Methane biofilters – a novel and sustainable approach to managing methane emissions from dairy farms?

Landcare Research
Manaaki Whenua

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Introduction

Methane (CH_4) is New Zealand's major agricultural greenhouse gas (GHG), mainly sourced from enteric fermentation and effluent ponds on dairy farms. Nationally, CH_4 represents 35% of our total GHG emissions on a CO_2-equivalent basis, and effective mitigation options have yet to be developed. Mitigating this potent gas has become increasingly urgent following new research (Shindell et al. 2009) indicating it has a much greater warming effect on the atmosphere than previously thought.

Most dairy farms in New Zealand are not large enough for CH_4 capture from effluent ponds and subsequent energy production to be economically viable. We are therefore developing a CH_4 biofilter using CH_4-oxidising bacteria (methanotrophs) as a low-cost alternative option to treat effluent pond emissions, and potentially treat enteric emissions from housed animals.

Experimental approach

Our understanding of how methanotrophs respond to changes in CH_4 concentration is being greatly enhanced using a unique automated system of monitoring CH_4 oxidised in laboratory chambers (Fig. 1). We are using methanotroph populations sourced from landfill cover soils because they are adapted to high CH_4 concentrations. The most active methanotrophs are being identified, and the results from these laboratory experiments have provided a sound basis for constructing and deploying a prototype methane biofilter on a Massey University dairy farm effluent pond (Fig. 2).

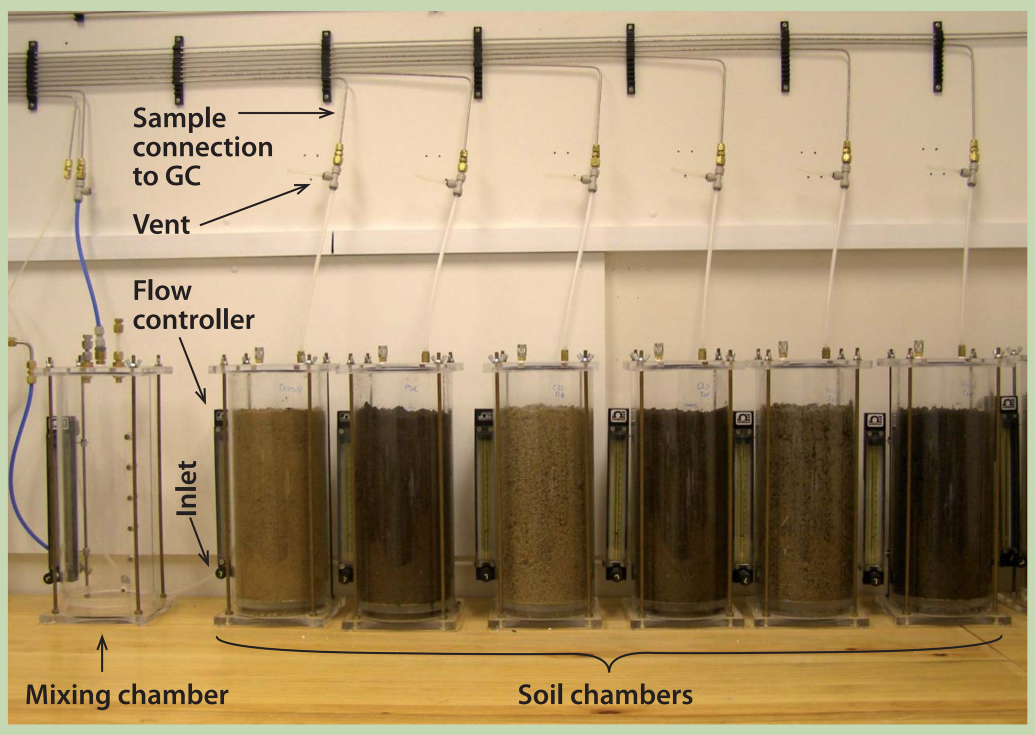


Figure 1 Chamber set-up

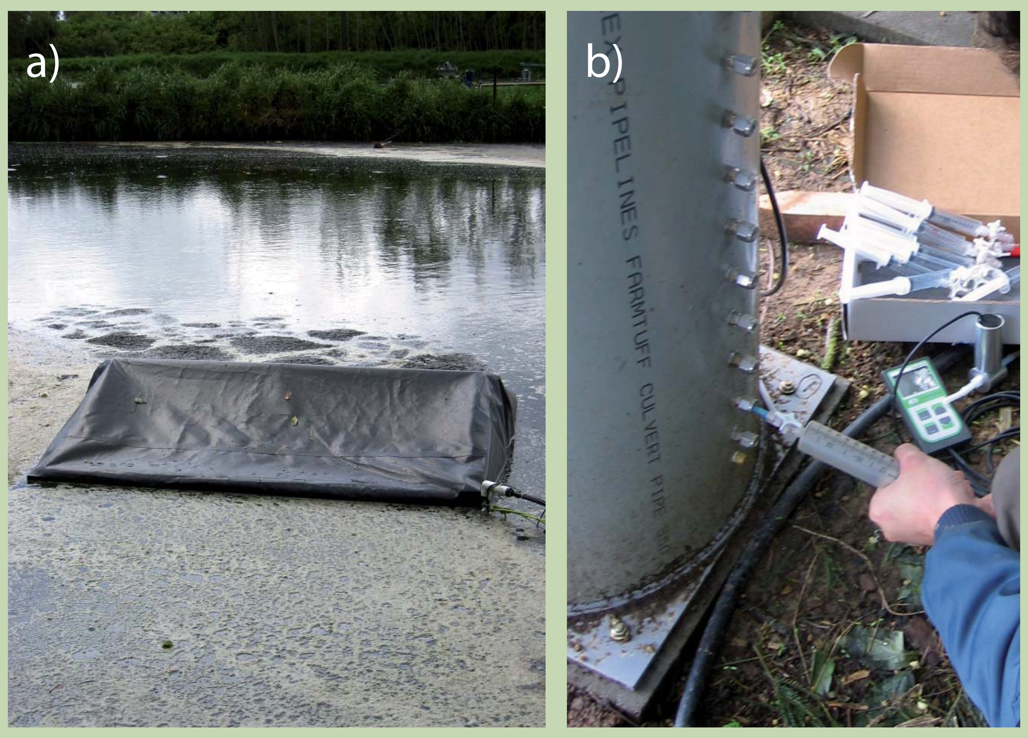


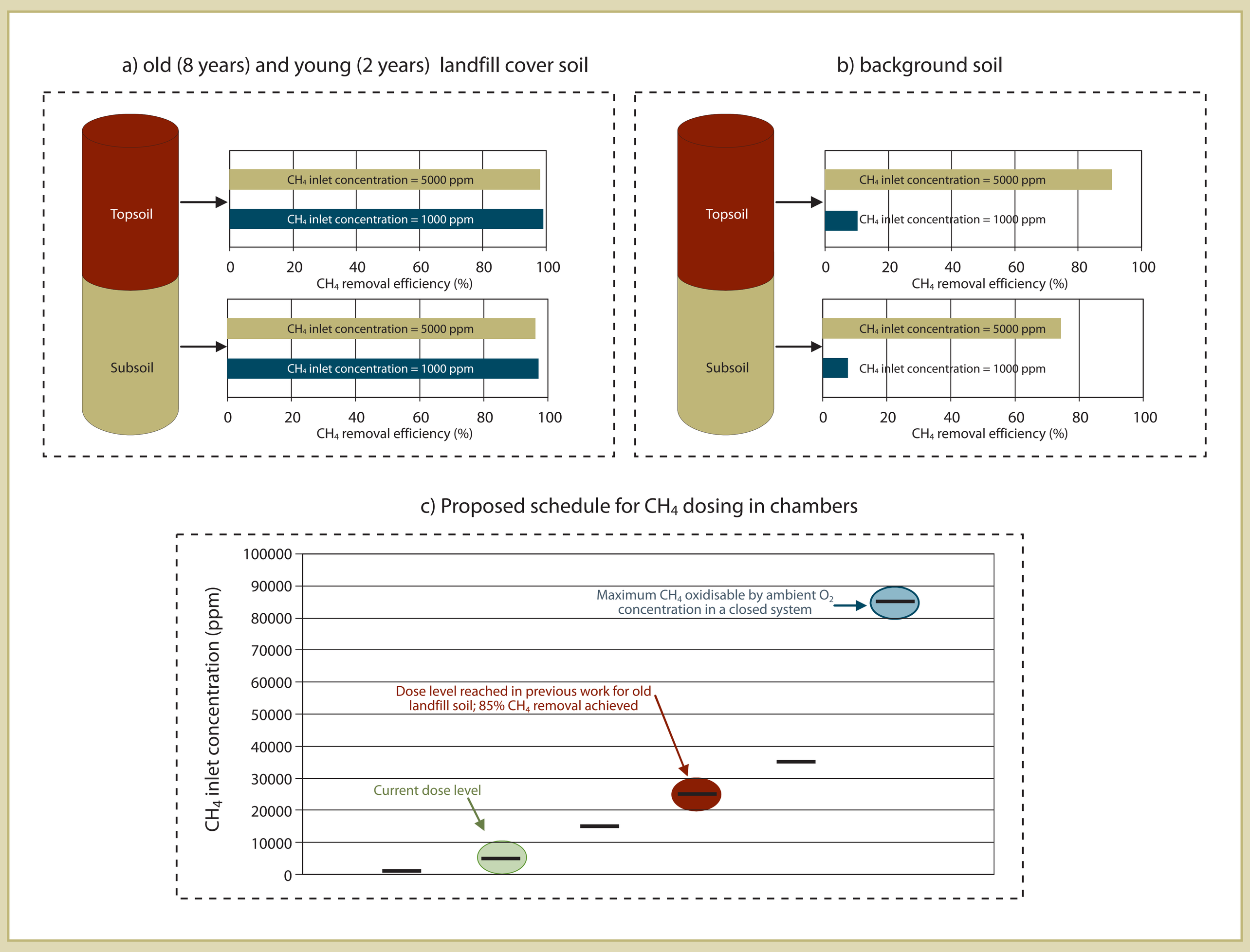
Figure 2 Field filter set-up a) gas capture system, b) filter with gas sampling ports

Current findings

Laboratory Chambers

Results (Fig. 3) suggest young and established landfill soils have a very high capacity for oxidising CH_4 over a wide range of concentrations. Even 'background' soils sampled away from the refuse exhibit a high CH_4 consumption rate with increased CH_4 dose.

Figure 3 CH_4 oxidation rates for soil chamber trials



Field Biofilter

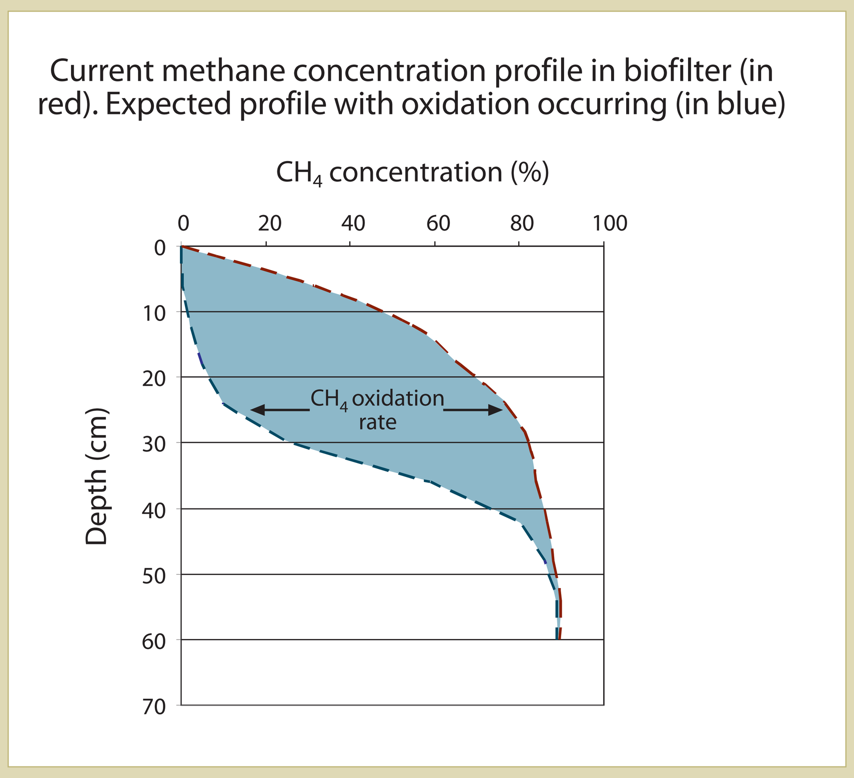
Biogas efflux from our pond surface cover is being measured using a unique volumetric flux meter that can measure low flow rates with minimal pressure drop.

Preliminary data indicate:

- Pond surface CH_4 efflux rates are greater than previously reported (McGrath & Mason 2004, Craggs et al. 2008).
- The unusually high fluxes are currently too high for effective oxidation in the test biofilter.
- Laboratory data suggest the methanotrophs in the biofilter may adapt over about a month.

The current CH_4 concentration profile in the field filter is shown by the red line in Fig. 4. As CH_4 oxidation increases, we expect the concentration profile in the filter to approach the trajectory shown by the blue line. This will then allow us to determine oxidation by comparing the area between the two profiles (Fig. 4).

Figure 4 Results from field study



Implications and road ahead

We chose to focus our efforts first on treating CH_4 emissions from effluent ponds because they represent a significant proportion of the total farm emissions. Also, the high concentration–low flow conditions provide an opportunity to demonstrate the potential of this simple technology to oxidise CH_4, and to assess its cost effectiveness. Treating enteric and waste emissions from housed animals may prove more challenging, but we believe our approach could also be feasible in such a low concentration–high flow environment.

References

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3 Shindell D. T., Faluveg G., Koch D. M., Schmidt D. A., Unger N., Bauer S. E. 2009 Improved attribution of climate forcing emissions. Science 326: 716–718

Acknowledgements

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