Ammonia Emissions from Dairy Farms: Why the Concern?

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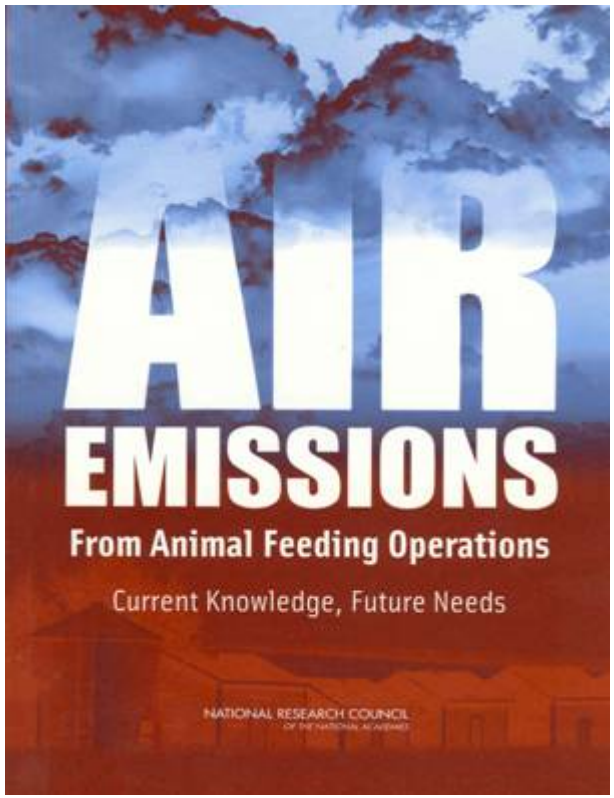
Ammonia
Why the Concern?



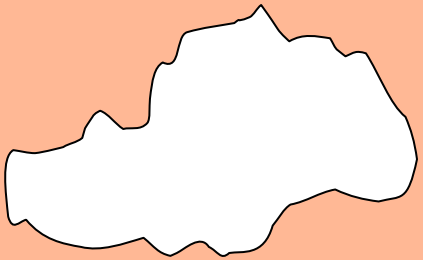
Policy is being formulated to mitigate emissions of air pollutants from animal agriculture

Global sources of ammonia

Source of Ammonia	Emission (Tg N/yr)
ANTHROPOGENIC	
Dairy cattle	5.5
Beef cattle/buffalo	8.7
Pigs	2.8
Horses	1.2
Sheep/goats	2.5
Poultry	1.3
Fertilizer	6.4
Biomass burning	2.0
Subtotal	30.4

- **For Wisconsin, "America's Dairyland", air emissions = ammonia = urine.**
- **Most nitrogen contained in dairy cow urine can be transformed rapidly and emitted as ammonia gas.**

Ammonia cycle



Transport and reaction

NH_4HSO_4

$(NH_4)_2SO_4$

NH_4NO_3

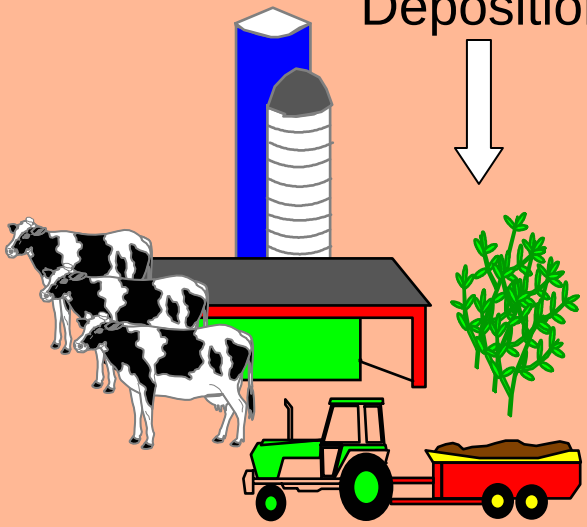
Deposition

(wet and dry)

NH_3^+

Emission

Deposition



- **Haze, visibility**
- **Human health**

- **Fertilization & Acidification**
- **Eutrophication**
- **Loss of biodiversity**

???

How much of total manure N

is recycled through crops on a dairy farm

(% of total herd annual excretion)

10 to 40 %

? What happens to manure N ?

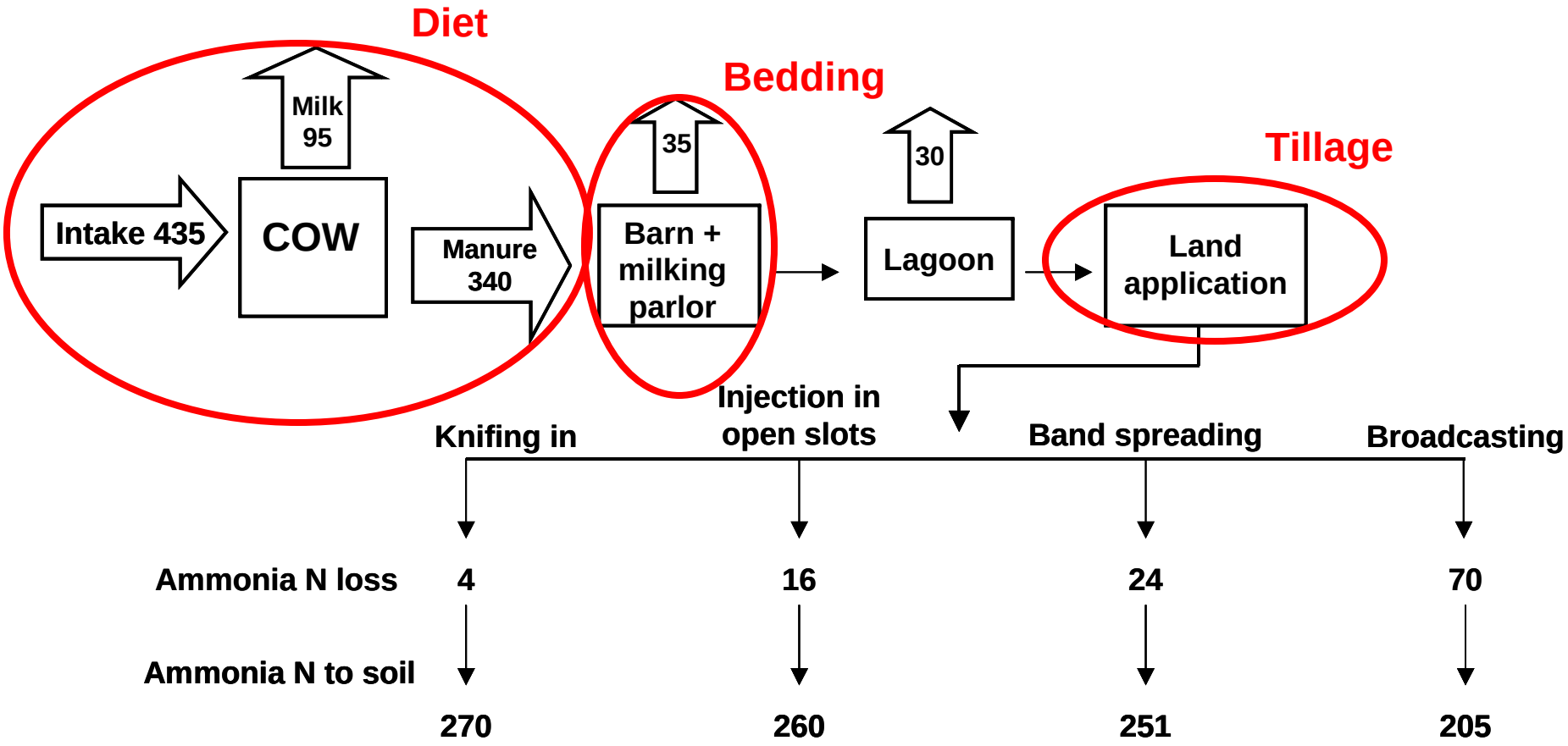
(% of excreted N)

- Lost as ammonia (20-40)
- Taken up by plants (20-40)
- Lost as nitrate (10-20)
- Denitrification (3-5)
- Immobilized by soil microorganisms (?)

Nitrogen use inefficiencies are inevitable.

But we can do much better!

Model of annual nitrogen (lbs.) inputs, outputs and cycling for a typical dairy cow*



*"cow equivalent" or herd average for lactating/dry cows and heifers

Key management practices that can reduce ammonia loss

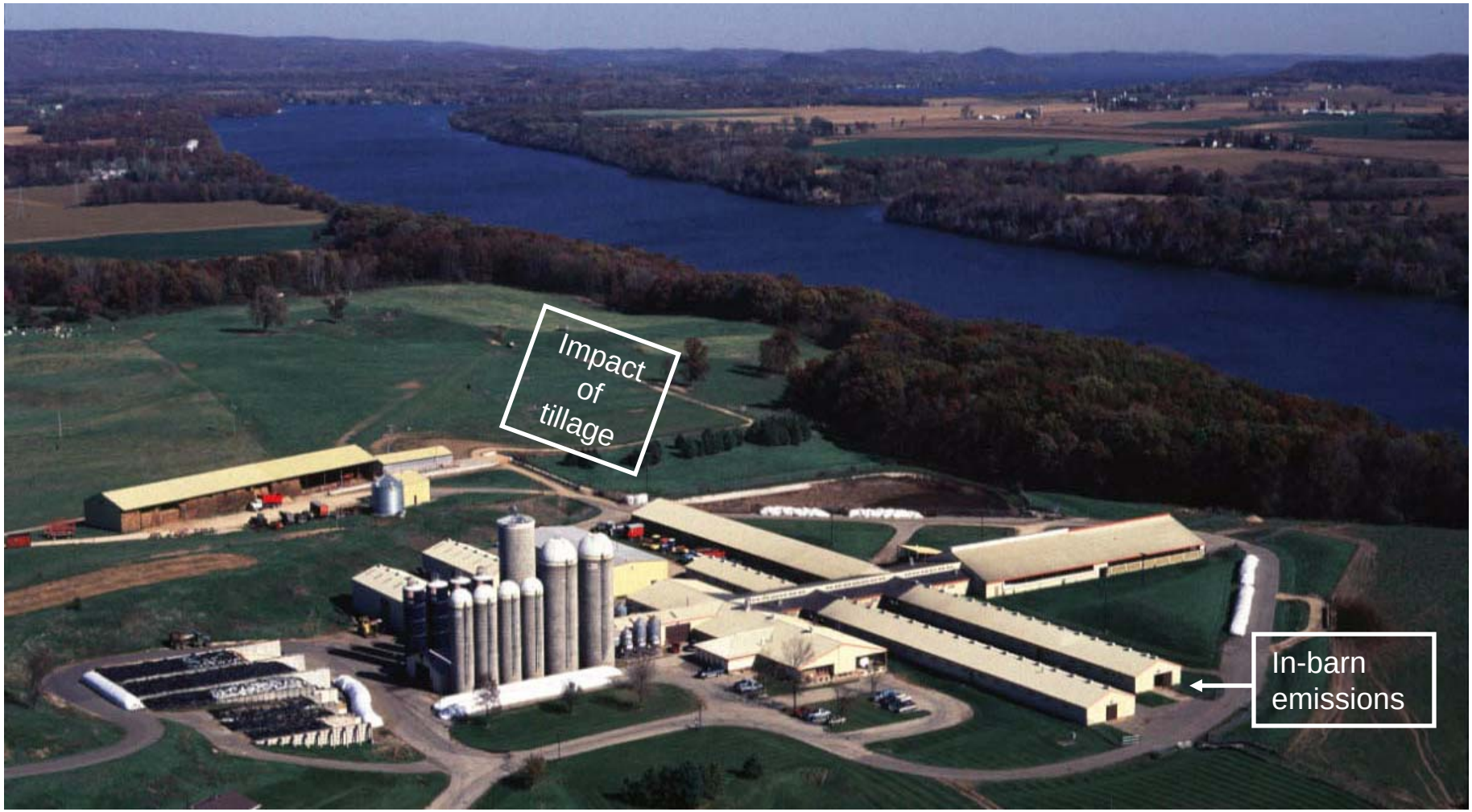
1. Remove excess protein from the cow's diet;
2. Improve manure handling and storage; and
3. Incorporate manure in the field (being mindful of possible tradeoffs in nitrate leaching).

What this can do

Implementation of these 3 practices will reduce ammonia nitrogen loss from the current level of 115 to 30-40 lbs/cow/yr.

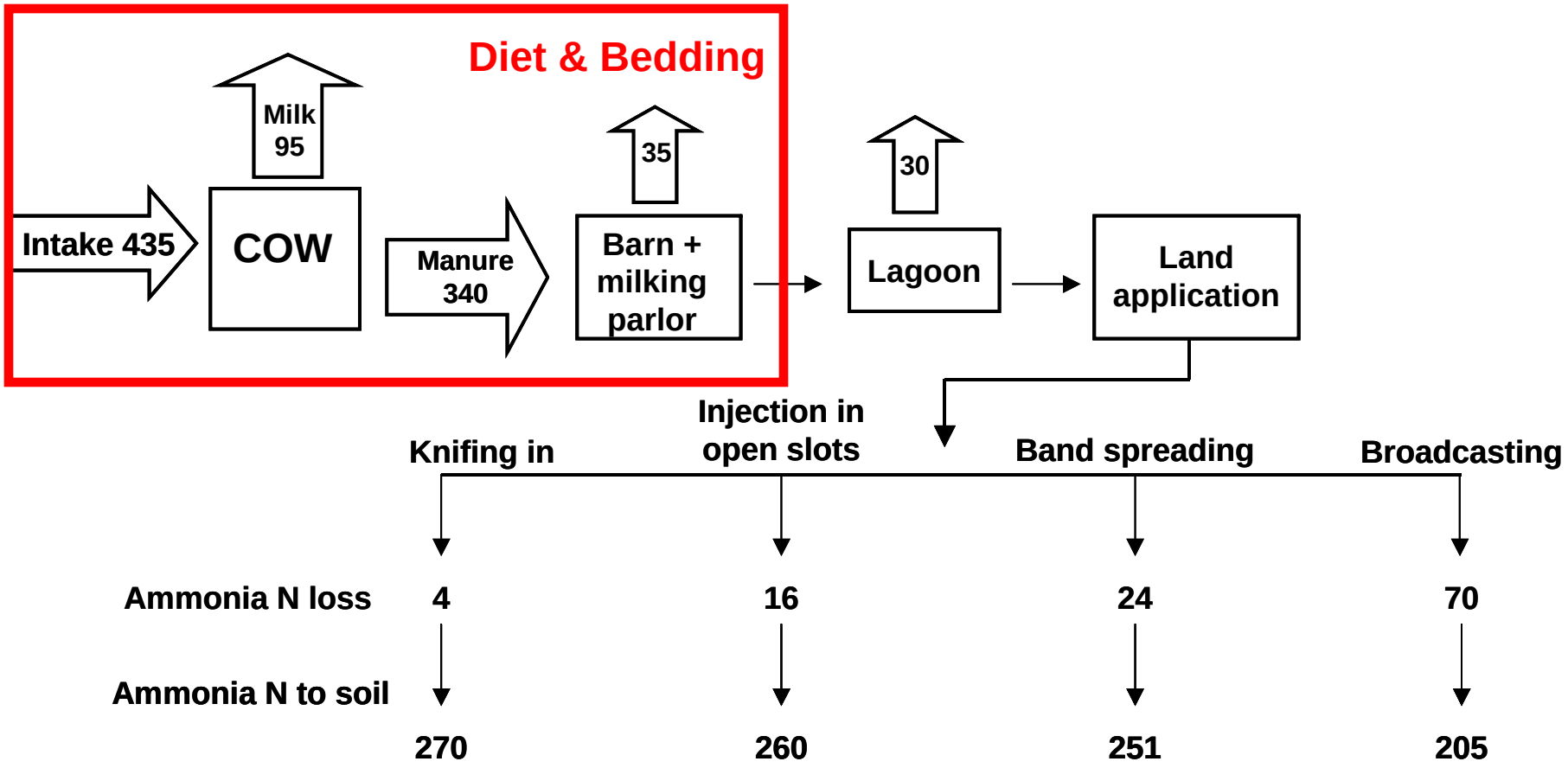
This means that an additional 80 lbs. N per cow would be available annually for application to field crops.

Ammonia research
US Dairy Forage Research Center, central Wisconsin

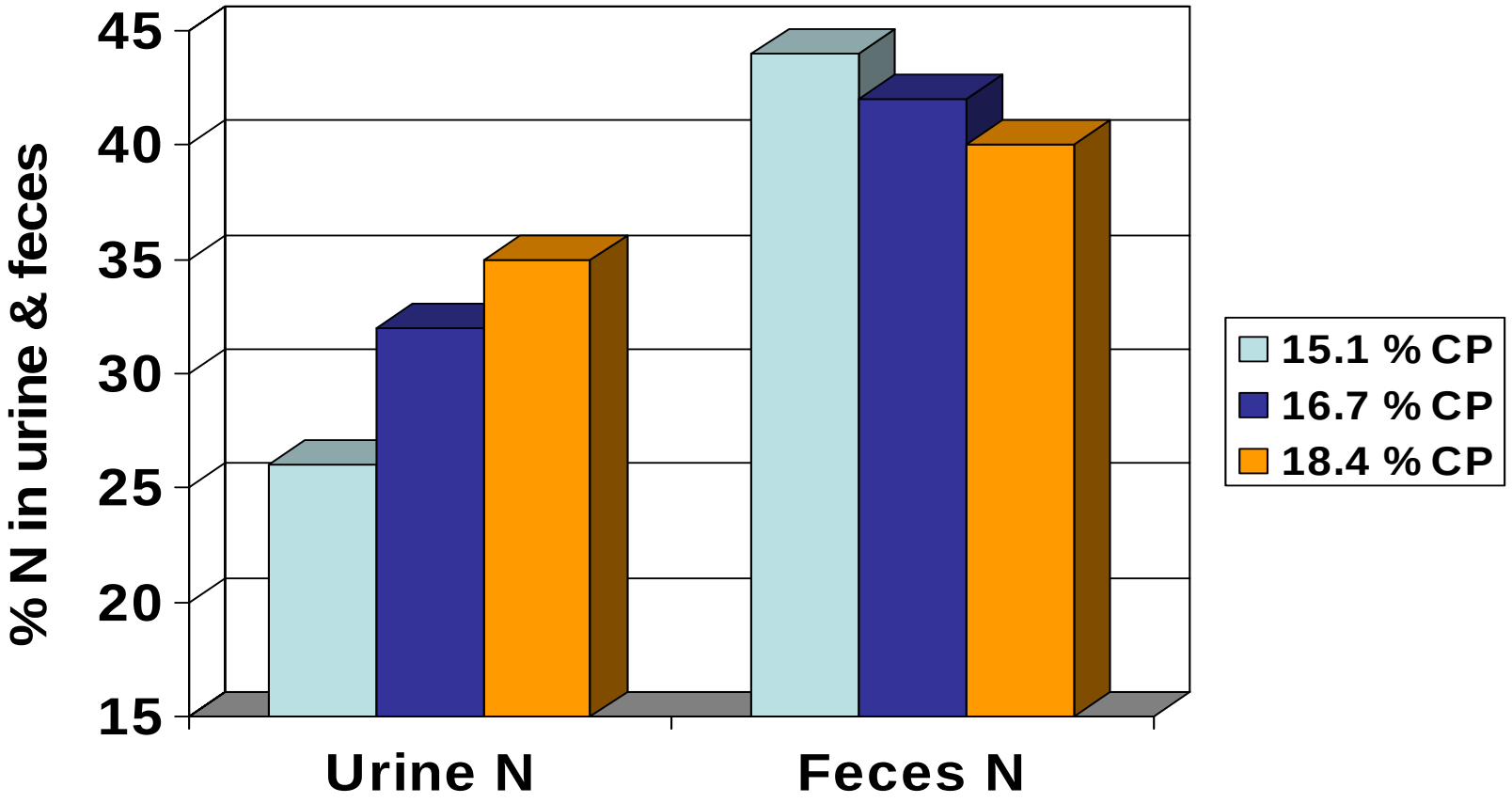


Initial focus areas and approaches

In-barn ammonia emissions



Impact of protein feeding on urine N excretion



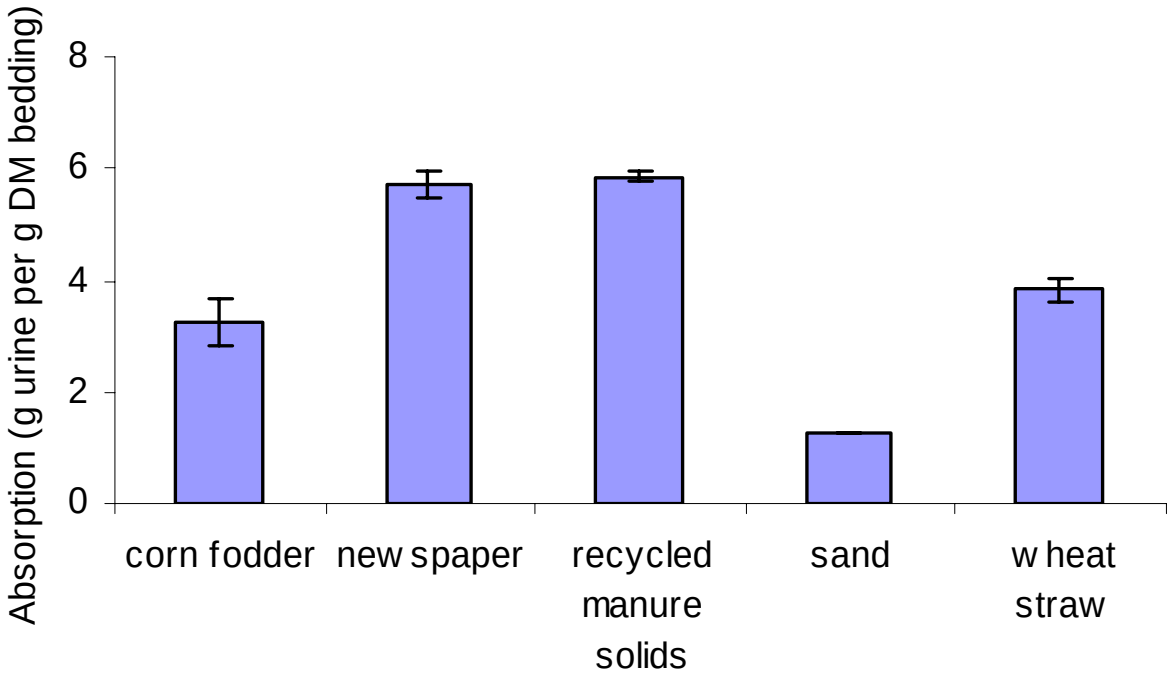
An increase in dietary N can shift N from feces to urine

Dairy diet impact on cumulative ammonia emissions from slurry applied to soil.

Feeding 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

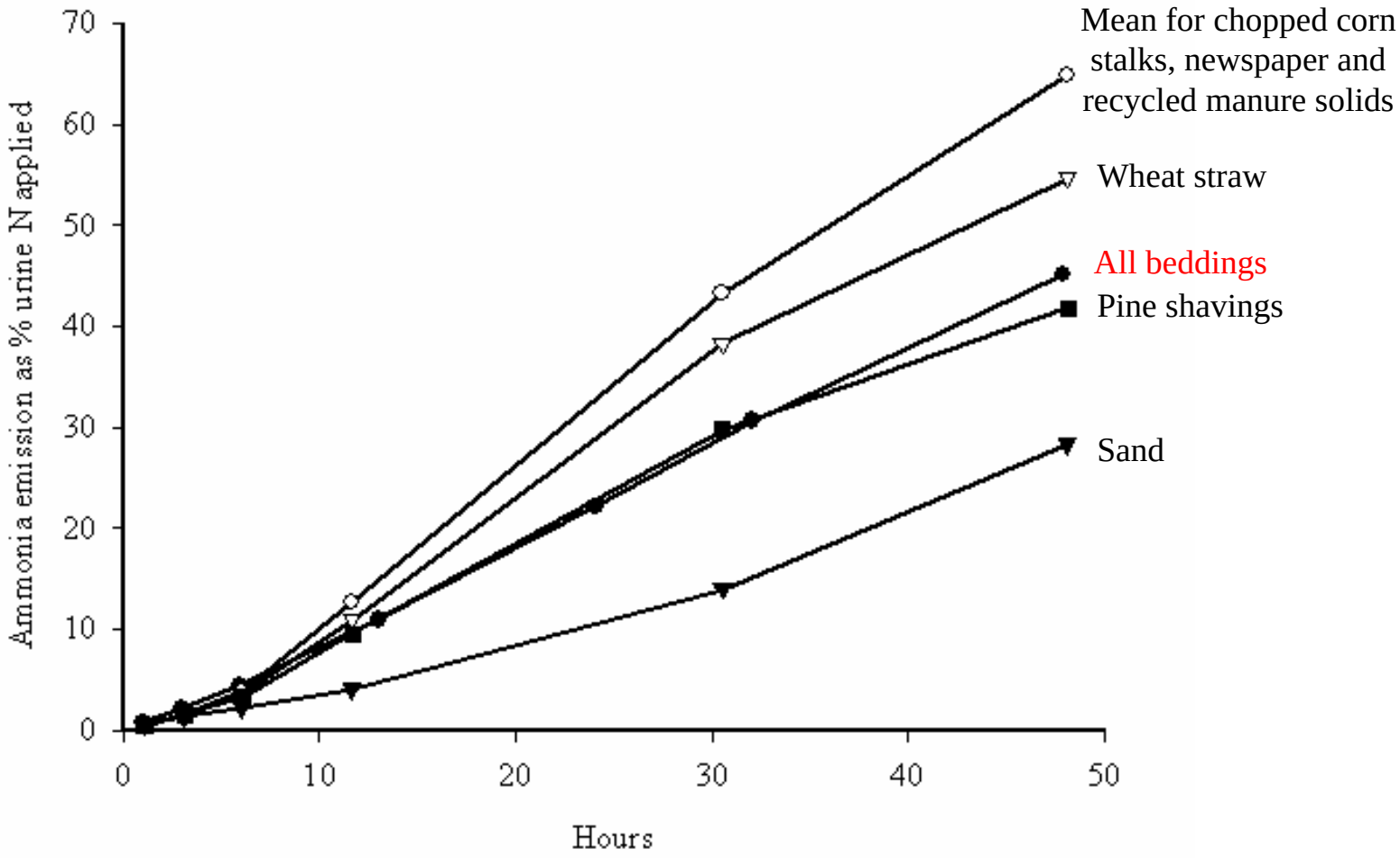
Beddings absorb different amounts of urine.



Also, NH_3 may bind to exchange sites, extra C may promote immobilization, bedding structure may physically reduce emission.

Ammonia emissions from bedding

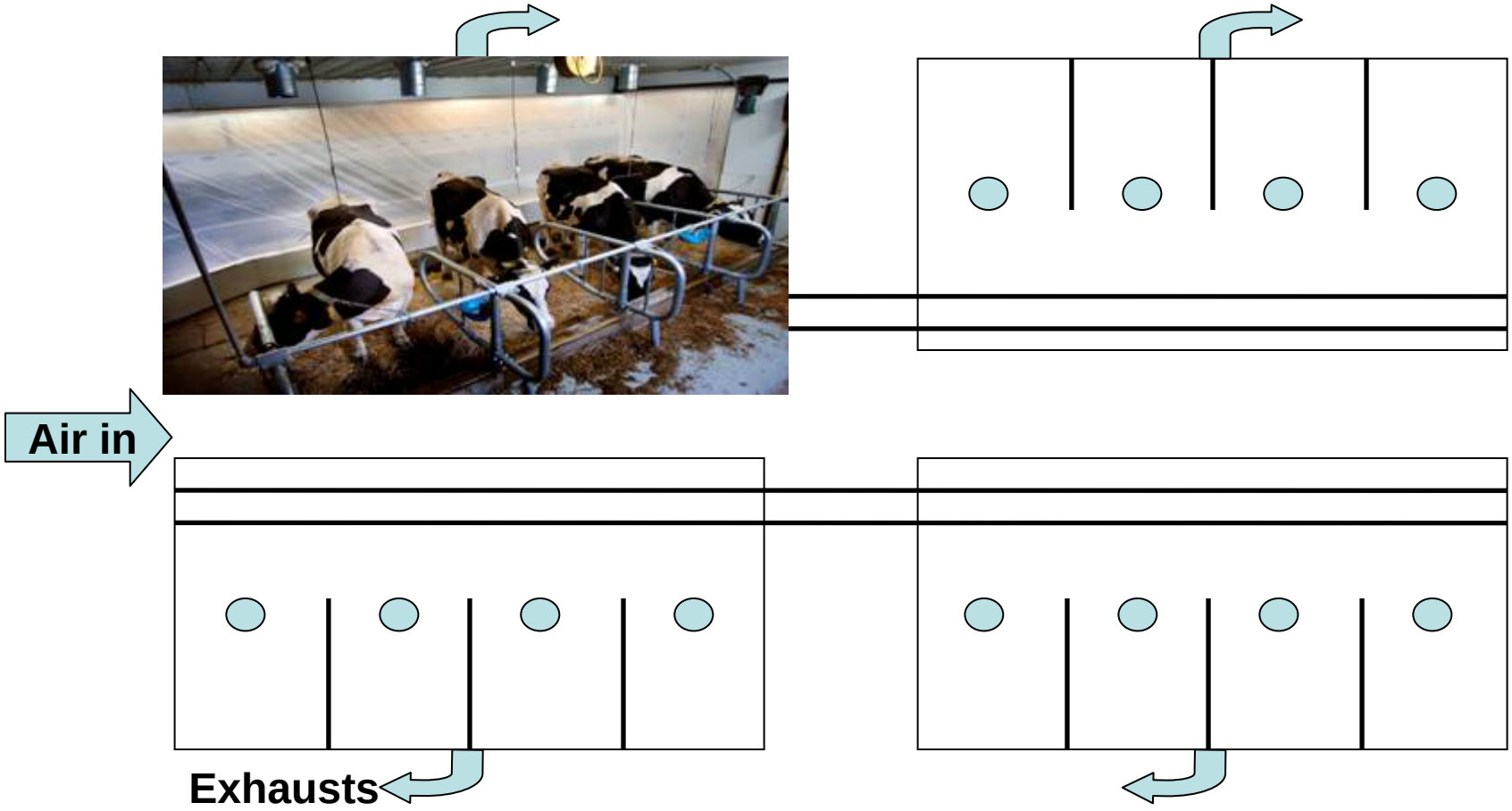
(lab chambers)



Misselbrook and Powell

Tracking in-barn ammonia emissions

4 chambers
4 cows/chamber



Cow Chambers

What we will study

- Dairy diet impacts on N excretions and losses
- Bedding impacts on N capture

Each every 4 months for 1-2 years

Cow Chambers

Daily schedule of activities

6AM: Cows are away from chambers being milked;

7AM: Cows return and fed;

8AM: Curtains down;

9AM: Emission recordings begin;

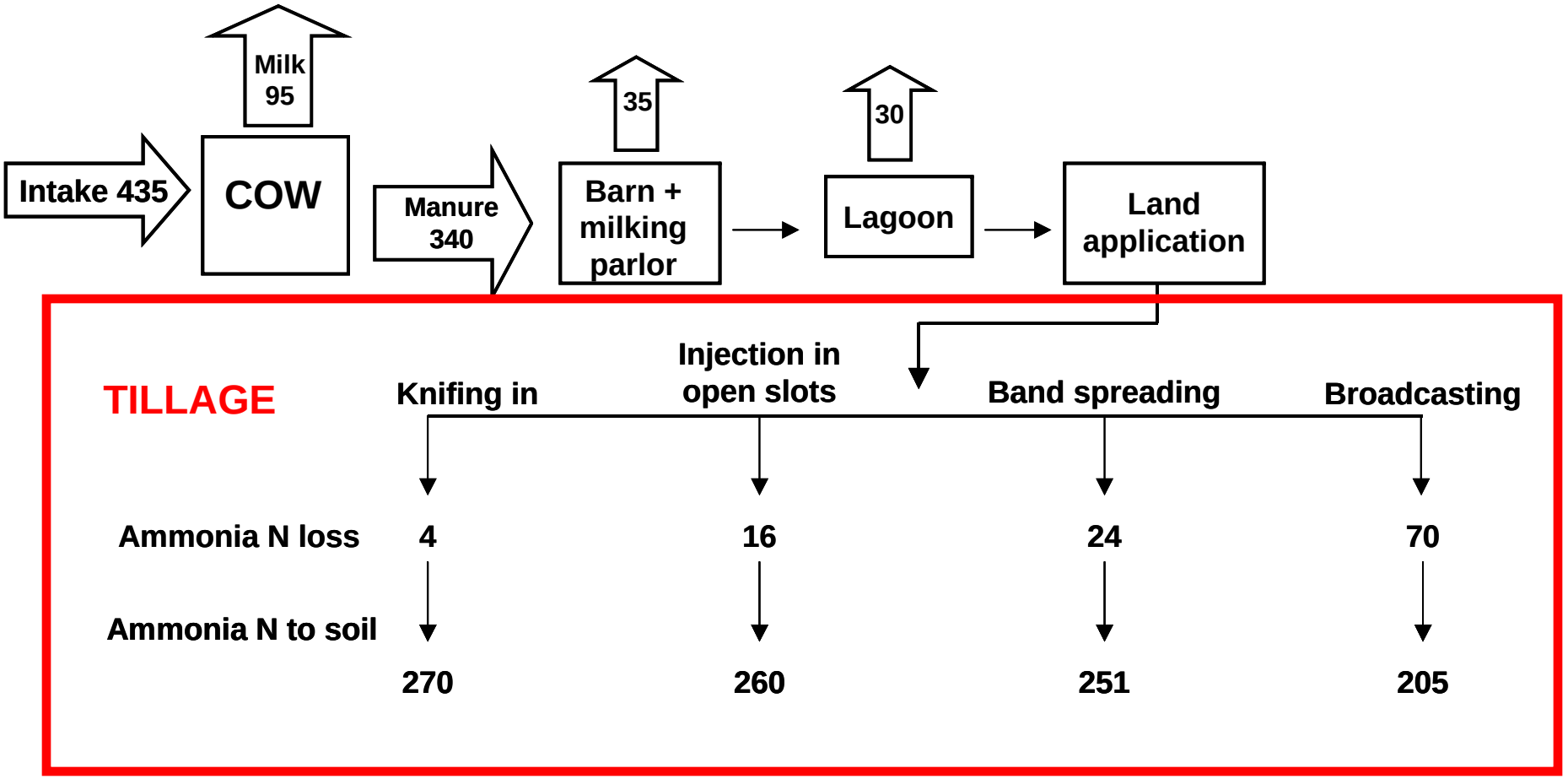
3PM: Emission recordings end, curtains up;

3-4 PM: Manure removed from chambers; cows are in milking parlor;

4PM: Cows return to stalls (curtains remain up until 8AM).

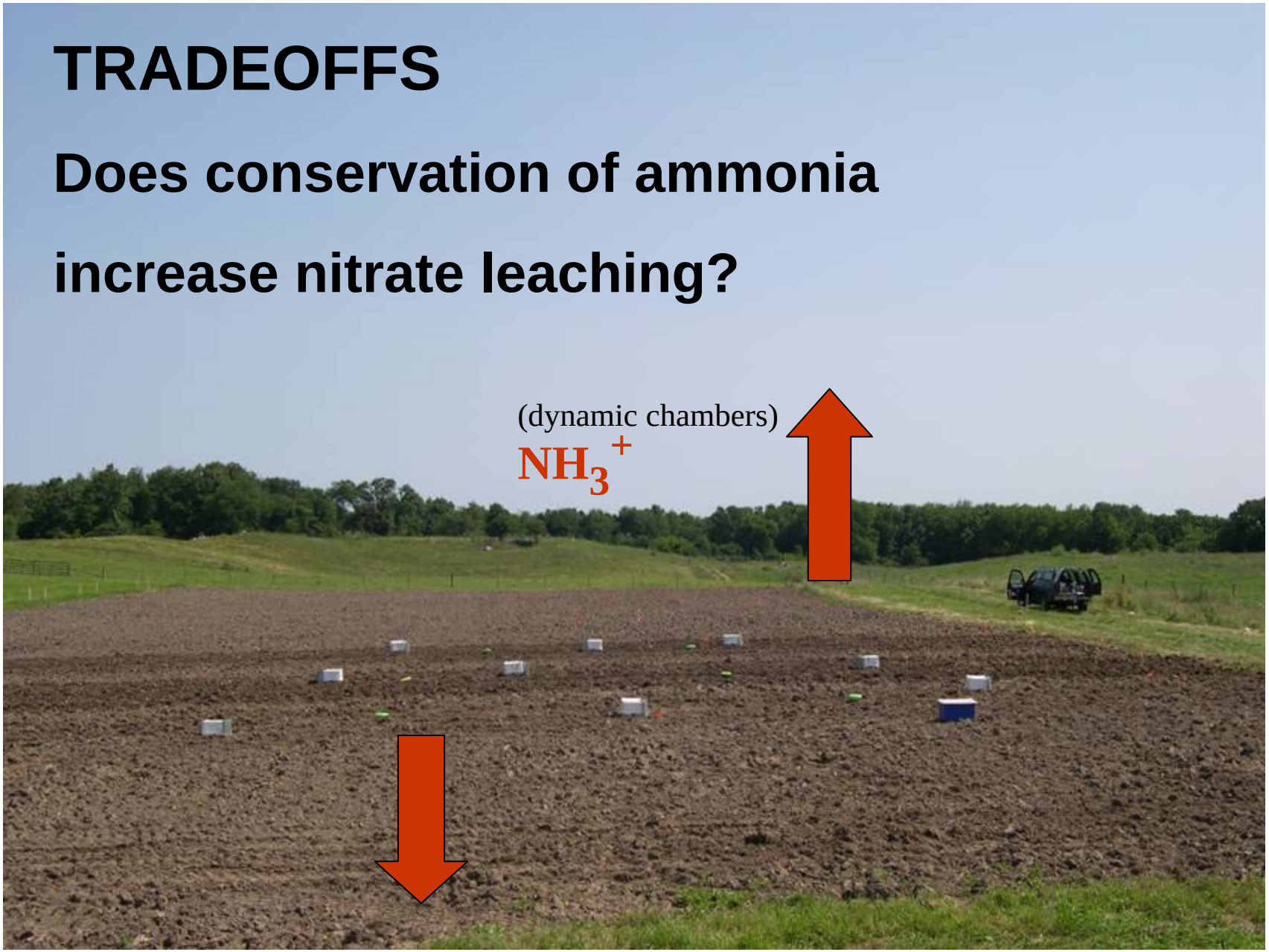
Ammonia emission = milk, MUN, feed CP, bedding, scrapping frequency

Ammonia losses: Impact of tillage



TRADEOFFS

Does conservation of ammonia increase nitrate leaching?

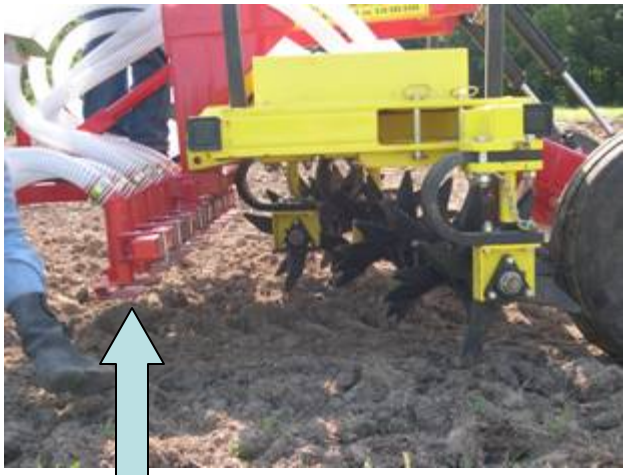


Research

Slurry

Applicator

Method 1: Injection

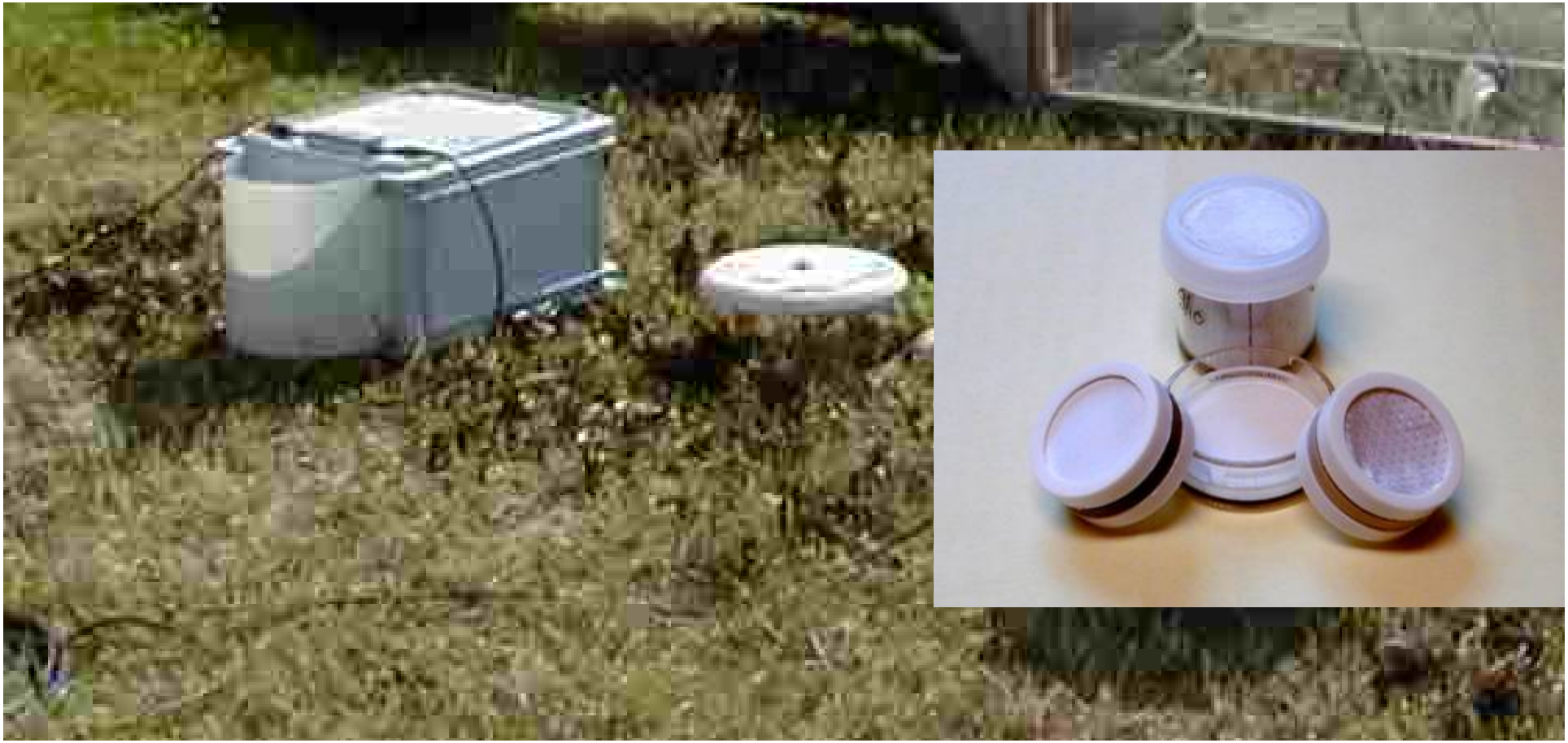


Splash plate

Aerway tool

Method 2: Broadcast (Aerway up)
Method 3: Broadcast followed by Aerway tillage

Tracking ammonia loss from field plots



Equilibrium concentration technique

Drainage lysimeters for trapping nitrates

from Michael Russelle

Ammonia Emissions and Tillage: Tradeoffs?

(initial results from 2004)

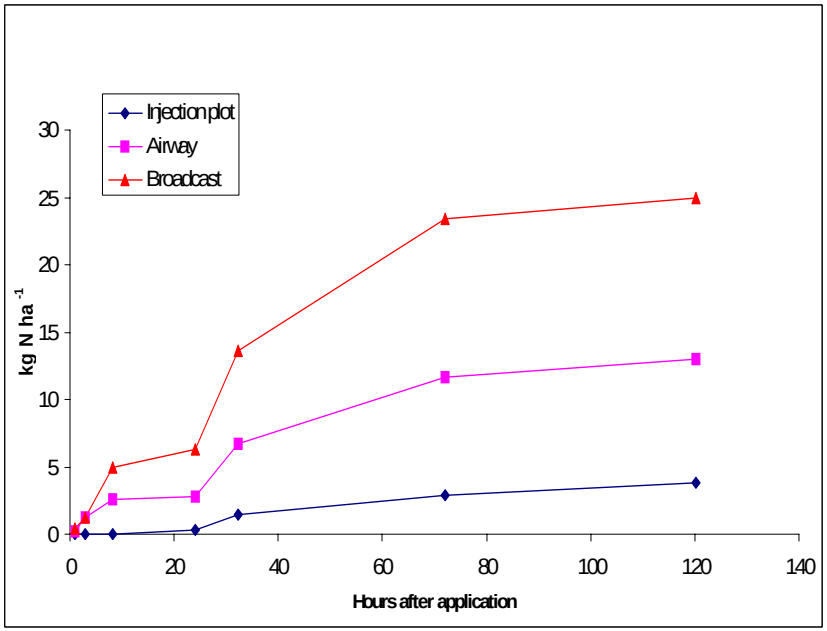
Ammonia loss

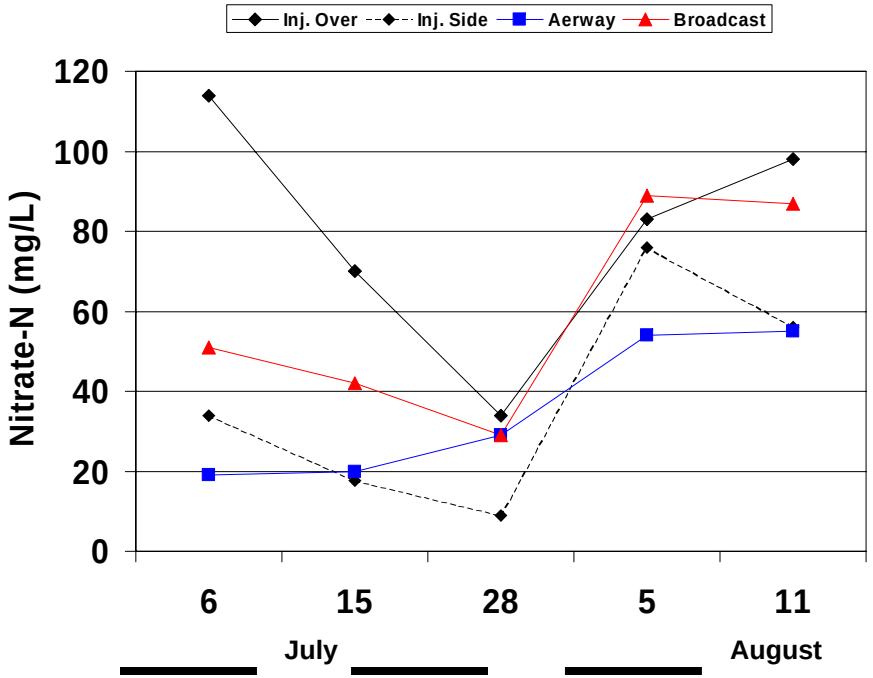
Injection<Aerway<Broadcast

Nitrate loss (in general)

Aerway<Broadcast<<Injection

Initial results: Ammonia-N losses





???

How much of total manure N ***is*** recycled through crops on a dairy farm?

10 to 40 %

How much of total manure N ***can be*** recycled through crops on a dairy farm?

40 to 60%

Due to changes in ammonia production and loss through

*****land application**
**** diet manipulation**
*** bedding, scraping interval**


Thank you!