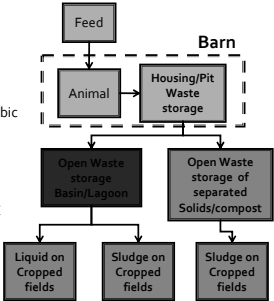


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Greenhouse gas emissions from open manure storage

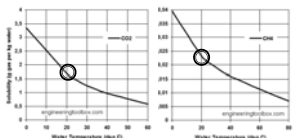
On-farm emissions of GHG

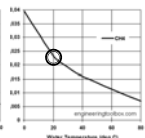
- Gases: CH₄, CO₂, N₂O
- Sources:
 - Feed storage
 - Animals in barn
 - Manure storage in/under barn
 - Manure storage in basin, anaerobic lagoon, compost pile
 - Manure spread onto field
 - Sludge solids
 - Injection, irrigation
- Emissions included in proposed EPA rule in black letters




Issues: Characteristics of gas being emitted

- CH₄ has low solubility in water: gas produced and bubbles rise to the surface
- CO₂ and N₂O have high solubility in water: molecular and turbulent diffusion processes dominate at liquid/air interface







Issues: Reporting and documenting lagoon/ basin measurements

- Proposed EPA ruling reporting of
 - CH₄ based on Total Volatile Solids in manure
 - N₂O based on total N in manure
- Reporting of emissions in literature on per animal, per input, and per area basis?
 - Available feed for conversion and efficiency of production
 - Available manure for conversion
 - Available surface area for emission
- Documenting farm operations, meteorological and source characteristics
- Emissions measurements of variable accuracy

Issues: Appropriate lagoon/ basin measurement methods

- Closed chambers that float on the lagoon
 - Good at measuring CH₄ emissions
 - Underestimates CO₂ and N₂O emissions (gas/liquid diffusion equilibrium)
 - Represents only a small area
 - Good for some inter-comparisons
- Open air (micrometeorological)
 - Good at measuring CH₄, CO₂, and N₂O
 - Represents a large area, often assuming homogeneous emissions across area
 - Weather-affected: hard to inter-compare

CO₂ and CH₄ lagoon emissions

- Gas production by anaerobic decomposition
- Only CH₄ emissions are in proposed reporting rule.
- Lagoon emission influenced by:
 - Temperature (Lagoon or air proxy)
 - Wind speed (effect most evident during warm months)
 - Volatile solids content



CH₄ lagoon emissions

- Equivalent CO₂ : over 100 y, 1 g = 21 g CO₂
- Inconclusive emission rates

Farm	Method	Location	kg CH ₄ head ⁻¹ yr ⁻¹	kg CO ₂ e head ⁻¹ yr ⁻¹	
Swine finisher	Biogas/ chamber	Taiwan	0.77	17.7	Su et al., 2003
Swine finisher	Biogas/chamber	KS	8.3	191	DeSutter and Ham, 2005
Swine finisher	flux gradient profile	GA	0.5	11.5	Sharpe and Harper, 1999
Swine finisher	flux gradient profile	NC	6.0	138	Sharpe et al., 2002
Swine sow	flux gradient profile	NC	1.6	36.8	Sharpe et al., 2002
Dairy	Biogas/chamber	Taiwan	4.9	113	Su et al., 2003

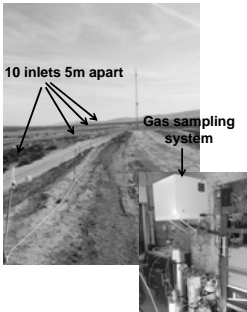
National Air Emissions Measurement Study (NAEMS)

- Air sampling through 'synthetic' open path system (S-OPS) consisting of 10 air inlets.
- An S-OPS at opposite sides (upwind/downwind) of the lagoon/basin. Air sampled sequentially.
- Measure CH₄ by photo-acoustic spectroscopy (PAS) of sampled air.

PAS rotating among:

- 4 Dairies
- 3 Swine Finishers
- 3 Swine Sow

- Emissions by backward Lagrangian Stochastic model

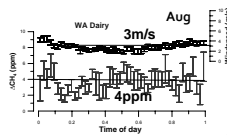


10 inlets 5m apart

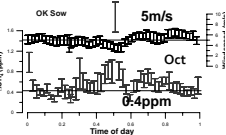
Gas sampling system

NAEMS CH₄ measurements

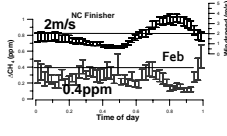
- Diurnal variation over 20d



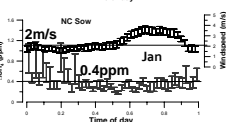
WA Dairy Aug
3m/s
4ppm



OK Sow Oct
5m/s
6.4ppm



NC Finisher Feb
2m/s
0.4ppm



NC Sow Jan
2m/s
0.4ppm
