Correspondence between small- and large-scale determinations of ammonia emissions from dairy barns

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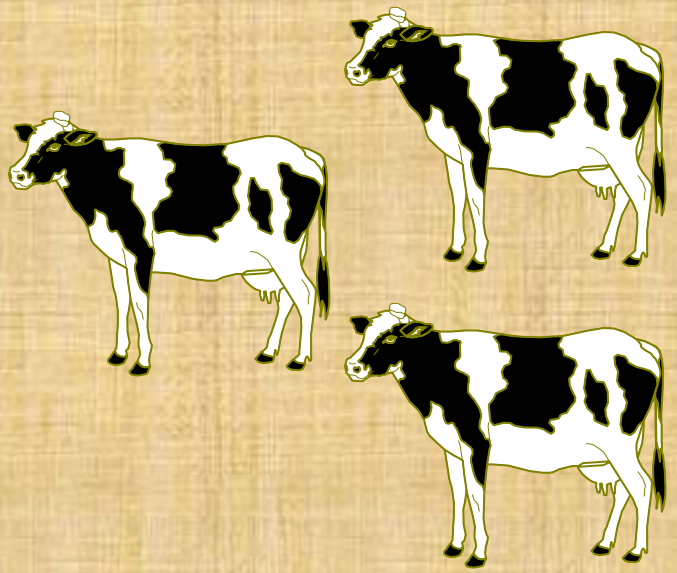
How much feed nitrogen is converted into milk on ‘typical’ dairy farms?

15-35%



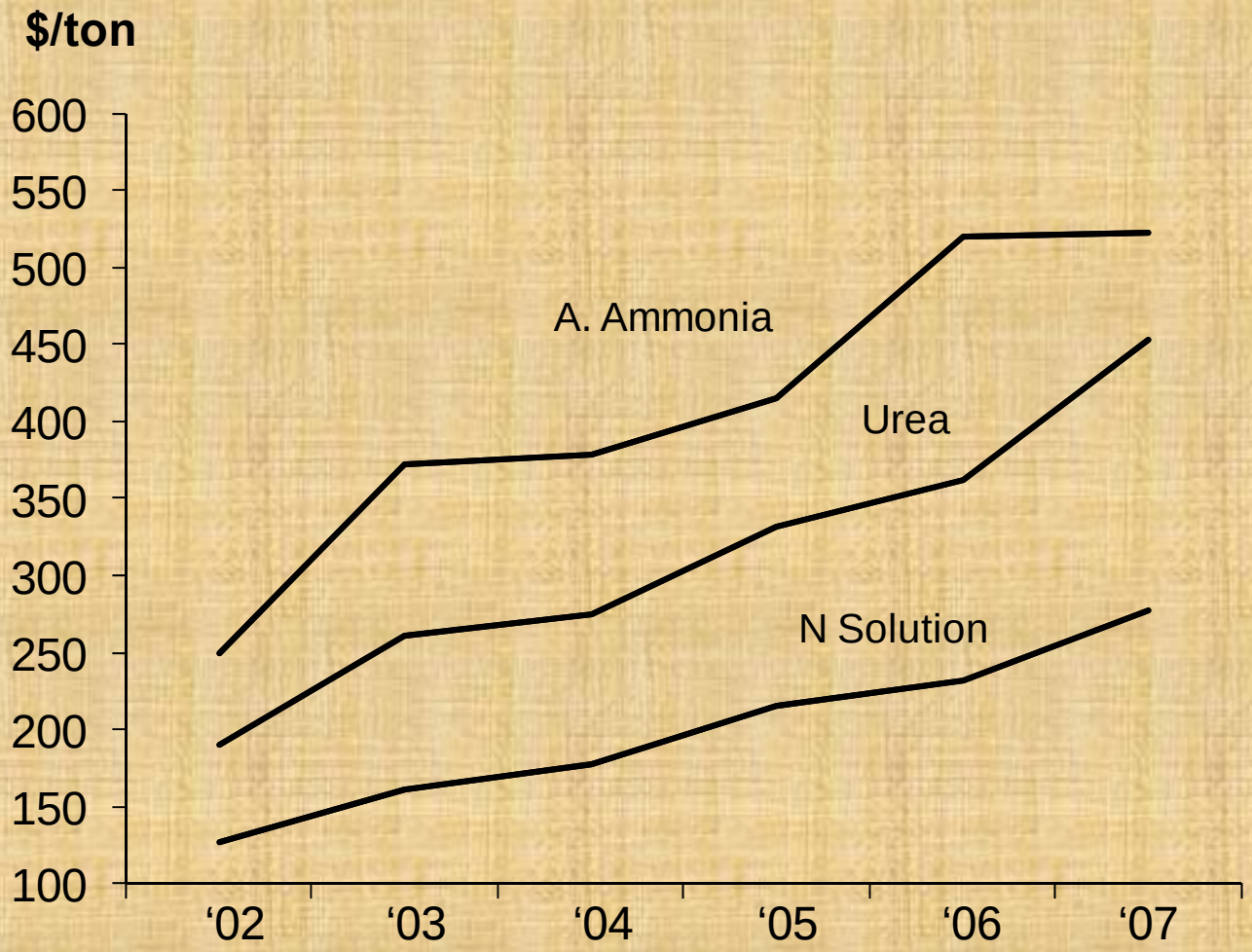
What Happens to the Nitrogen in Dairy Manure?

- Lost as ammonia (20-40%)
- Taken up by plants (20-40%)
- Lost via nitrate leaching (5-15%)
- Lost via denitrification (2-3%)
- Immobilized by soil microorganisms (?)

What We Know

- Ammonia production and loss occur almost immediately in the barn and continue through manure storage and land application.
- This loss of nitrogen greatly reduces the fertilizer value of manure.

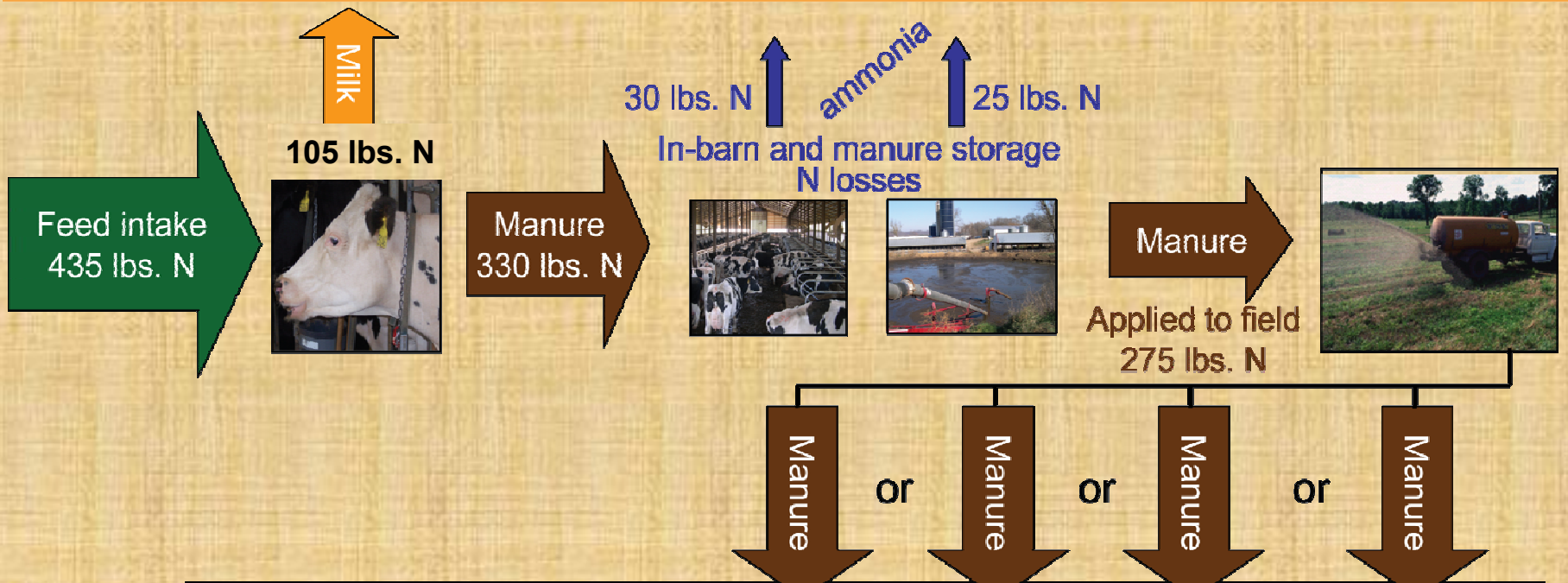
Escalating fertilizer N prices



USDA-NASS, 2008

From feed to field: Nitrogen flow on a typical confinement dairy operation

(pounds nitrogen/cow/year)



Impact of manure application on nitrogen cycling	Knifing in	Injecting in open slots	Band spreading	Broadcasting
Ammonia N loss	5	15	24	70
N going to soil	270	260	251	205

Enhancement of Manure Nitrogen Use on Dairy Farms

Dairy Rations: Manipulate the amount and form of crude protein (CP) fed to lactating cows

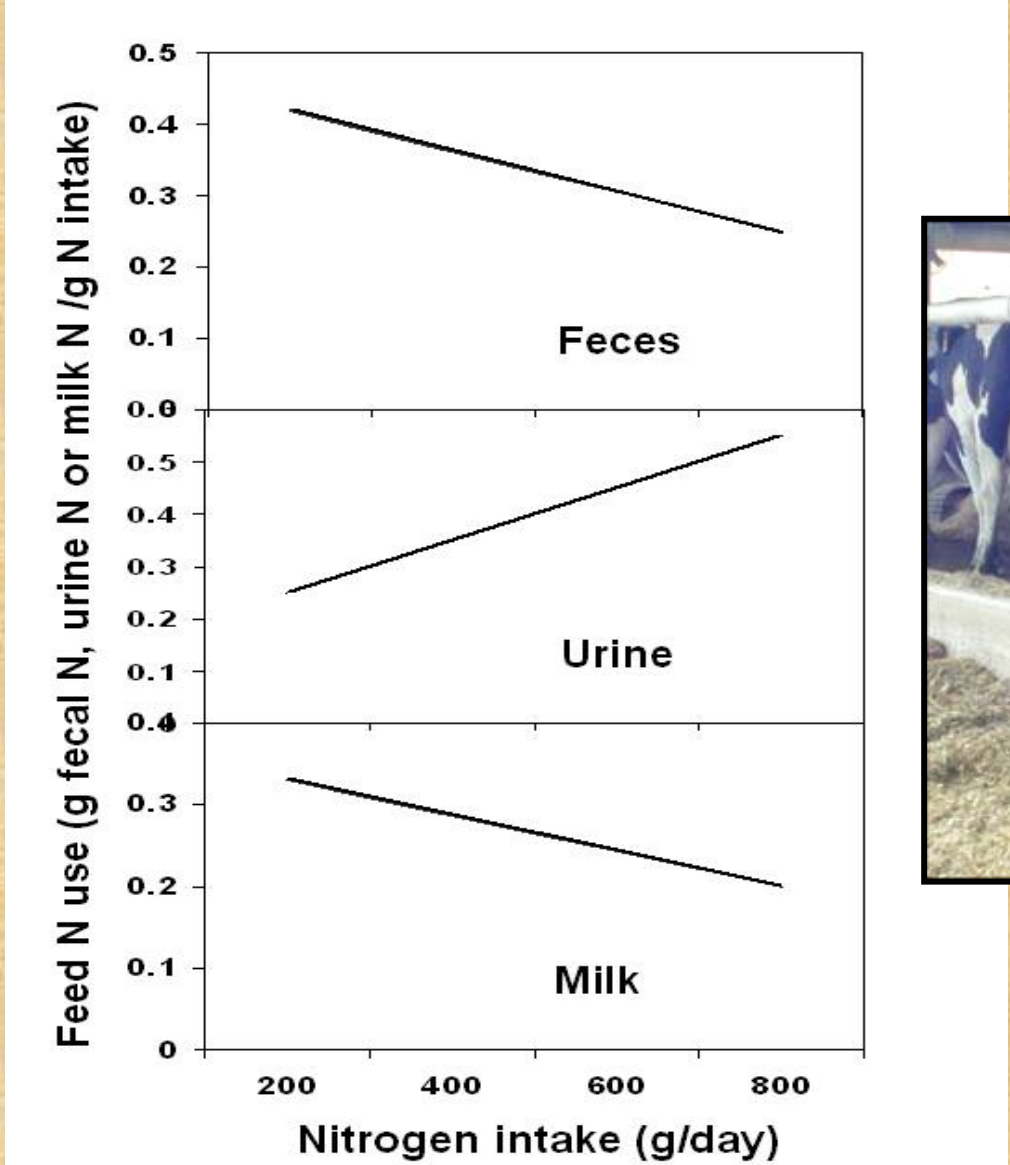
Targeted Impacts

(1) maintain high milk production and quality
(2) reduced urinary N excretion

Efficiency Gains: 20-25%

(1) less ammonia N emitted
(2) more manure N available to crops/pasture

Excess feed nitrogen is excreted in urine



Castillo et al., 2000

Enhancement of Manure Nitrogen Use on Dairy Farms

Stall Bedding: Separate feces and urine

Targeted Impacts

(1) reduced urease activity, ammonia formation and emission

(2) increased ammonium N levels in manure

Efficiency Gains: 10-15%

(1) more urine N conserved and recycled

(2) enhances synchrony of manure N release with crop N needs

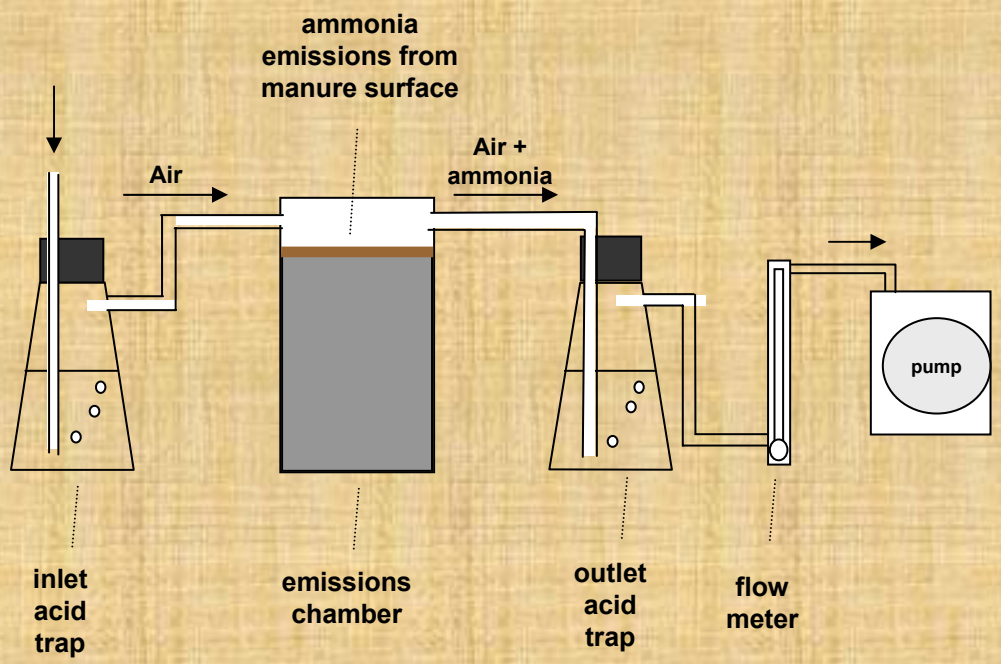
Correspondence between small- and large-scale determinations of ammonia emissions from dairy barns

- Lab chambers
- Barn chambers
- Lasers

g NH_3/cow/d

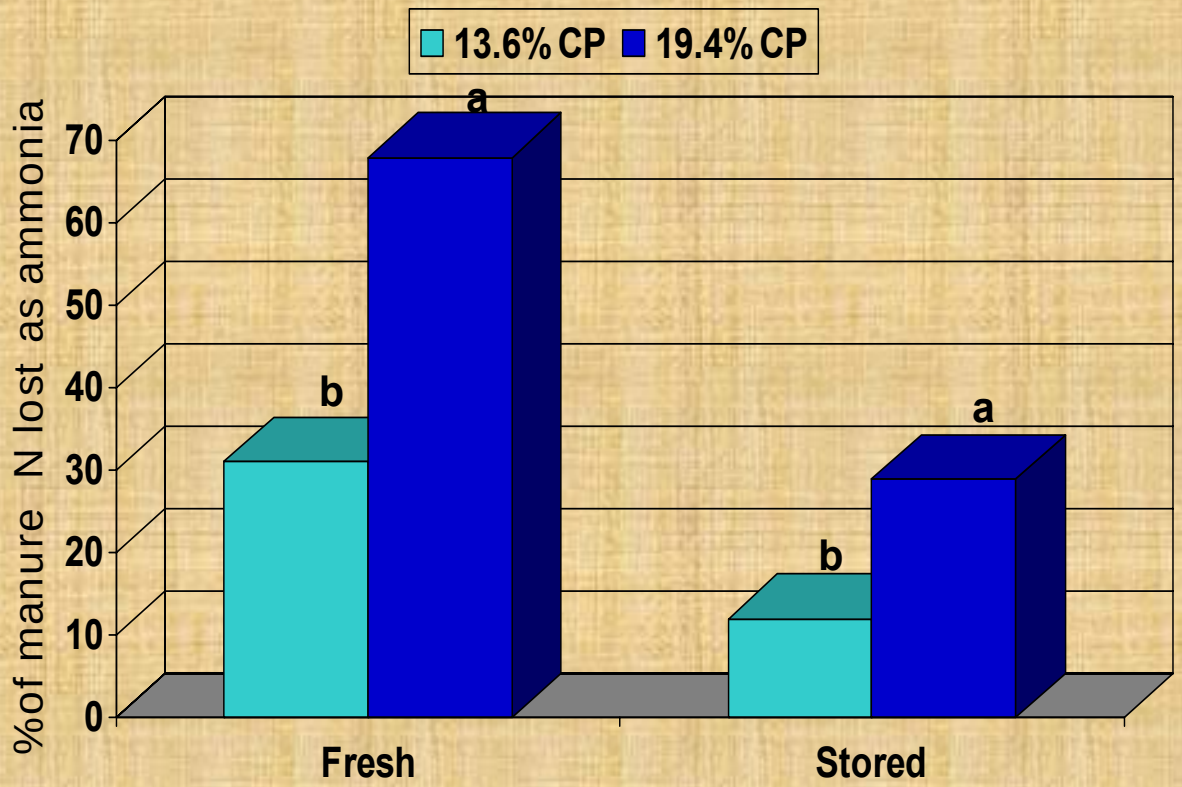
g NH_3/m^2/d

Laboratory chamber system
To measure relative ammonia emissions



Laboratory chamber system

Impact of dietary CP level on ammonia emissions from manure applied to barn floor



Misselbrook et al. 2005

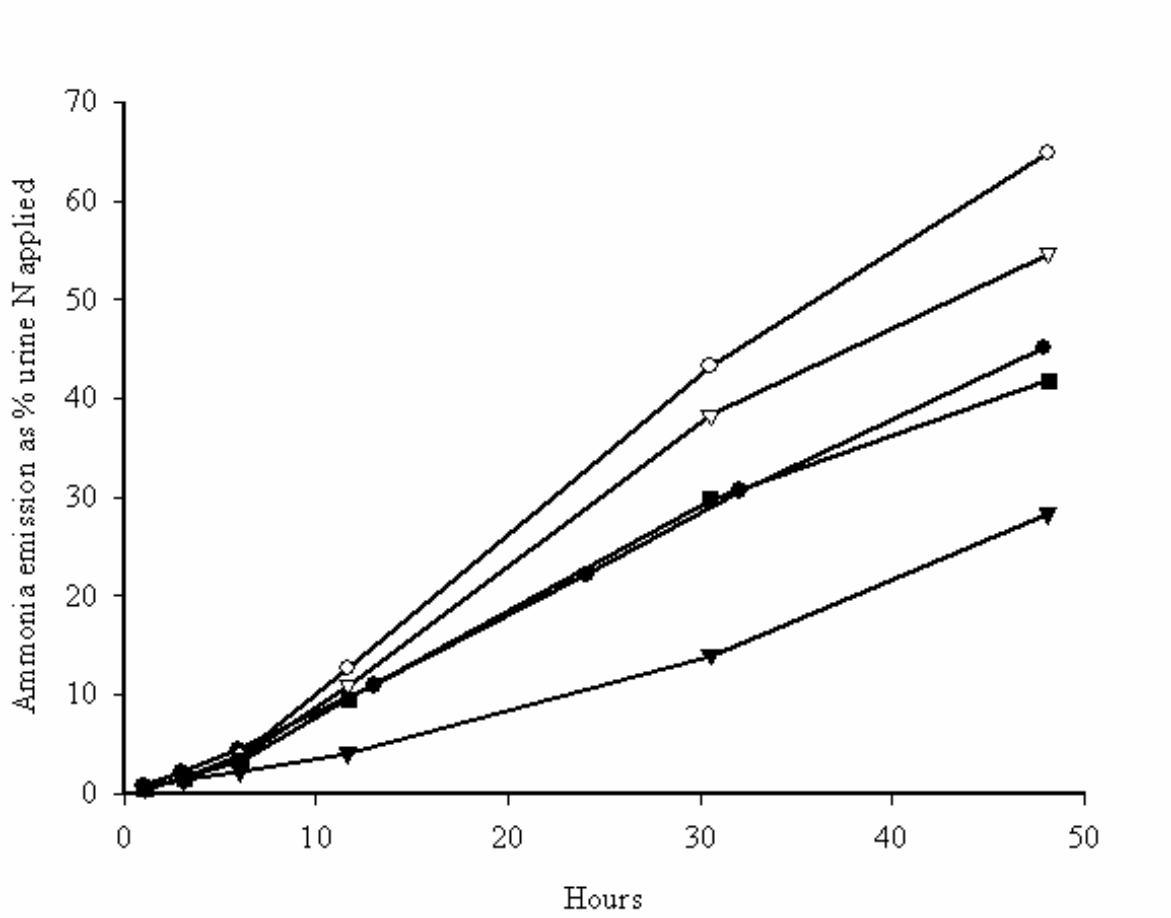
Laboratory chamber system

Impact of dietary CP level and forage type on ammonia emissions from manure applied to soil

Trial type	Trial components	Slurry type	
		Fresh	Stored
		% applied N volatilized	
CP level	13.6%	31b	12b
	19.4%	68a	29a
Forage tannin type	Alfalfa	31a	30a
	BF-T-Low	33a	23b
	BF-T-High	25b	19b

Misselbrook et al. 2005

Lab chamber – Bedding impacts



recycled manure solids, ○

chopped straw, ∇

pine shavings, ■

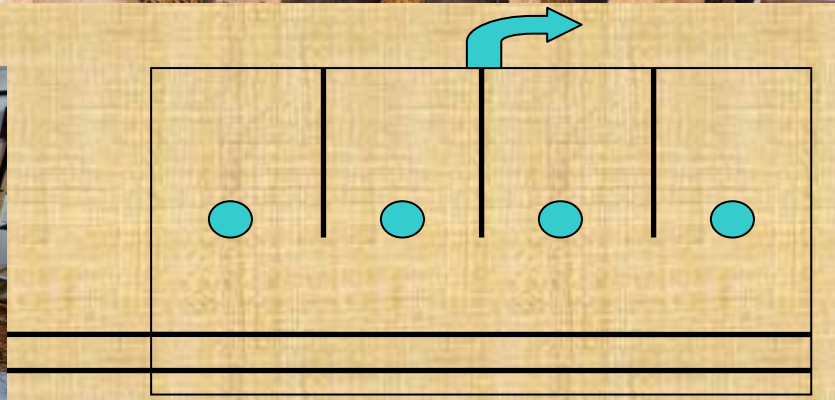
sand, ▼

Misselbrook et al. 2005

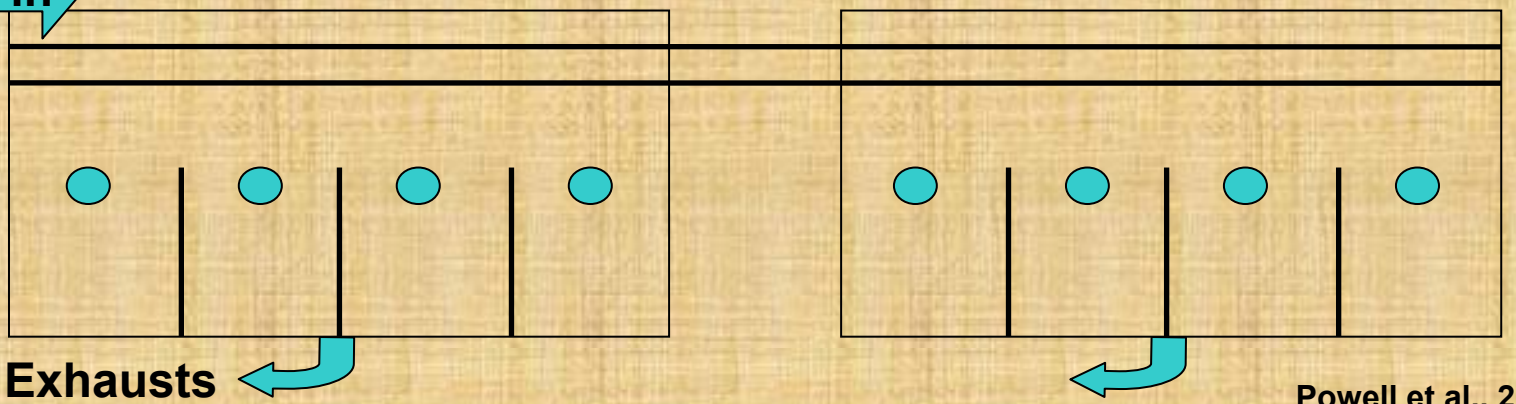
Larger Scale Estimates
Ammonia N Emissions from Dairy Barns

Scaling-up: From Laboratory to In-barn Measurements

E-barn chambers

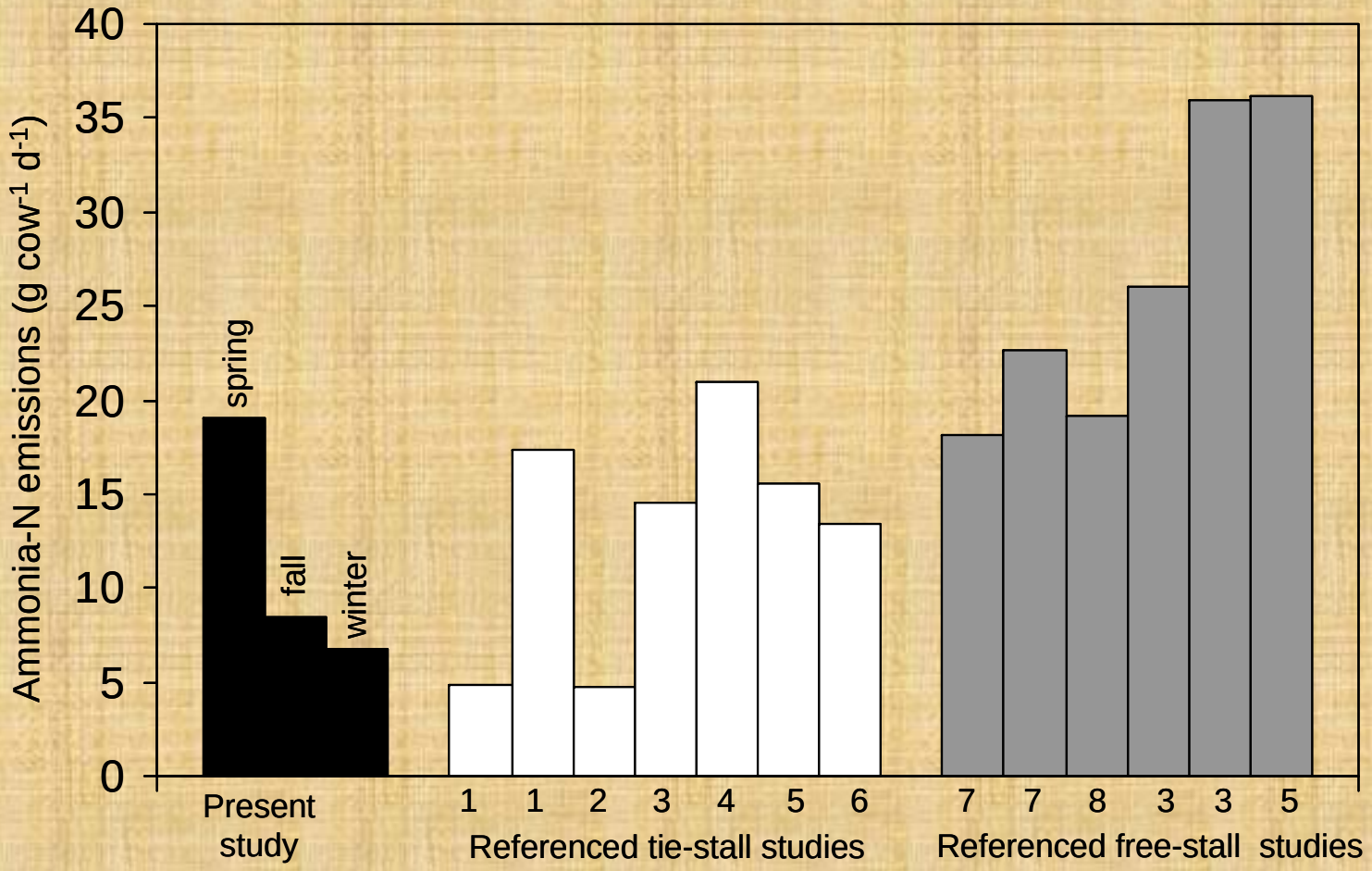


Air in



Powell et al., 2007

Ammonia emissions from barn chambers compared to other studies



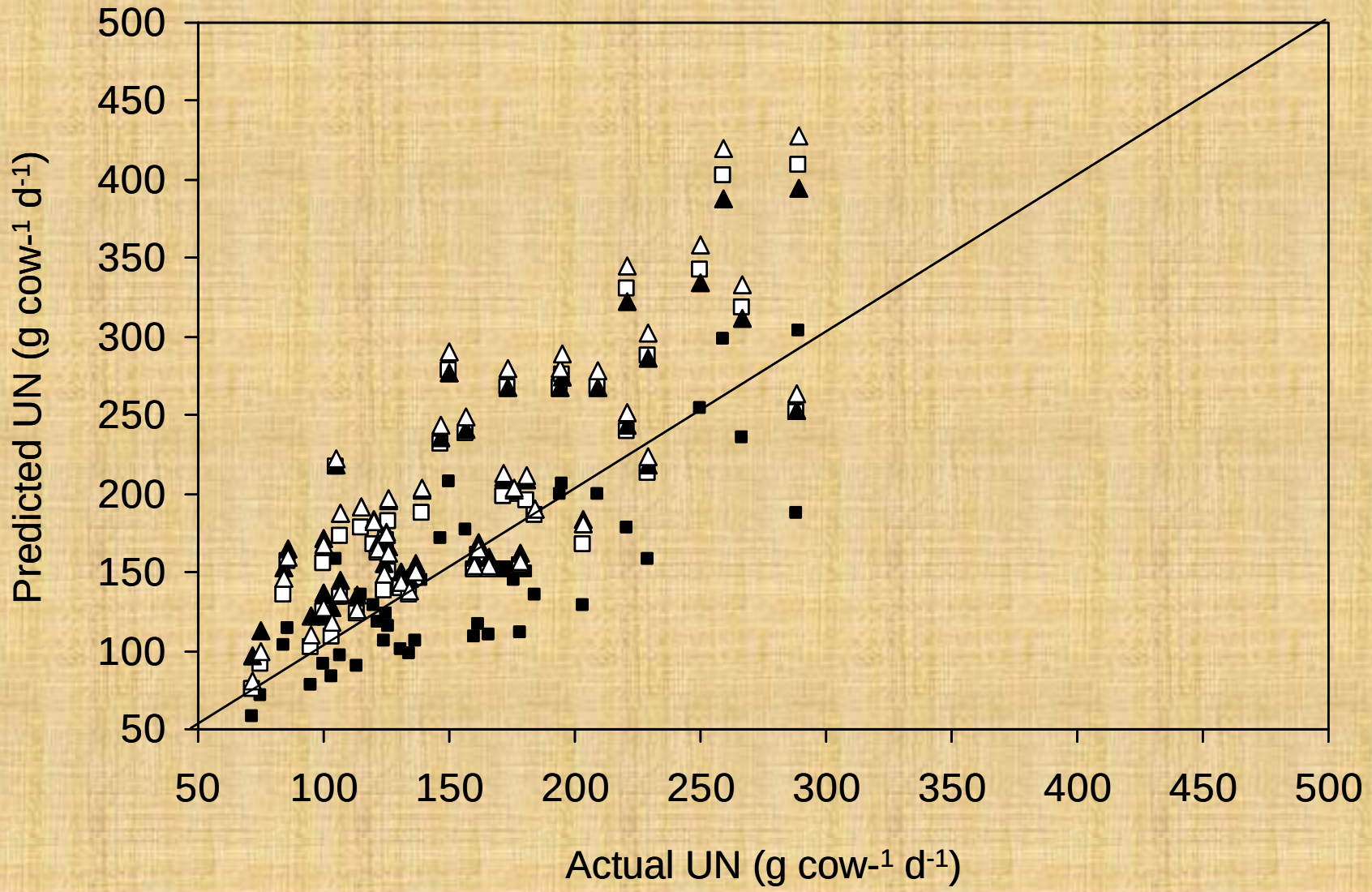
Powell et al., 2008

Barn chamber nitrogen balances

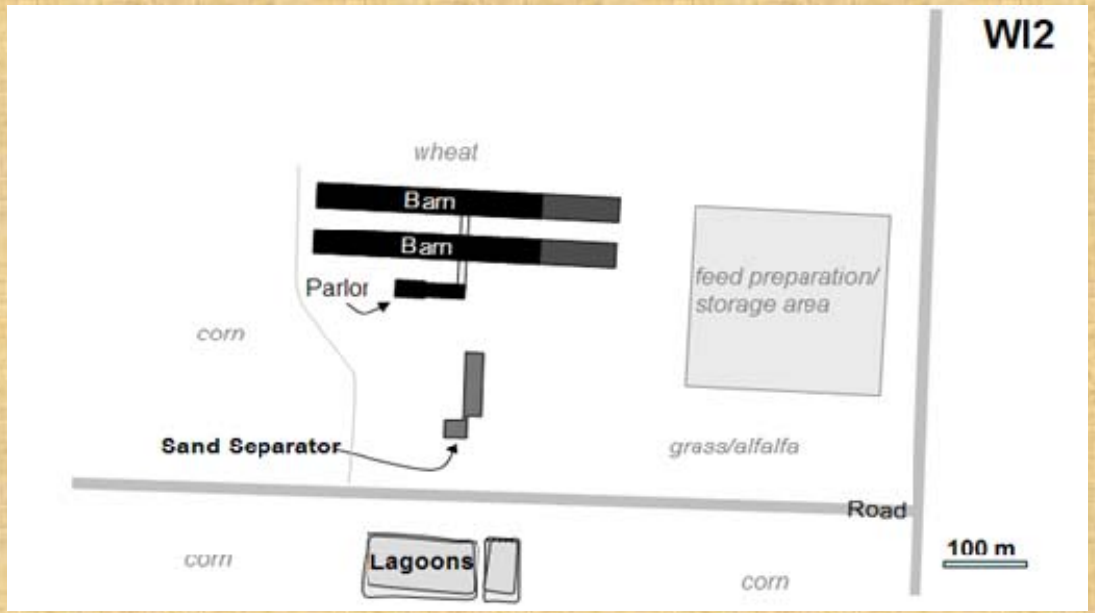
Variable	Trial season		
	Spring	Early-Fall	Winter
	g N chamber^{-1} d^{-1}		
INPUTS			
Feed consumed	2964	2433	2416
Bedding	103	110	94
OUTPUTS			
Milk	775	736	731
Manure removed	1933	1331	1495
Live weight gain	41	188	71
Ammonia loss	83	34	27
	%		
BALANCE	**93**	**91**	**95**

Powell et al., 2008

Barn chambers: Actual vs. predicted urinary N



Use of Lasers to Measure Ammonia Emissions



Flesch et al., 2008; Harper et al., 2008

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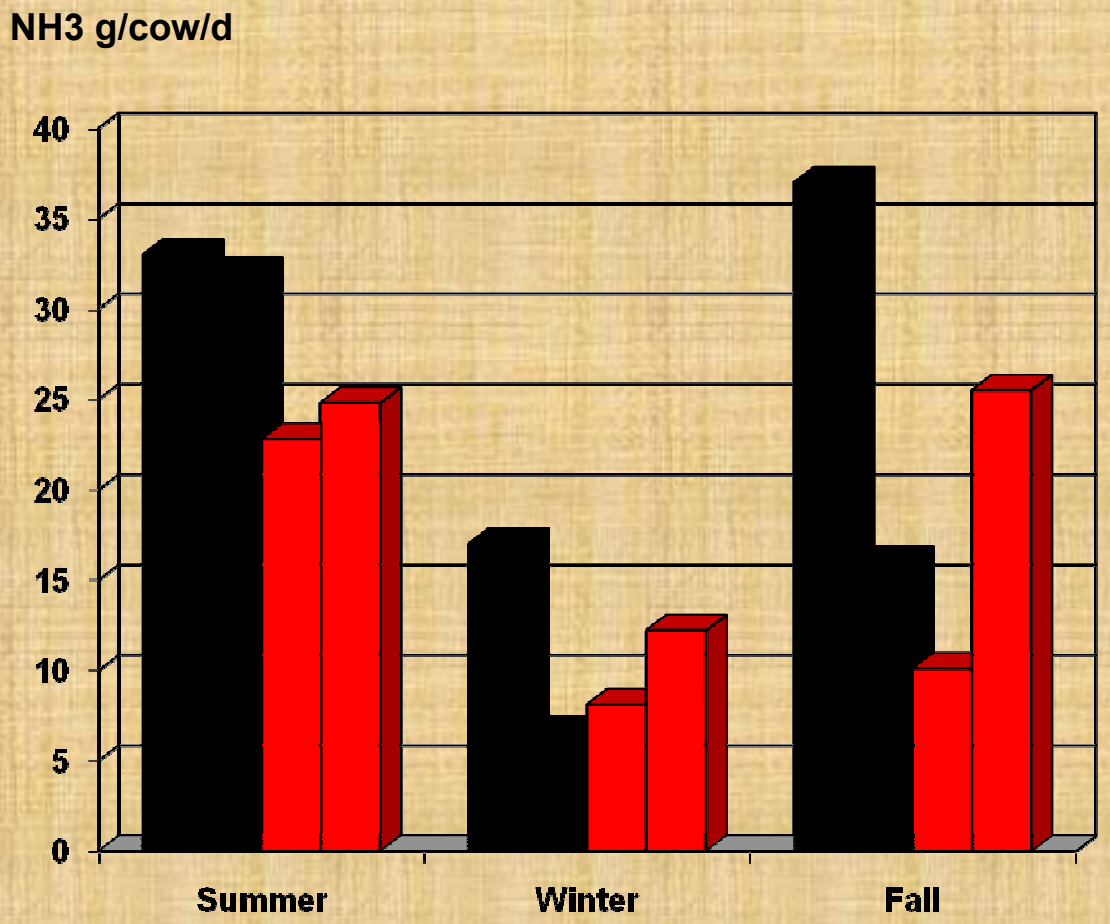
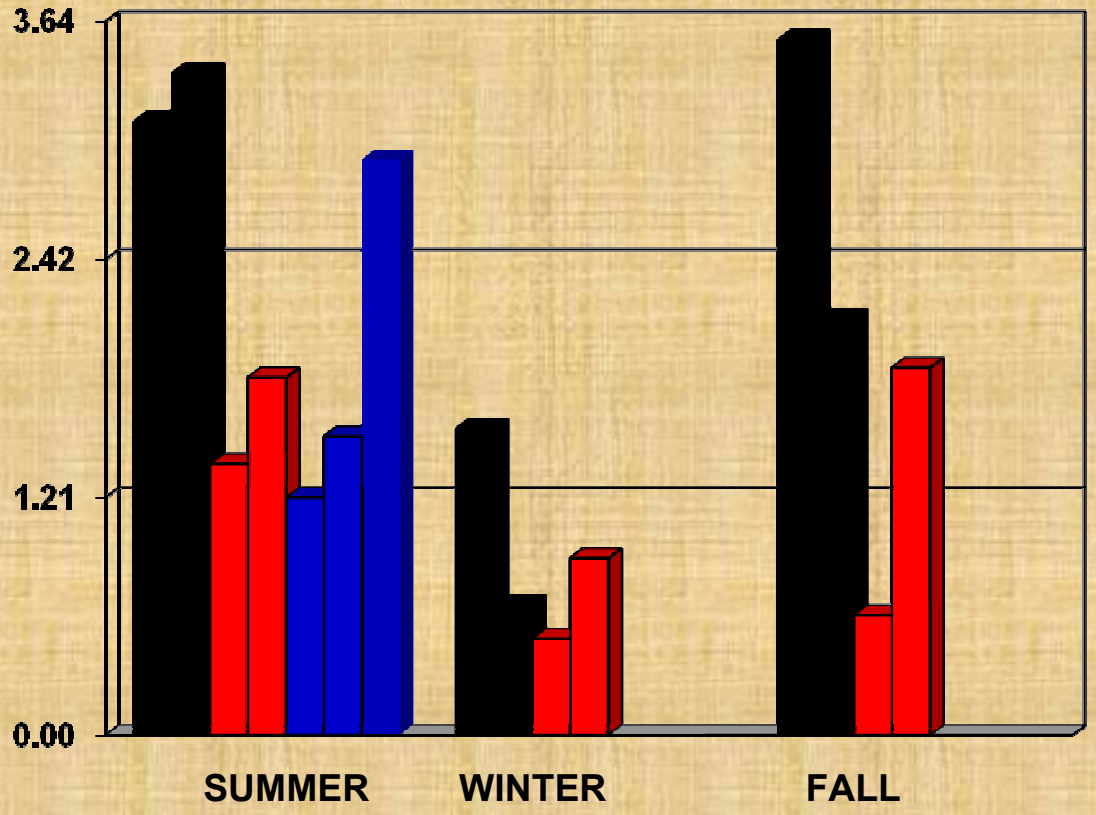


Laser

Barn chamber

NH3 g/m^2/d



Laser

Barn chamber

Lab chamber

Summary

Achievable reductions in ammonia emissions from dairy farms

Impact of improved management on reductions in ammonia emission

Management practice	Mechanism for decrease ammonia loss	Decrease in ammonia loss (%)
Remove excess and/or feed balanced dietary protein	Decrease N output in urine	10 to 15
Cover manure storage	Decrease ammonia escape	20 to 30
Incorporate or inject manure	Reduce ammonia production and loss	30 to 50

Implementation of these management practices has the potential to reduce ammonia N loss from about 115 to 30-40 lbs/cow/yr, a 65-70% reduction.


Thanks for your attention!