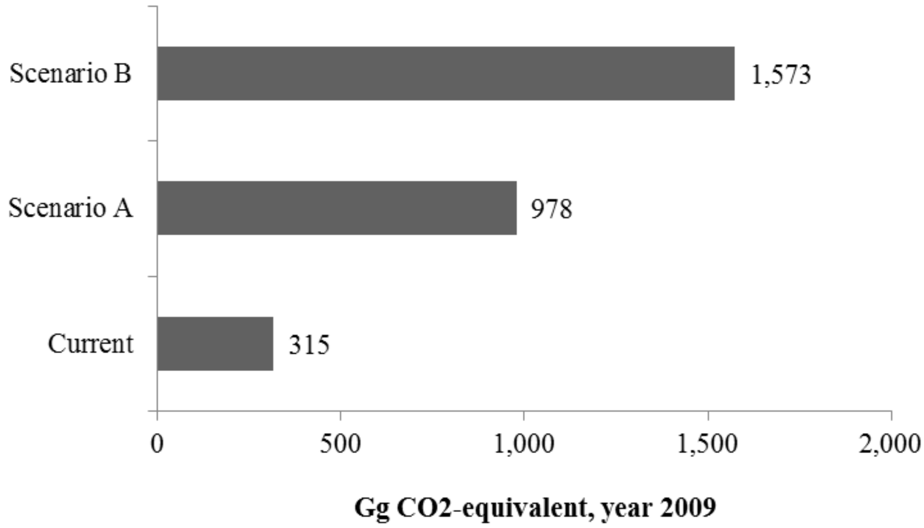

Figure 1: Comparative assessment of methane emission during dairy manure management in New Zealand adapted from Laubach et al. (2014): 'Current' represents the current estimated for year 2009; Scenario A represents farm management practices associated with the assumptions currently used in the NZ Inventory; Scenario B represents changes in farm management practices based on Luo et al. (2013) and Laubach et al. (2014) surveys and analysis.

The good news is, however, that these emissions represent the 'low hanging fruit' of climate change mitigation during dairying because technologies that can efficiently recover methane or prevent its formation are already available on the market (Figure 2; Pratt et al., 2014b; Shilton et al., 2010). A change of research investment strategy is therefore urgently needed nationally.

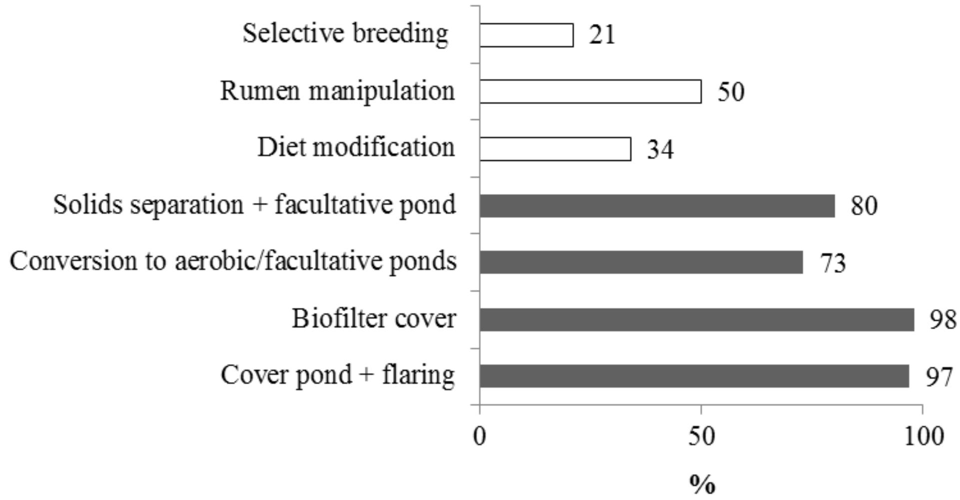

Figure 2: Comparative assessment of mitigation potential (%) of enteric emissions reduction (white) and manure management emissions reduction (grey) strategies, adapted from Pratt et al. (2014b).

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REFERENCES

Chung M., Shilton A., Guieysse B., Pratt C. 2013. Questioning the accuracy of greenhouse gas accounting from agricultural waste: A case study. Journal of Environmental Quality 42, 654-659.

IPCC, 2006. Emissions from Livestock and Manure Management. In: Eggleston, S., Buendia, I., Miwa, K., Ngara, T., Tanabe, K. (Eds.), 2006 IPCC guidelines for national greenhouse gas inventories. IGES, Kanegawa, Japan, pp. 10.11-10.87.

Laubach J., Guieysse B., Pratt C., Shilton A., Chung M., Heubeck S., Park J., Craggs R., Woodward B., van der Weerden T. Review of gaseous emissions of methane, nitrous oxide and ammonia, and nitrate leaching to water, from farm dairy effluent storage and application to land. MPI Technical Paper.

Ledgard S. and Brier G. 2004 Estimation of the proportion of animal excreta transferred to the farm dairy effluent system. Report for the Ministry of Agriculture and Forestry, Wellington, New Zealand.

Luo J., Longhurst B., Ledgard S., Woodward B., Saggar S, van der Weerden T, Lindsey S, Zonderland-Thomassen M, Olubode-Awosola F, Turner J, Boyes M and Pinares C 2013 Review of greenhouse gas emissions from housing/stand-off pad systems. Report for the Ministry for Primary Industries, Wellington, New Zealand.

MfE, 2013. Detailed methodologies for agricultural greenhouse gas emission calculation. New Zealand Ministry for the Environment, Wellington.

Pratt C., Walcroft A., Shilton A., Guieysse B., Chung M., Craggs R., Heubeck S. 2012. Revised methane emission factors and parameters for dairy effluent ponds. Ministry for Primary Industries.

Pratt C., Guieysse B., Shilton A., Chung, M. 2014a. New Zealand's flawed methodology for estimating methane emissions from anaerobic dairy effluent ponds New Zealand Journal of Agricultural Research. Online. DOI:10.1080/00288233.2014.911751

Pratt C., Redding M., Hill J., Shilton A., Guieysse B., Chung M. 2014b. Good science for good policy: targeting agricultural manure greenhouse gas, Animal Production Science, accepted,

Shilton A., Guieysse B., Pratt C., Walcroft A., 2010. GHG abatement: the new paradigm for wastewater management in the agricultural industry - economic evaluation of options for a typical New Zealand dairy farm. Massey University, NZ.