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Summer Ammonia Emission Rates From Free-Stall and Open-Lot Dairies in Central Texas

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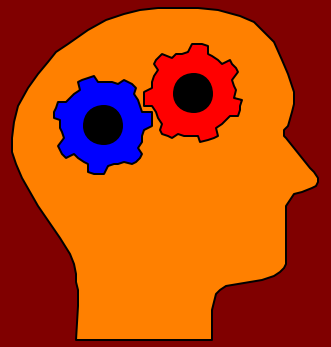
Introduction



Major Source of Ammonia ?

AFOs

Fertilizer applications

Livestock housing
Outdoor corrals used by livestock
Manure stores
Grazing livestock

Why ammonia emission?

NH_3 is a major contributor to $PM_{2.5}$

What needs to be done?

Need to quantify ***accurate*** NH3 emissions from GLAS

What do we expect?

NH3 emissions may be regulated in future

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Study Objective

- ✓ To estimate and compare summer ammonia emission rates (ERs) of free-stall and open-lot dairies using a flux chamber protocol.

<u>This protocol resulted in:</u>

- real-time estimations
- emission fluxes and rates.

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Sampled Dairies

Free-stall Dairy

Open-lot Dairy

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Sampling Equipment

Flux Chamber

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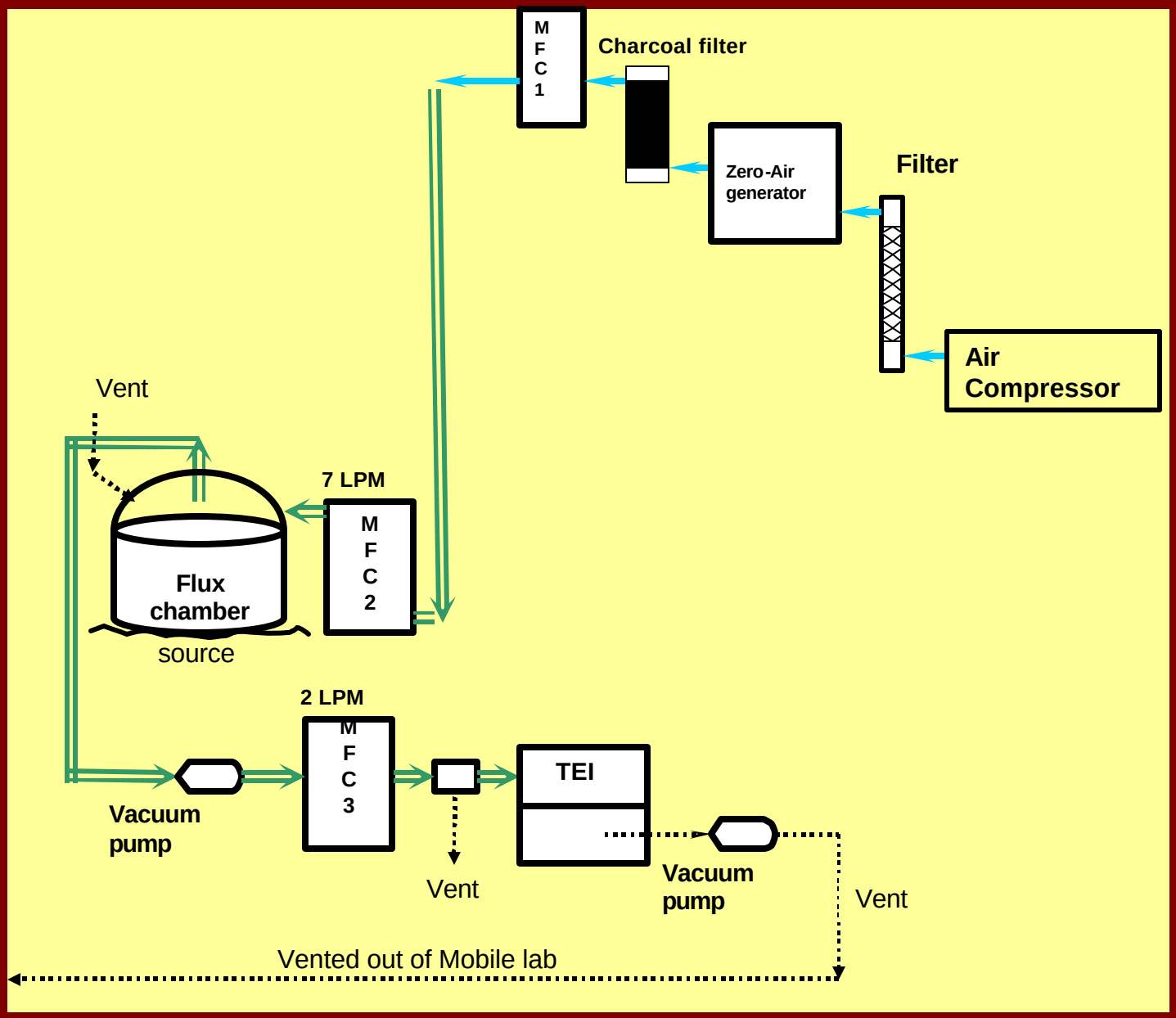
Flux Chamber & Analyzer Setup



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Free-Stall Sampling

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Free-stall Dairy Lagoon Sampling

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Open-lot Sampling

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Open-lot Dairy Lagoon Sampling

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NH_3 Flux & Emission Rate Calculations

$$C_{mass} = 1000 \times \left(\frac{P}{RT} \right) \times C_{ppm} \times MW_p$$

$$EFl_{NH_3} = \frac{C_{mass} \times V_{fc}}{A_{FC}}$$

$$ER = EFl x A_s$$

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NH_3 Concentrations & ERs for Free-stall Dairy

GLAS	Number of Samples	Concentration (ppm)	Mass Concentration ($\mu g/m^3$)	Flow Rate (L/min)	Emission Flux ($\mu g/m^2/s$)	Area (m^2)	Emission Rates (kg/day)
Compost	11	1.9 ±1.6[b]	1321	7.10	0.81 ±0.7 [b]	16600	1.17 ±0.97 [b]
Freestall	14					9790	
Non-feed	5	57.5 ±50.5	33349	7.09	20.53 ±23	2700	4.79 ±5.4
Feed	5	74.0 ±72.4	51574	7.09	31.75 ±31	3090	8.48 ±8.3
Bedding	2	2.4 ±22.2	1698	7.09	1.05 ±9.5	3800	0.34 ±3.1
Water Area	2	21.7 ±84.4	15113	7.09	9.30 ±36.2	200	0.16 ±0.63
Open Lot	8	4.8 ±3.9	3317	7.10	2.05 ±1.7	38000	6.72 ±5.5
Crowding Area	4	9.6 ±8.2	6690	7.03	4.06 ±3.4	925	0.32 ±0.3
Separated Solids	4	3.7 ±7.2	2428	7.09	1.50 ±2.9	109	0.01 ±0.03
Lagoon 1	8	32.8 ±7.1	22878	7.10	14.09 ±3.0	19200	23.4 ±5
Lagoon 2	6	28.1 ±2.9	19588	7.10	12.07 ±1.3	17000	17.72 ±1.9
Statistic	55[a]	-	-	-	-	101624[a]	63.1 [a] ±31.1

[a] Summation
[b] 95% confidence interval (CI)

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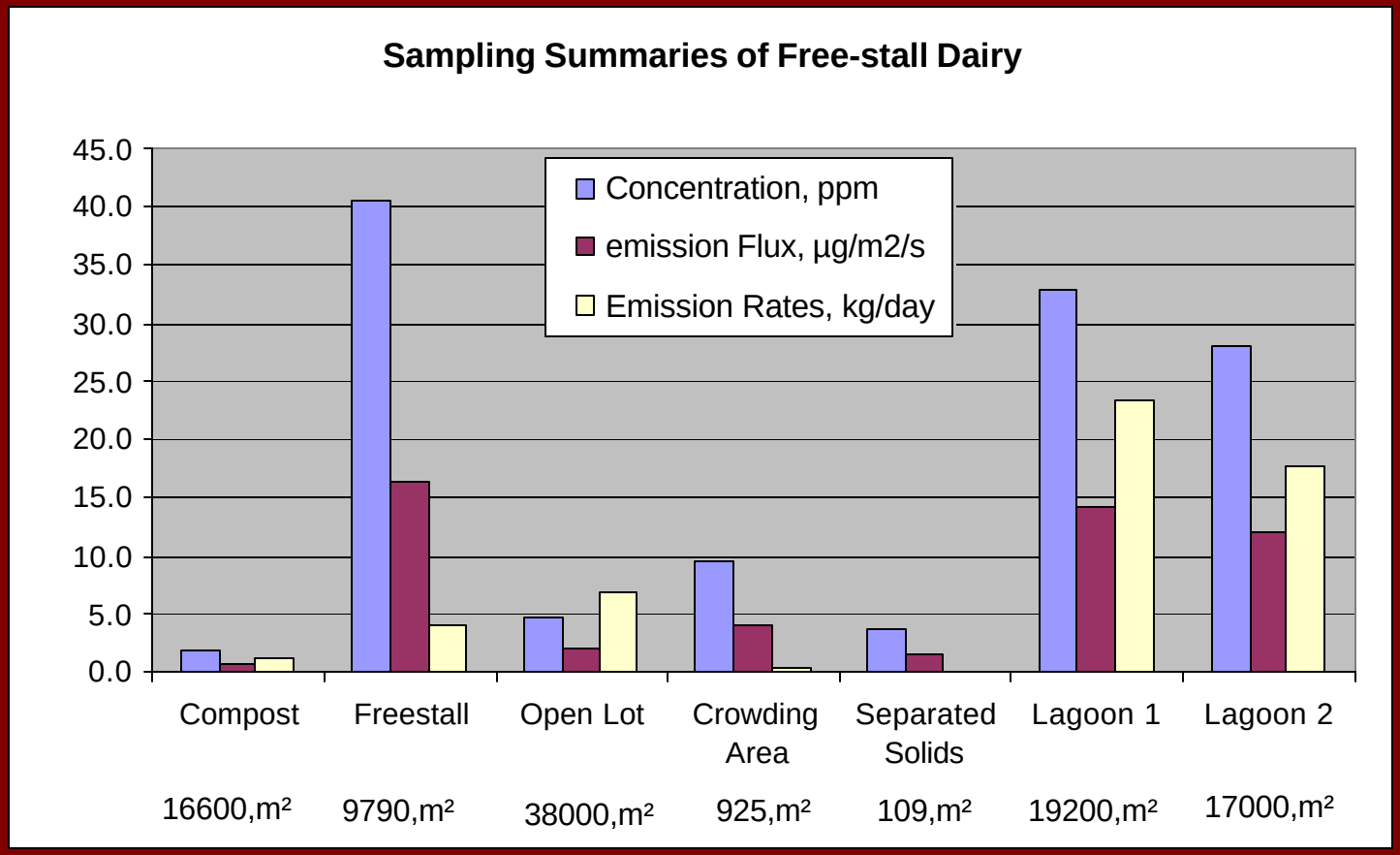

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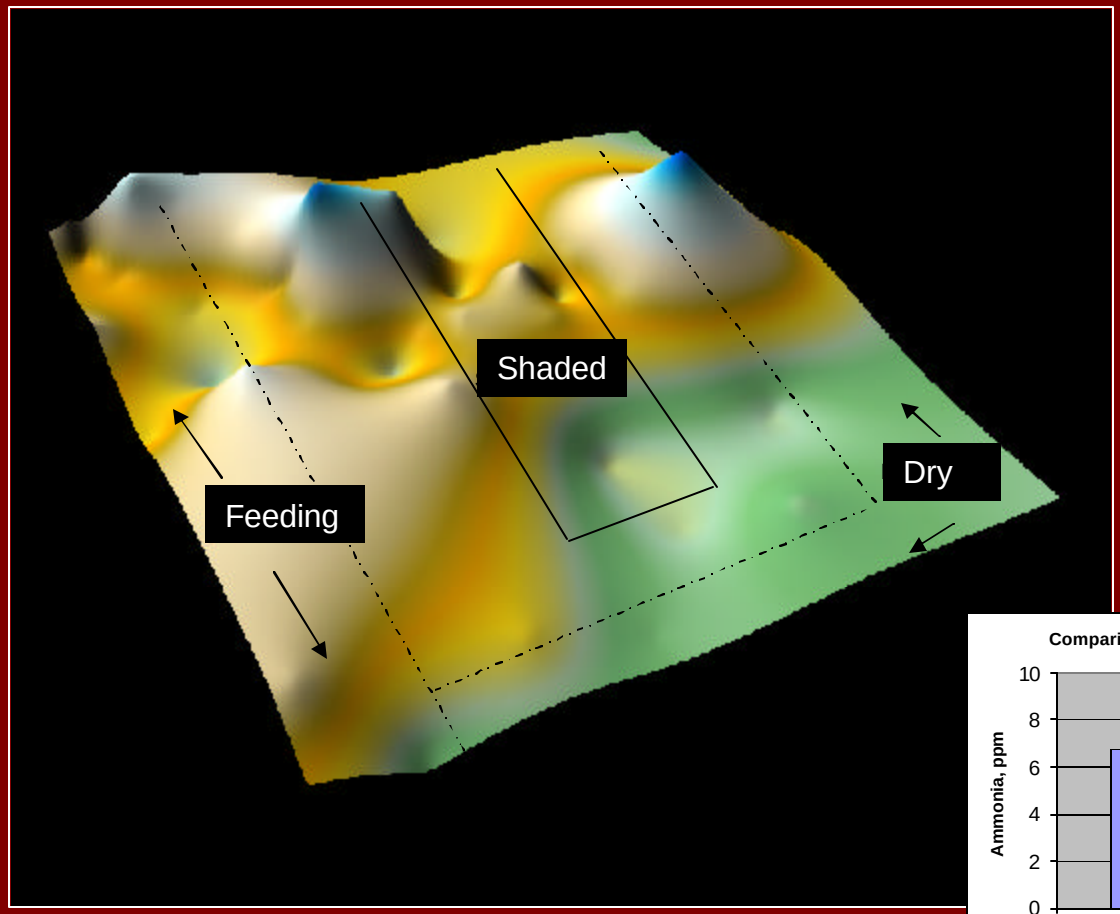
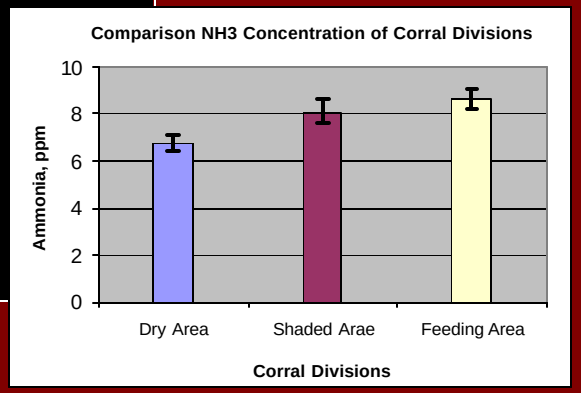
Spatial variability of ammonia concentrations at the open-lot corral





($p_{dry\text{-}feeding}$ =0.00< 0.05 and $p_{dry\text{-}shaded}$ =0.01< 0.05)

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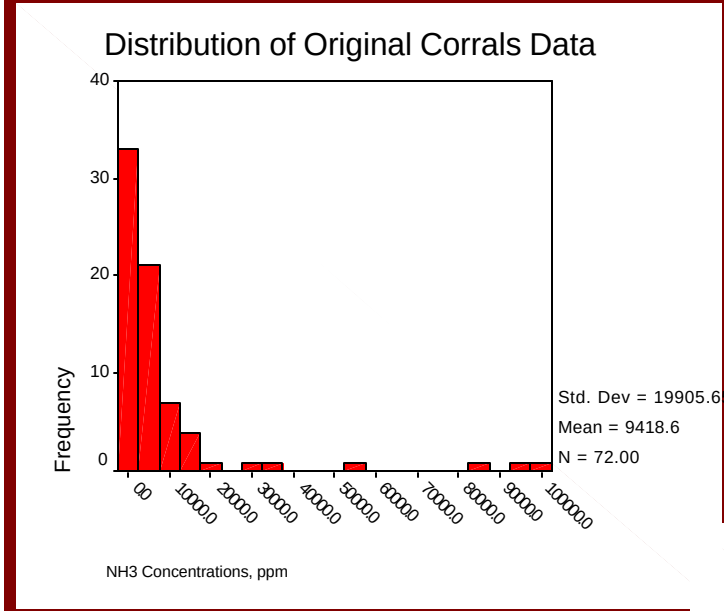
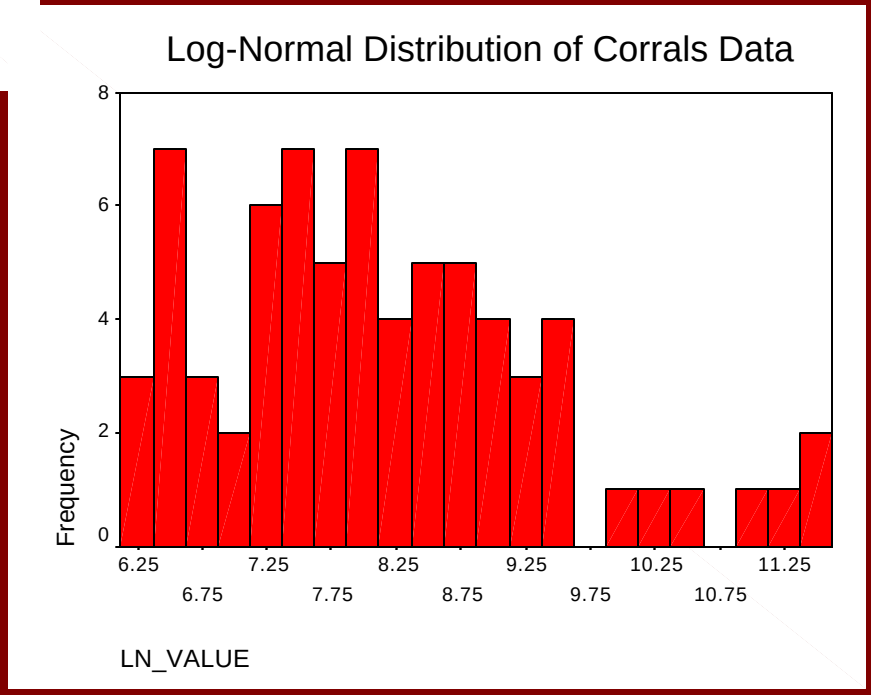
Normalization Process of Openlot Corrals Data





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NH_3 Concentrations & ERs for Open-lot Dairy

GLAS	Number of Samples	Concentration (ppm)	Mass Concentration ($\mu g/m^3$)	Flow Rate (L/min)	Emission Flux ($\mu g/m^2/s$)	Area (m^2)	Emission Rates (kg/day)
Open Lots (earthen corrals)	72	2.9 (±0.1)[b]	2076 (±44)	7.1 (±0.01)	1.3 (±0.3)	102840	11.4 (±0.2)
Lagoon-1	8	11.2 (±0.9)	7810 (±657)	7.1 (±0.01)	4.8 (±0.4)	6273	2.6 (±0.2)
Lagoon-2	35	3.8 (±0.6)	2660 (±444)	7.1 (±0.01)	1.6 (±0.3)	46094	6.5 (±1.1)
Milking Parlor	6	5.6 (±4.1)	3896 (±2877)	7.1 (±0.02)	2.4 (±1.8)	500	0.1 (±0.1)
MP Alley	5	0.8 (±0.4)	575 (±306)	7.1 (±0.02)	0.4 (±0.2)	1500	0.05 (±0.02)
Statistic	126[a]	-	-	-	-	157207[a]	20.6 [a] ± 1.6

[a] Summation
[b] 95% confidence interval (CI)

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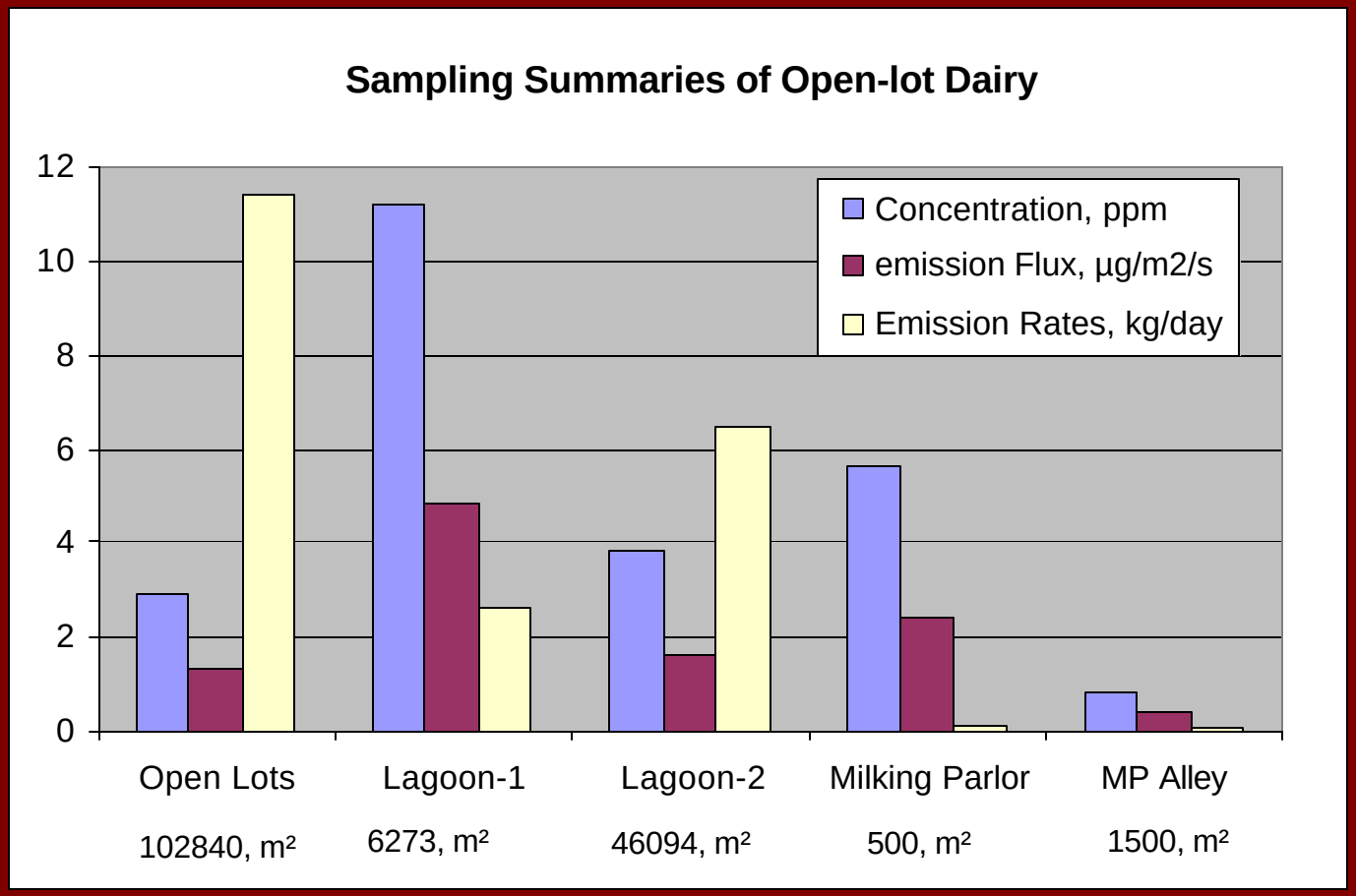

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Key Results

- ✓ The estimated emission rates for the facilities:
  63.1 ± 31.1 kg.day^{-1} (free-stall dairy)
  20.6 ± 1.6 kg.day^{-1} (open-lot dairy).
- ✓ Lagoons (65%) and open-lot corrals (55%) were the highest contributors to NH_3 emission for the facilities.
- ✓ Higher NH_3 ERs from the free-stall dairy were due to higher NH_3 concentration as a result of greater manure loading of lagoons and barns as compared to open-lot dairy lagoons and corrals.

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Conclusions

- ✓ Difference between the overall emission rates from each dairy was due to :
  - *1- Dairy waste loading rates*
  - *2- Animal population density (corrals vs. free-stall).*
  - 3- W*aste management practices*
- ✓ *There is a need for an accurate technique to measure NH_3 emissions from (AFOs) to obtain reliable emissions data.*
- ✓ Long-term studies needed to examine the impact of management practices on reducing NH_3 emissions from AFOs.

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