GHG and Odour Emissions from Manure Spreading

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

Joy Agnew, P.Eng, M.Sc.
Prairie Agricultural Machinery Institute
Humboldt, SK

PAMI

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

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?

Solid Manure Injection Prototype




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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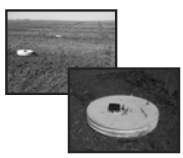
Data Collection

- 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

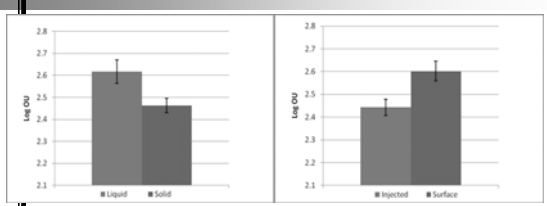
Factorial design:
5 manures x 2 modes x 4 rates x 1 time x 3 reps = 120 plots

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
  - CO_2, CH_4, N_2O
  - CO_2-e = CO_2 + 21 * CH_4 + 310 * N_2O



Odour Unit (log OU) Results



- Differences are statistically significant at 95% level of confidence

Error bars represent standard error of the mean

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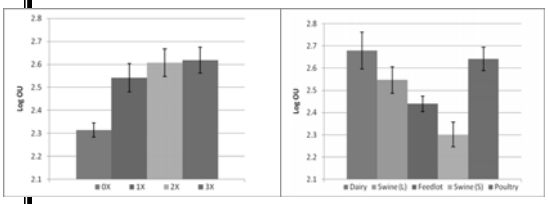
Odour Unit (log OU) Results



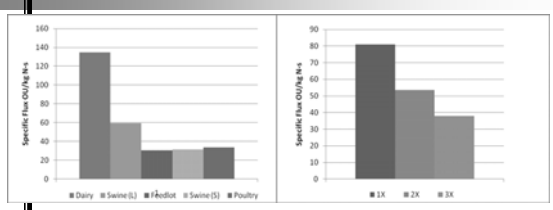
- 1X, 2X, 3X rates not different from each other
- Poultry manure application generated highest odours of solid manure

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/m^2-s) divided by the actual N application rate (kg/m^2)
  - Units: OU/kg N-s
- Allows better comparisons among different types of manure

Specific Odour Flux Results



- 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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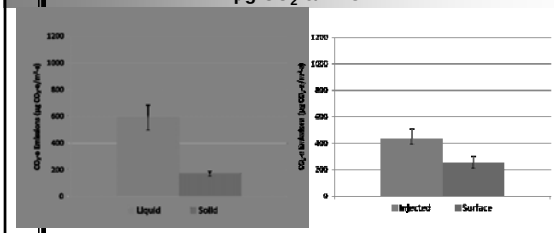
GHG Flux Results

µg CO_2-e/m²-s



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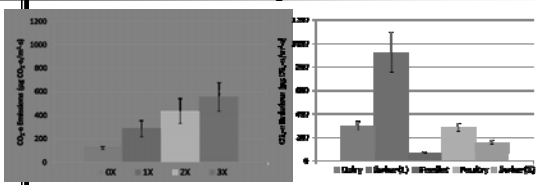
GHG Flux Results

µg CO_2-e/m²-s

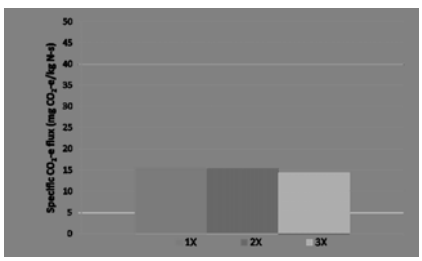


- Poultry manure again generated highest emissions of all solid manures when applied on a mass basis
- Specific flux brings emissions from poultry manure back on par with other solid manures

Error bars represent standard error of the mean

Specific GHG Flux Results

mg CO_2-e/kg N-s



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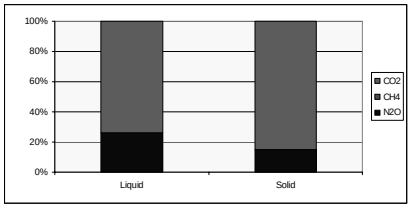
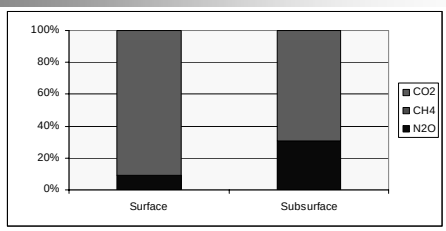
Contributions of 3 GHG's



- CO_2 makes up a large portion of total emissions, but they are relatively constant and uncontrollable
- N_2O is more variable and manageable (and of greater concern)
- CH_4 is negligible

Contributions of 3 GHG's



- N_2O contributes to a larger proportion of emissions from liquid and injected treatments

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 N_2O 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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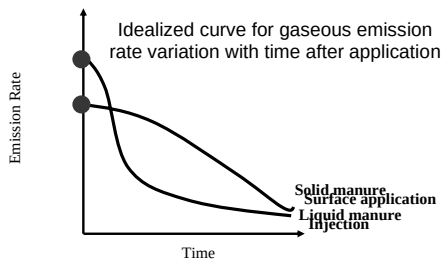
Interpretation Cautions

- 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

Emission Rate Trend



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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Summary

- Based on specific fluxes, immediately after application:
  - Odours from liquid manure 68% higher than from solid manure
  - GHGs from liquid manure 85% higher than from solid manure

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Contact Information

For information on odour and GHG emission research:

Joy Agnew
jagnew@pami.ca
(306) 682-5033 ext 280

For information on solid manure injection prototype:

Hubert Landry
hlandry@pami.ca
(306) 682-5033 ext 266