


GHG and Odour Emissions from Manure Spreading


A comparison of liquid and solid manure and surface and subsurface application

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Overview

- Background of manure application in Saskatchewan and Canada
 - Solid manure injection prototype
- Odour and GHG issues
- Results
 - Odour
 - GHG
- Significance of results
- Emission rate modeling





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Manure Application in Canada

- 150 million tonnes of manure produced annually in Canada
 - Main sources: solid beef, solid poultry, liquid swine, liquid dairy
 - Majority is land applied
 - Manure was applied to 3.4 million hectares of land in Canada in 2005
 - 68% of land applied with manure was applied with solid
 - 60% of land applied with manure was injected or incorporated

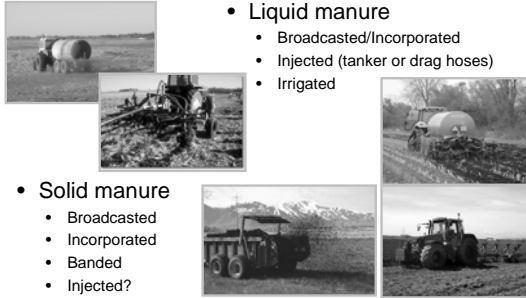


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Manure Application in Canada

- Liquid manure
 - Broadcasted/Incorporated
 - Injected (tanker or drag hoses)
 - Irrigated
- Solid manure
 - Broadcasted
 - Incorporated
 - Banded
 - Injected?



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Solid Manure Injection Prototype



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Odour and GHG Issues

- Odours from manure spreading concern neighbours and communities
 - Do odour reducing strategies actually reduce odours?
- Approximately 5% of total GHG comes from livestock production
 - Do odour reducing strategies significantly increase GHG emissions?
- Are odour and GHG emissions different from solid vs liquid manure?

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Data Collection

- Plot scale rather than field scale
 - Simulated application (2 m x 1 m)
 - Machine application (3 m x 10 m)
- Two manure types (solid, liquid)
 - Solid: feedlot, poultry, swine
 - Liquid: swine, dairy
- Two application methods (surface, subsurface)
- Four application rates (0X, 1X, 2X, 3X)
- One time after application
- Three replications

Factorial design:
 5 manures x 2 modes x 4 rates x 1 time x 3 reps = 120 plots

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Data Collection

- Odours
 - Flux chamber @ 2 cfm and dynamic dilution olfactometry
 - Immediately after application
- GHG
 - Static chambers (approx 40 L) and gas chromatography
 - 24 hrs after application
 - CO₂, CH₄, N₂O
 - CO₂-e = CO₂ + 21 * CH₄ + 310 * N₂O

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Odour Unit (log OU) Results

Manure Type	Log OU (approx.)
Liquid	2.6
Solid	2.45

Application Method	Log OU (approx.)
Injected	2.45
Surface	2.6

- Differences are statistically significant at 95% level of confidence

Error bars represent standard error of the mean
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Odour Unit (log OU) Results

The left chart shows log OU values for 1X, 2X, and 3X rates across four manure types. The right chart shows log OU values for Dairy, Swine(S), Feedlot, and Poultry manure types.

- 1X, 2X, 3X rates not different from each other
- Poultry manure application generated highest odours of solid manure

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Error bars represent standard error of the mean

Specific Odour Flux

- N content of manures varied and actual application rates varied slightly from target application rates
 - N application rates varied among experiments and manure types
- “Specific Odour Flux” is the odour flux (OU/m²-s) divided by the actual N application rate (kg/m²)
 - Units: OU/kg N-s
- Allows better comparisons among different types of manure

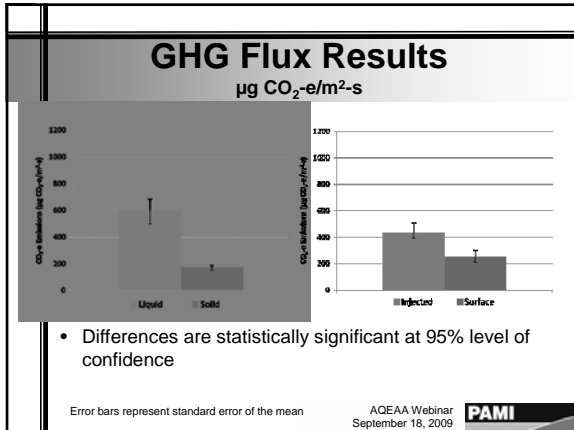
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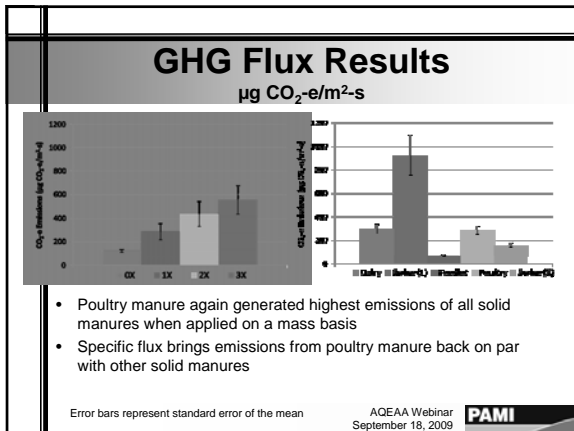
Specific Odour Flux Results

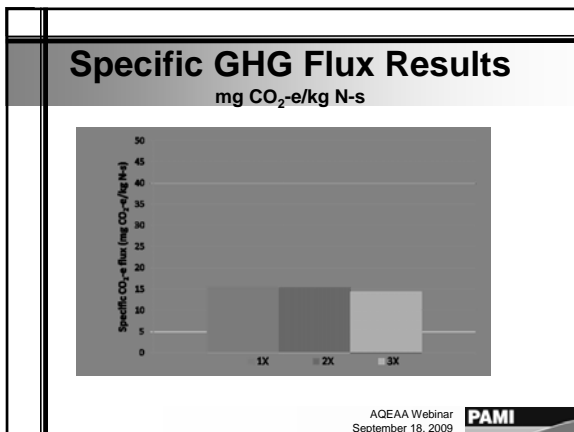
The left chart shows Specific Odour Flux (OU/kg N-s) for Dairy, Swine(S), Feedlot, and Poultry manure types. The right chart shows Specific Odour Flux (OU/kg N-s) for 1X, 2X, and 3X application rates.

- When applied on a per mass or volume basis, poultry manure generated the highest odours
- When applied on a per kg N basis, poultry manure odours are comparable to other solid manures

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Contributions of 3 GHG's

Manure Type	CO ₂ (%)	CH ₄ (%)	N ₂ O (%)
Liquid	0	75	25
Solid	0	85	15

- CO₂ makes up a large portion of total emissions, but they are relatively constant and uncontrollable
- N₂O is more variable and manageable (and of greater concern)
- CH₄ is negligible

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Contributions of 3 GHG's

Manure Type	CO ₂ (%)	CH ₄ (%)	N ₂ O (%)
Surface	0	90	10
Subsurface	0	65	35

- N₂O contributes to a larger proportion of emissions from liquid and injected treatments

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Implications of Results

- Injection of both liquid and solid manure resulted in lower odours
 - Reduced contact with air = reduced volatilization
 - Injection reduced odours from solid manure more consistently (coverage more consistent at higher rates)
- Injection of both liquid and solid manure resulted in higher GHG emissions
 - Denitrifier activity beneath soil surface promotes N₂O generation and emission
 - Increase from solid manure injection not statistically significant (P = 0.108)

Injection of solid poultry manure (with prototype) reduced ammonia emissions by 98%

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Interpretation Cautions

- Odour emissions from liquid manure higher than from solid manure....**initially!**
 - What about 1 hr after application? 24 hrs after?
- GHG emissions from injection higher than surface application....**initially!**
 - What about 1 week after application? 2 months after application?
- Emission rate over time required for odour dispersion modeling and calculations involving GHG contributions

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Emission Rate Trend

Idealized curve for gaseous emission rate variation with time after application

**Solid manure
Surface application**
**Liquid manure
Injection**

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Summary

- “Immediately” after application:
 - Injection of solid manure reduced odours by 47% and increased GHG's by 27%
 - Injection of liquid manure reduced odours by 24% and increased GHG's by 44%
- Emission rate trend over time will help determine effect of manure type and application method on **total** emissions

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<h2>Summary</h2>
<ul style="list-style-type: none">• Based on specific fluxes, immediately after application:<ul style="list-style-type: none">– Odours from liquid manure 68% higher than from solid manure– GHGs from liquid manure 85% higher than from solid manure
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