AMMONIA EMISSIONS FROM DAIRY ANIMALS

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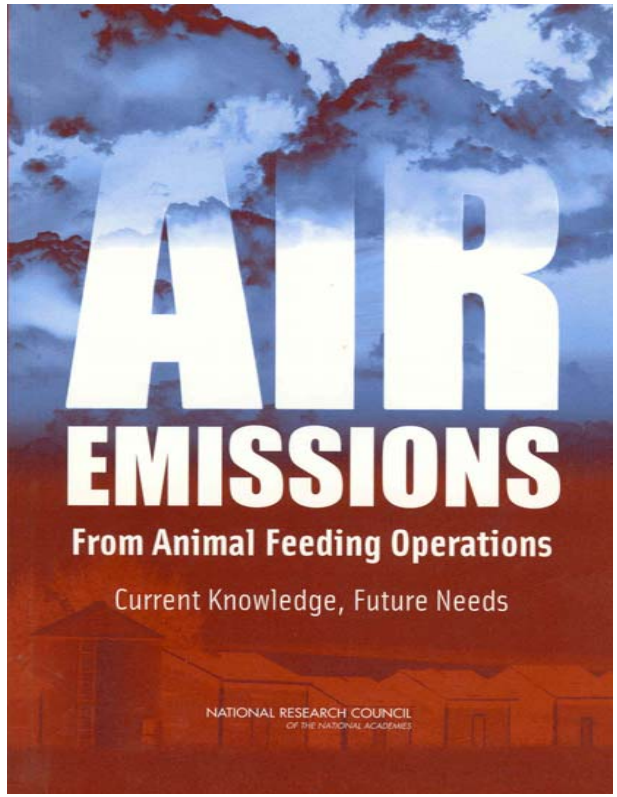
AMMONIA EMISSIONS FROM DAIRY ANIMALS

- **Why the concern?**
- **What we know.**
- **What we don't know.**
- **Approaches to provide more answers.**

Ammonia

Why the Concern?

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



- **For the dairy industry, air emissions relate directly to ammonia.**

- **Most of the nitrogen contained in the urine excreted by dairy cows can be transformed rapidly and emitted as ammonia gas.**

Why the concern?

Ammonia provides the basis for particulate formation in the atmosphere, which can create haze and imperil human health

Ammonia re-deposition can degrade natural ecosystems

Why the concern?

Under the federal Consolidated Emissions Reporting Rule, each State in the U.S. has to report ammonia gas emissions to EPA.

These estimates will be used in air quality regulations to control the air-borne particulates and haze that affect many regions of the US

Why the concern?

Public awareness and scrutiny

ISCONSIN STATE

MAY 28, 2004

Ag conference explores importance of ammonia emissions

JAN SHEPEL

MADISON

really pleased with the interest we got. There were regulatory people there, aca-

tle cause 57 percent. Poultry, pigs and fertilizer are the next largest emitters.

Ammonia: Next Big Environmental Issue to Face Farmers?

By Brenda Murphy
Managing Editor

erance levels in place.

Tom Misselbrook, a visit-

Farm odor issue moves to forefront

By Jim Massey

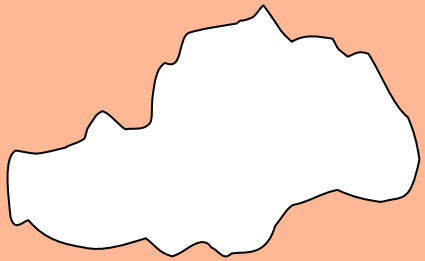
Editor

farms produce a considerable percentage of ammonia in the atmosphere.

particularly high level of ammonia emissions, Mr. Powell said. Much of that can

Mr. Jacobson said state officials have about two years to pull together information on

Ammonia cycle



Transport and reaction

NH_4HSO_4

$(NH_4)_2SO_4$

NH_4NO_3

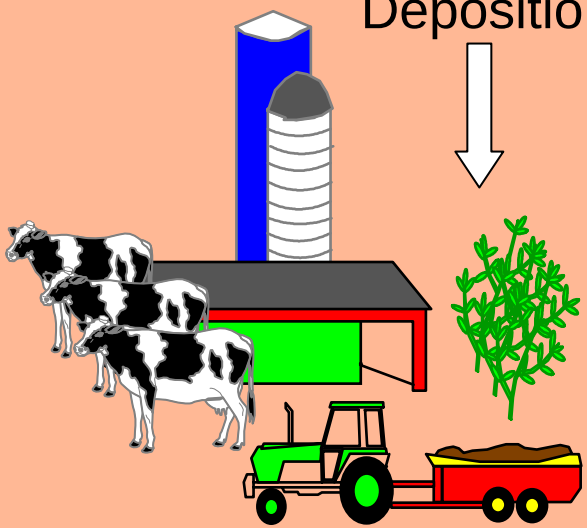
Deposition

(wet and dry)

NH_3^+

Emission

Deposition



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

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

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 can greatly reduce the fertilizer value of manure.

What we know:

Because ammonia is a gas, losses are inevitable.

But ammonia nitrogen loss can be reduced, and the fertilizer value of manure can be maintained through management.

What we know:

How much of total feed N (crude protein) is converted into milk?

15 to 25%

(% of total CP fed to the whole herd)

Feed N use inefficiencies are inevitable.

But we can do better!

What we know:

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

(a farm that grows most of its own forage & grain)

10 to 40 %

What we know:

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 (?)

Manure N use inefficiencies are inevitable.

But we can do much better!

What we don't know:

- How much ammonia is emitted from dairy farms on a "whole-farm" basis?

- How much ammonia is lost in the components of dairy production?

- What magnitude of ammonia reductions can we expect through:
  - diet manipulation
  - bedding
  - manure storage
  - land application

Approaches to find more answers:

- Research seeks to understand the underlying principles for ammonia production and loss; compare management practices; and devise strategies to implement improved management systems.

- Managing ammonia loss requires a systems approach, but we must understand the pieces before assembling the system.

Nitrogen flow (lbs/cow/year)
Typical confinement dairy operation

Impact of diet on milk N : manure N

Milk 95

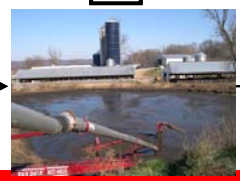
Intake 435

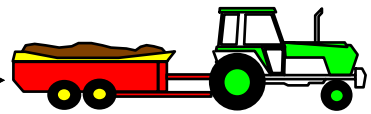
Manure 340

In-barn and manure storage N losses

35

30

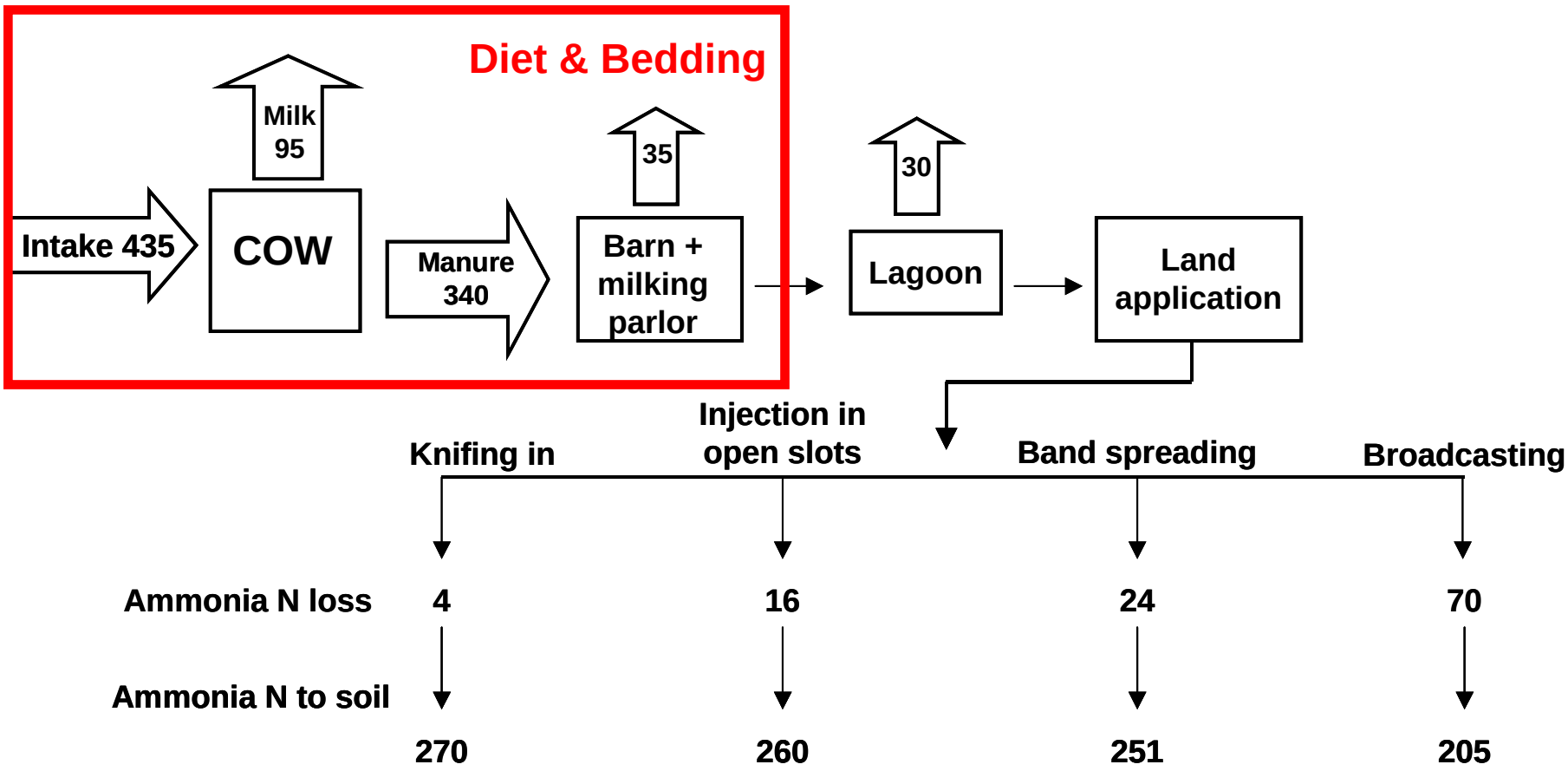




Impact of tillage on manure N cycling

	Knifing in	Injection in open slots	Band spreading	Broadcasting
Ammonia N loss	4	16	24	70
Ammonia N to soil	270	260	251	205

In-barn ammonia emissions



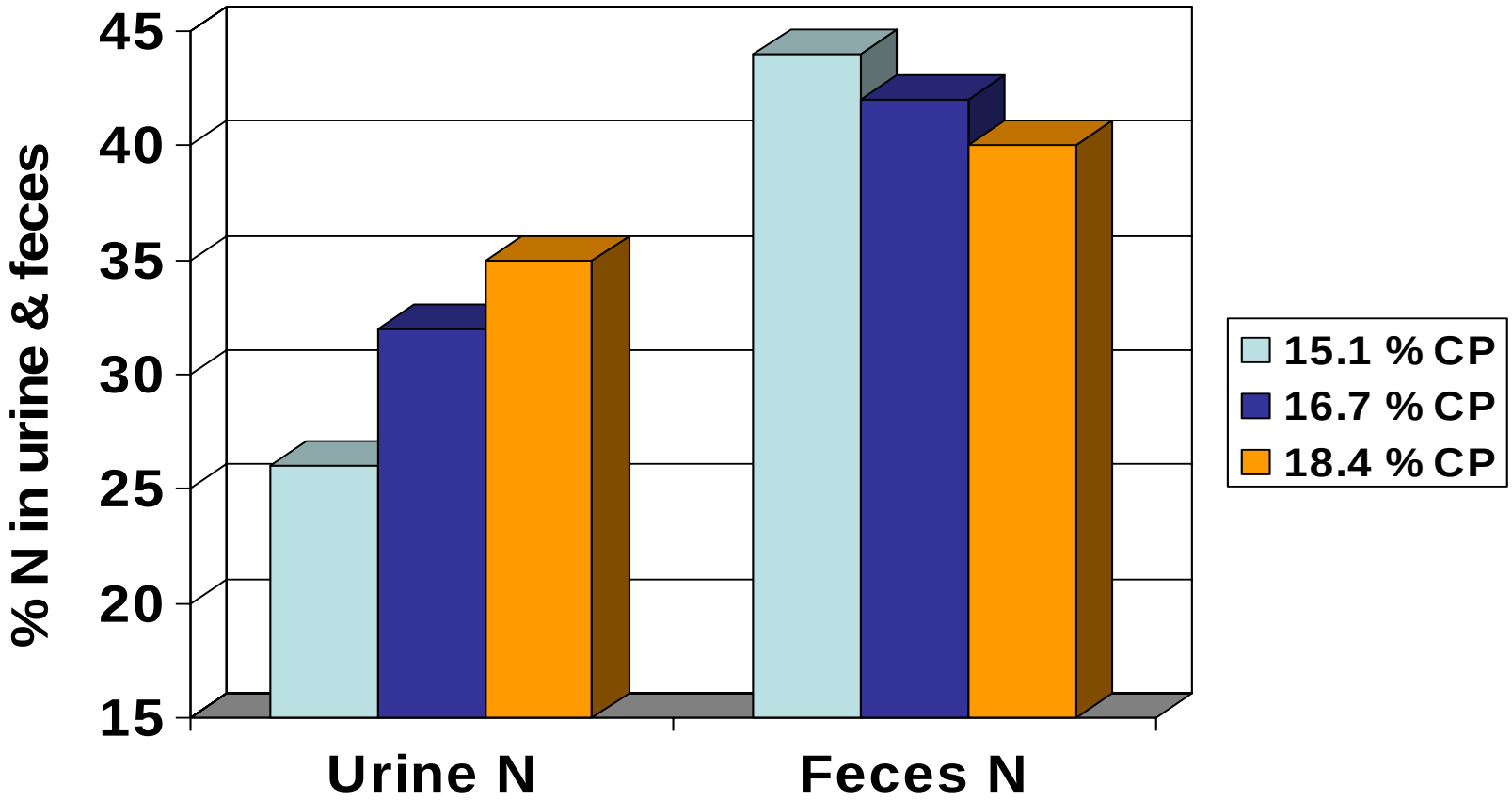
Diet studies

Rationale **– Dietary manipulation designed to improve N-use efficiency by lactating cow (i.e., more feed N going into milk) will influence:**

- **total manure N excreted**
- **relative manure N proportions in urine vs. feces**
- **changes in other urinary/fecal constituents**

Research seeks to assess the impact of these changes on ammonia emissions from the barn floor and following manure application to land.

Impact of protein feeding on urine N excretion



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

Broderick, 2003

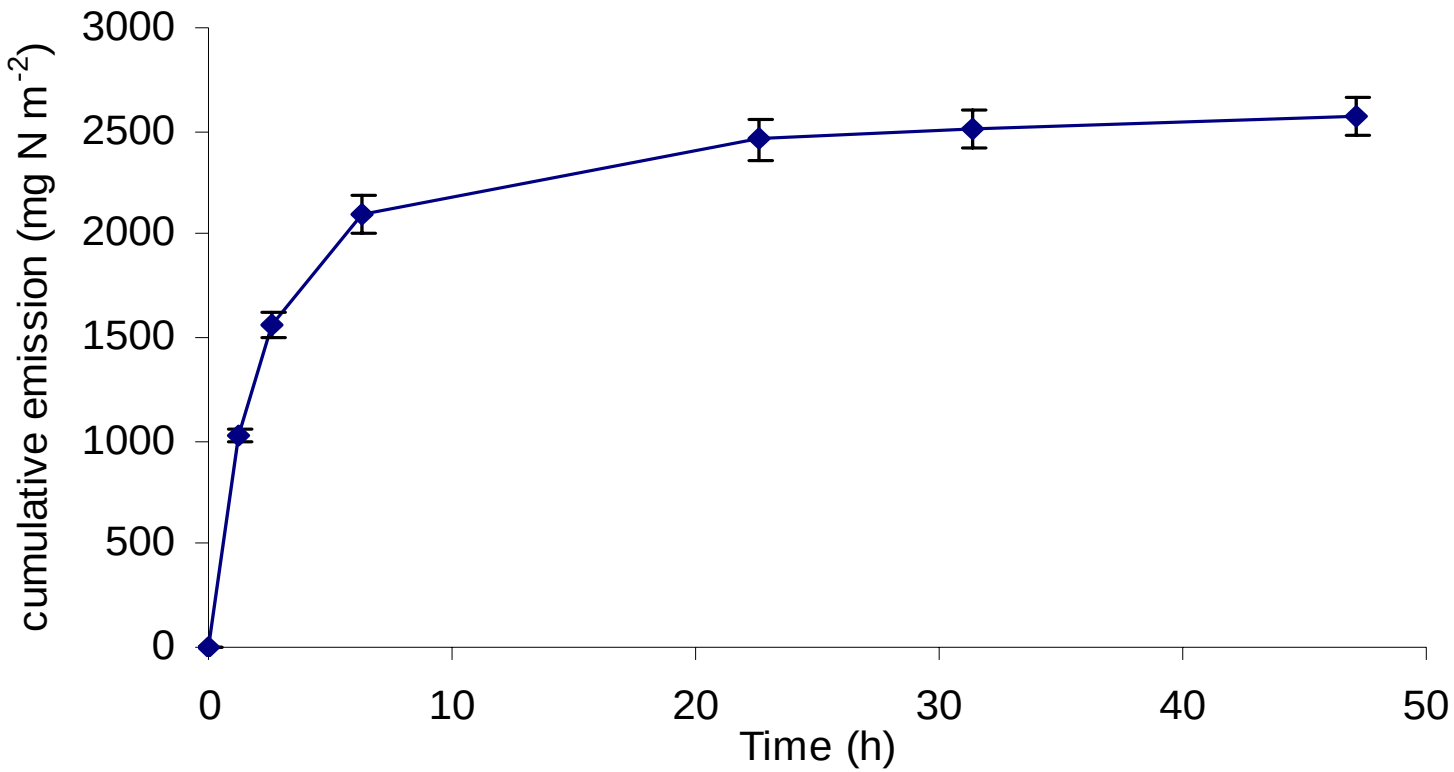
Dairy diet impact on cumulative ammonia emissions from slurry applied to soil.

Feeding trial type	Trial components	Slurry type	
		Fresh	Stored
		% applied N lost as ammonia	
CP level	13.6%	31b	12b
	19.4%	68a	29a

Misselbrook et al., 2005

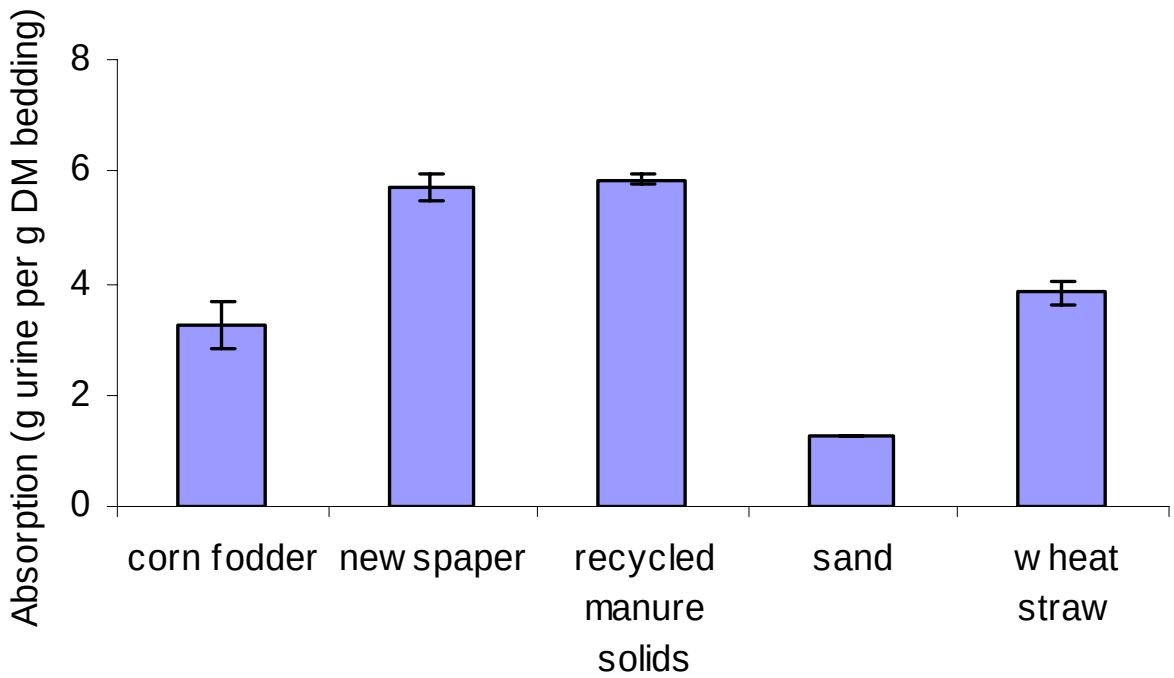
Potential in-barn ammonia losses

Most ammonia loss occurs within 4-6 hours after manure excretion



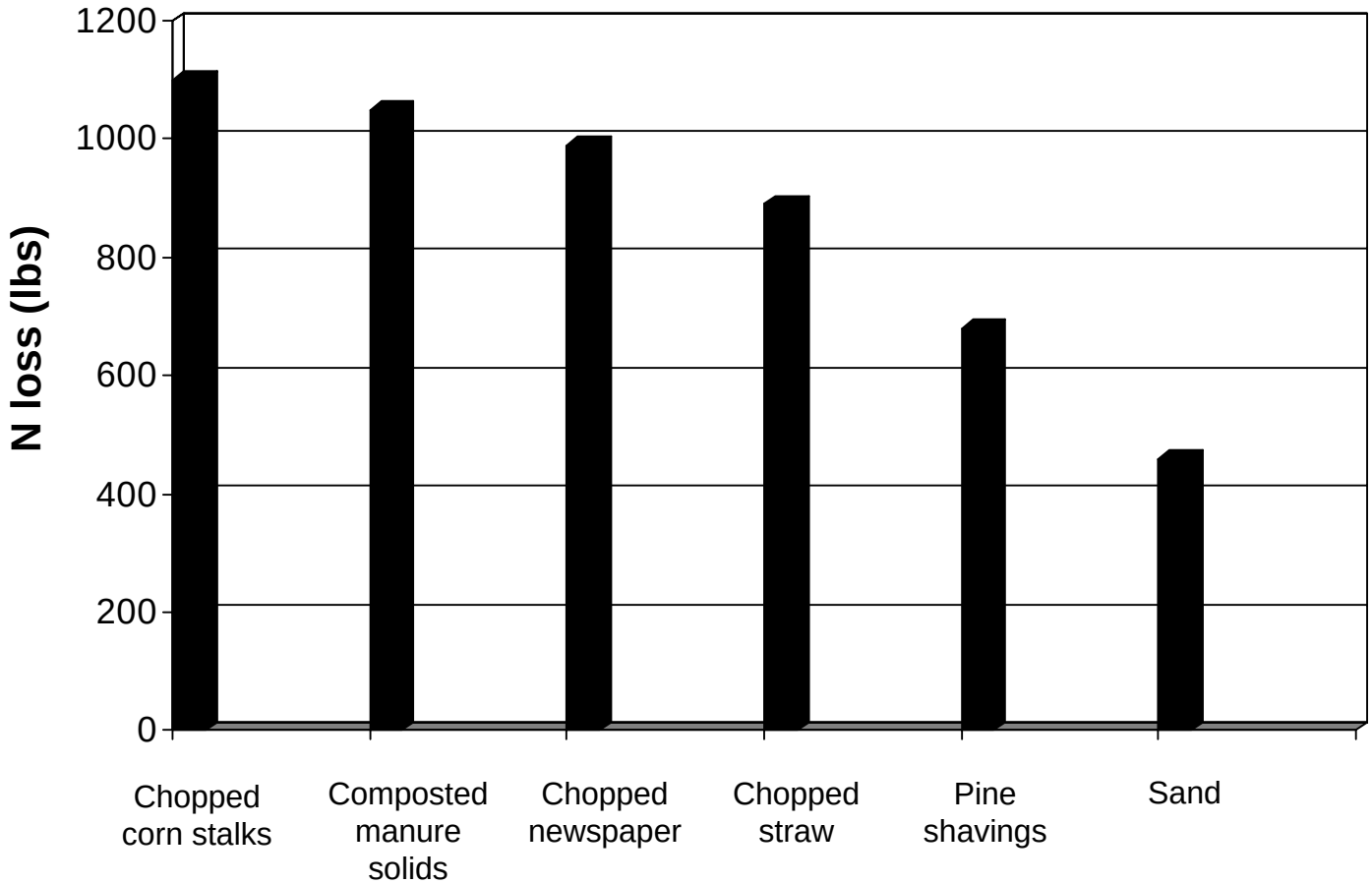
Bedding types

Different bedding types absorb different amounts of urine.



Bedding types

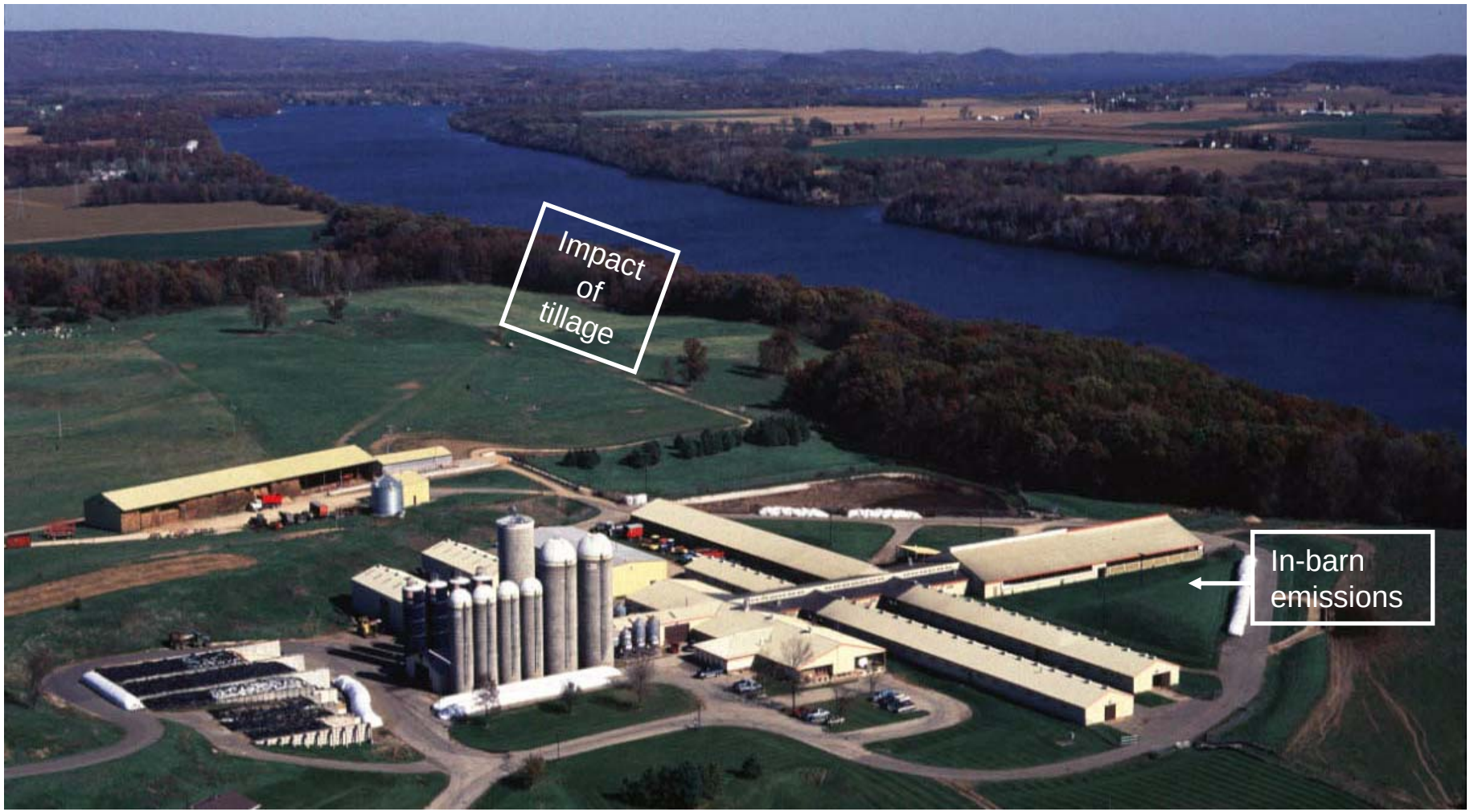
Annual loss of ammonia nitrogen
100 tie-stalls using different beddings



Those that absorb the most urine also have high losses (wicking effect)

Operational-scale ammonia research

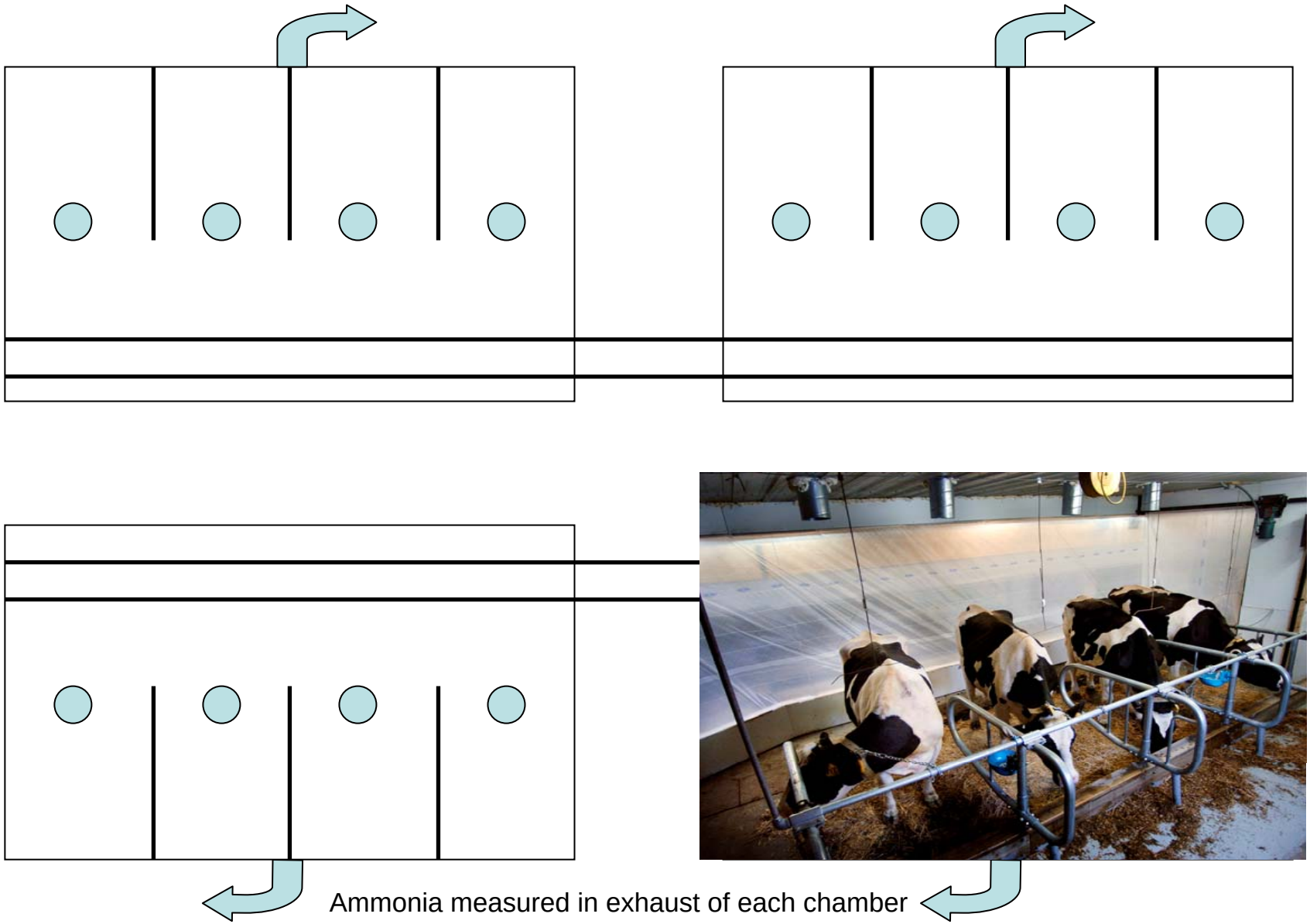
US Dairy Forage Research Center, central Wisconsin



E-barn chambers

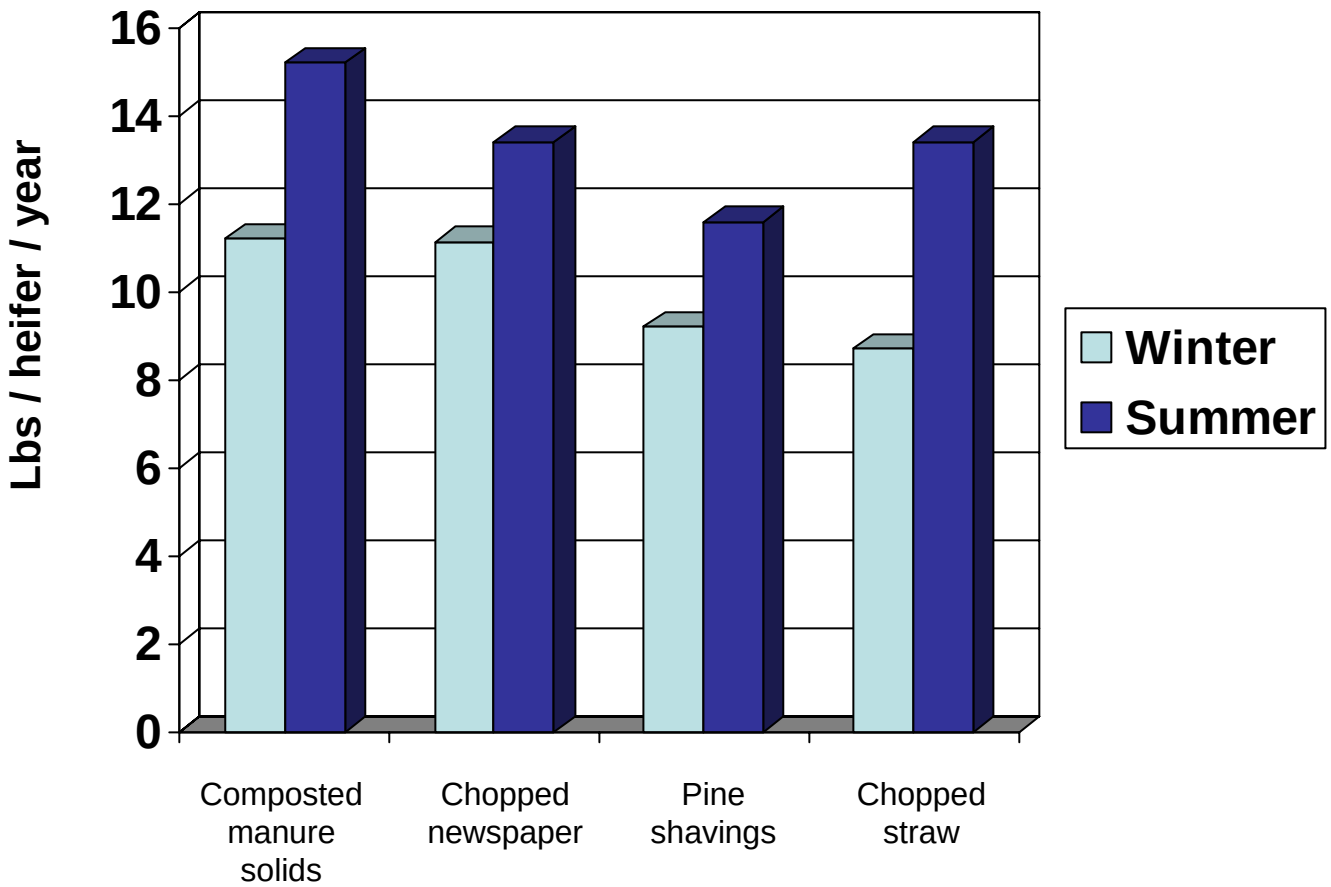
Study the influence of management factors (diet and bedding type) on ammonia emissions at a realistic scale.

Tracking in-barn ammonia emissions
Four ammonia emission chambers (4 cows/chamber)



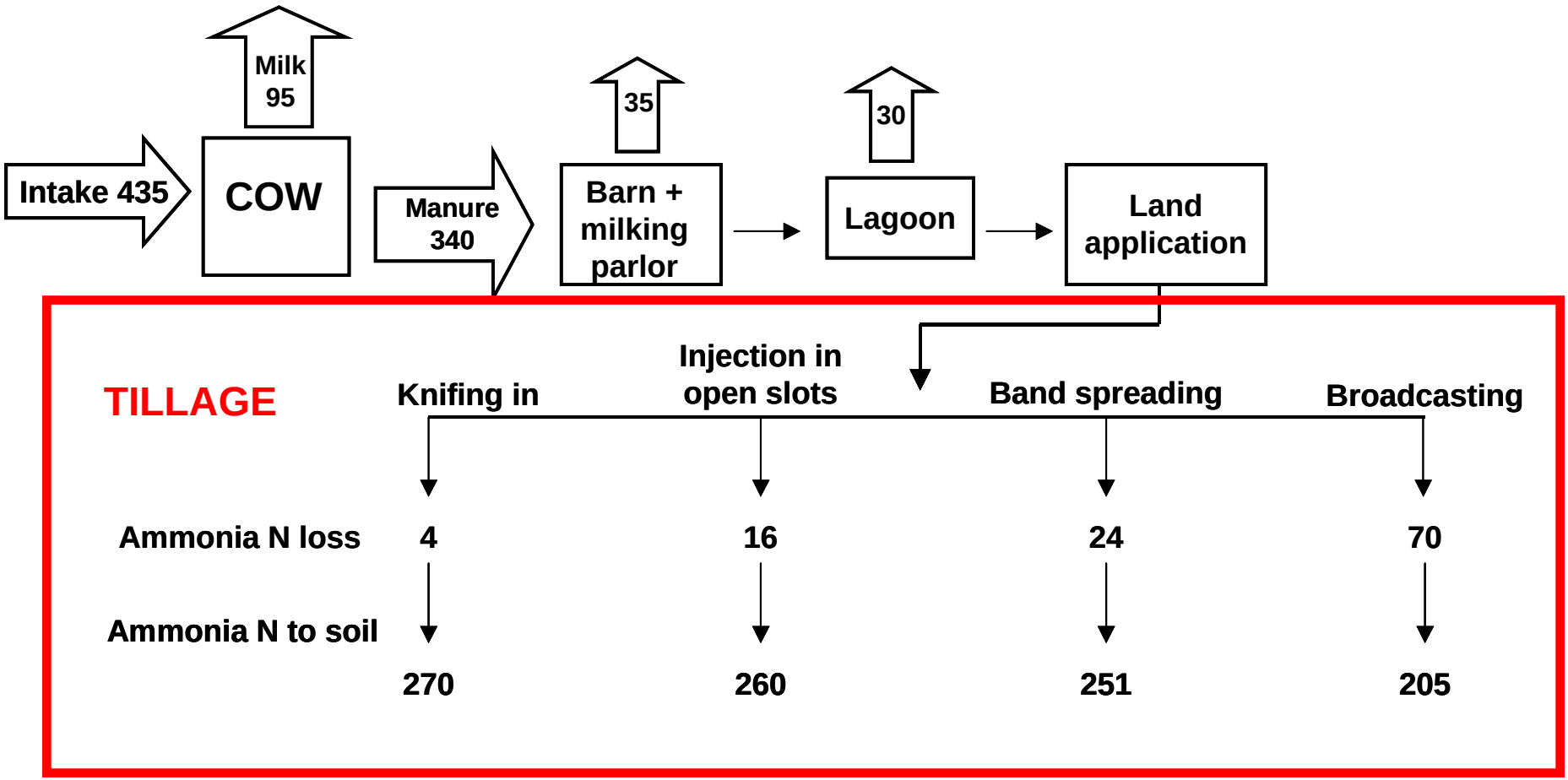
Ammonia measured in exhaust of each chamber

Ammonia N loss from dairy heifers in tie-stalls using different beddings.



Summer emissions are 20-55% greater than winter

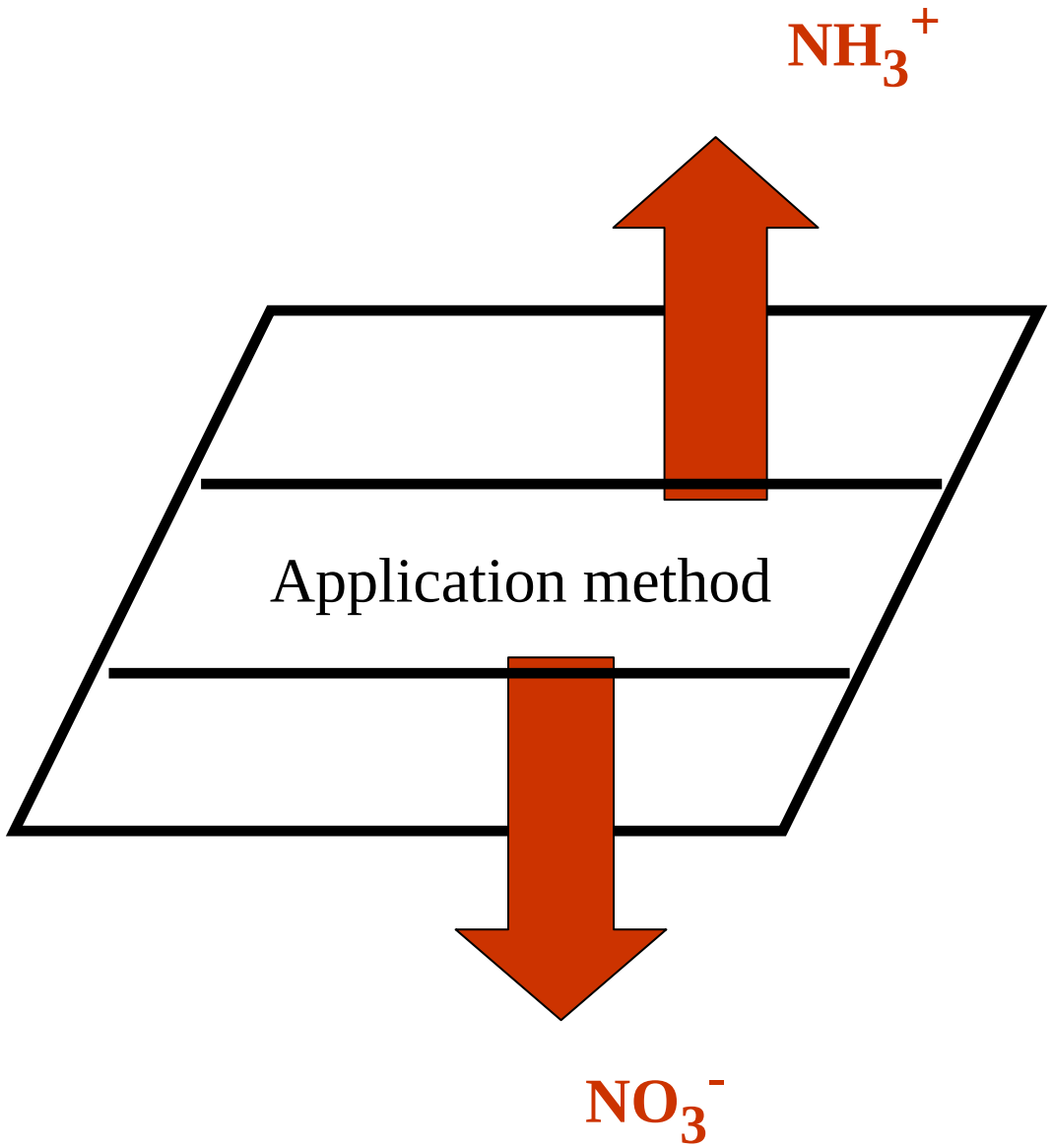
Ammonia losses: Impact of tillage.



Management of dairy slurry nitrogen.

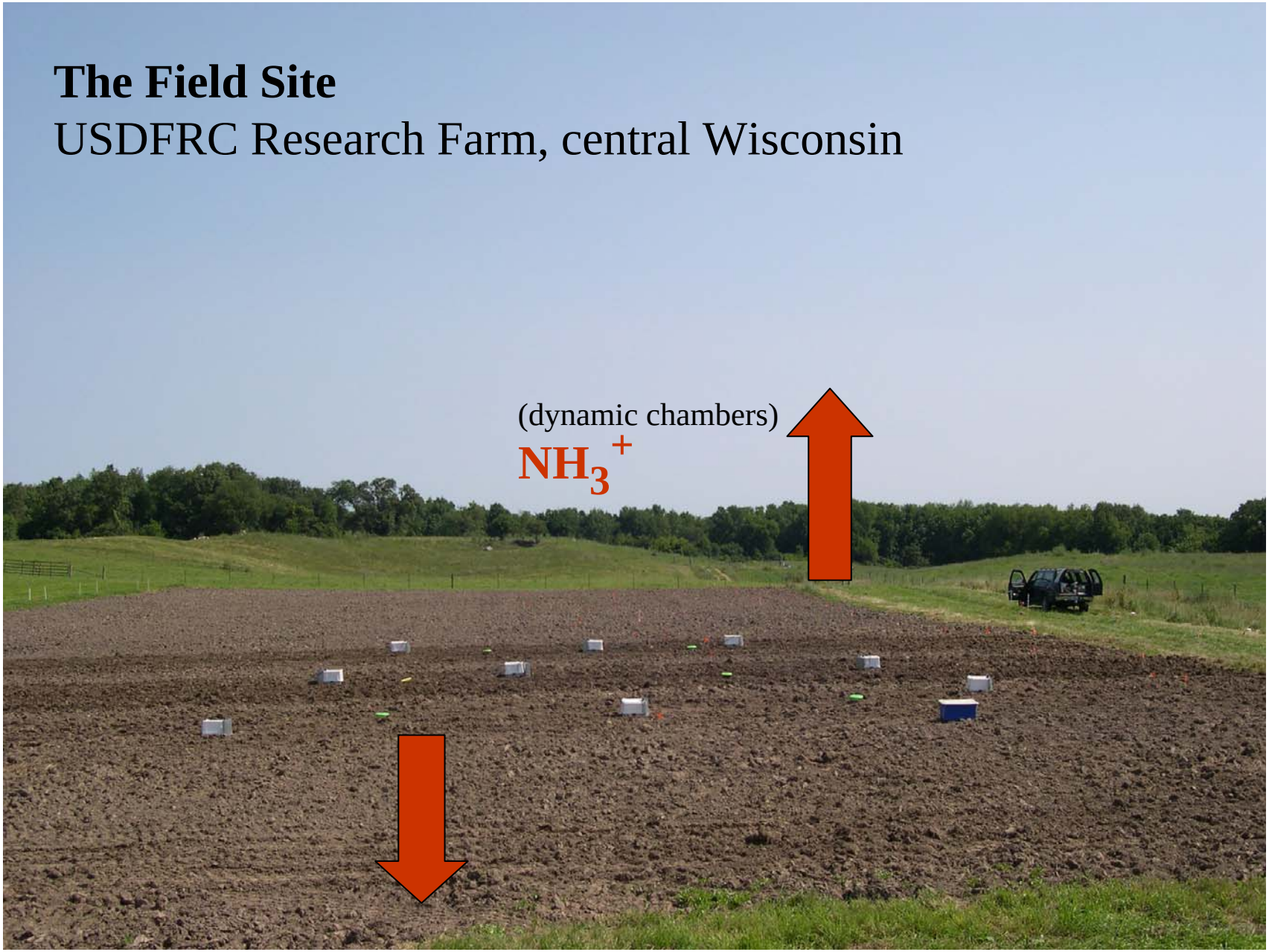
TRADEOFFS

Does conservation of ammonia increase nitrate leaching?

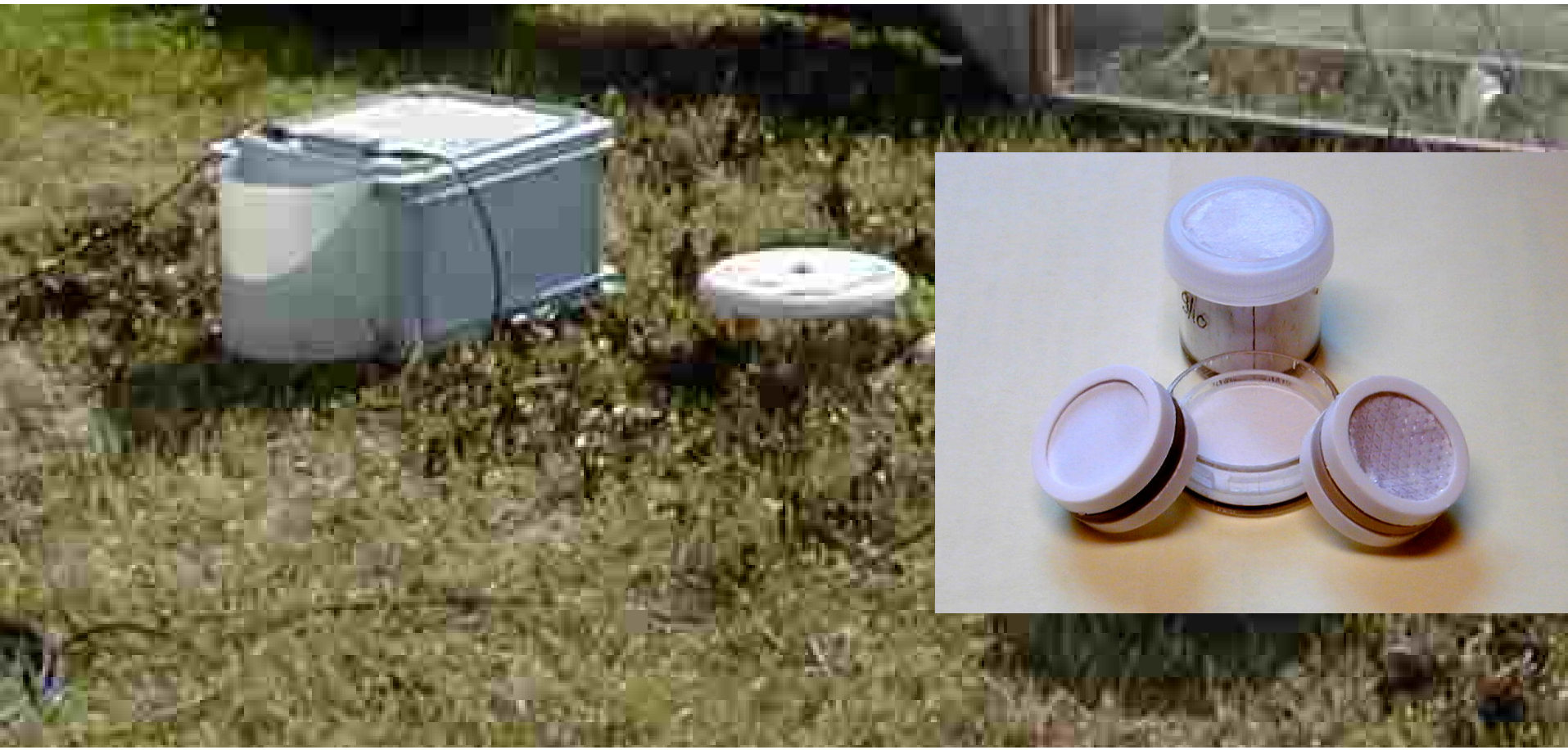


The Field Site

USDFRC Research Farm, central Wisconsin



Field plot study – ammonia emissions

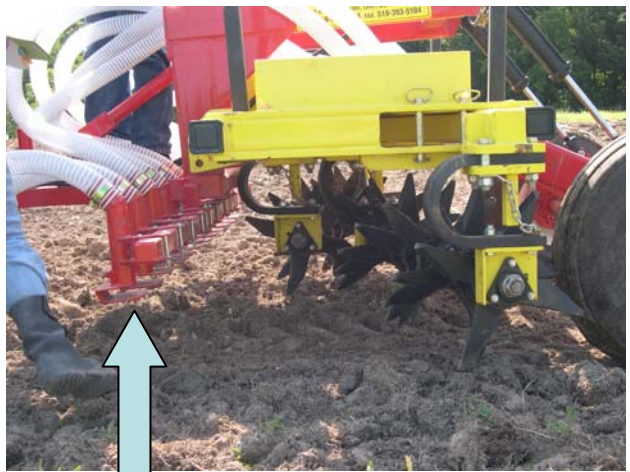


Equilibrium concentration technique

Drainage lysimeters for trapping nitrates

Compliments of Michael Russelle

Research Slurry Applicator



Method 1: Injection

Splash plate

Aerway tool

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

Partial tillage with Aerway tool

Ammonia Emissions and Tillage: Tradeoffs?

(initial results)

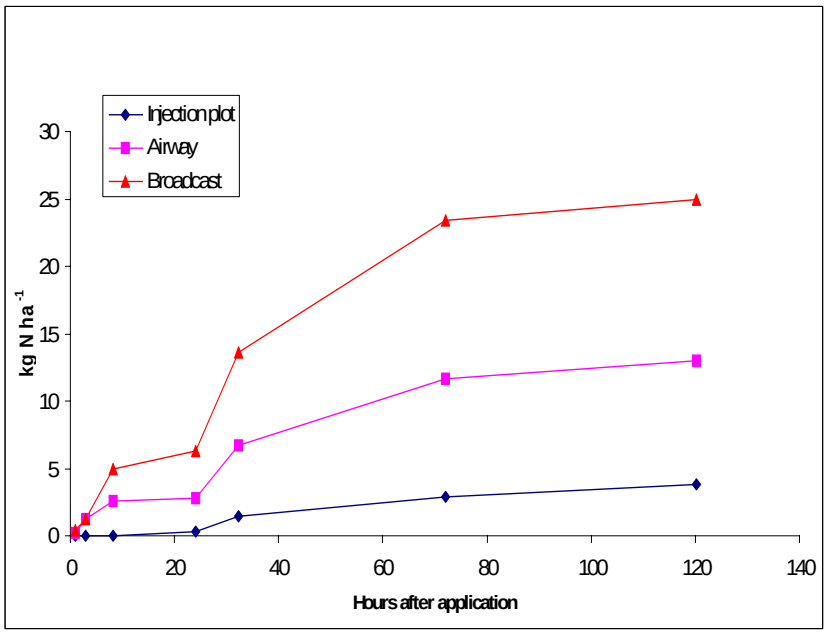
Ammonia loss

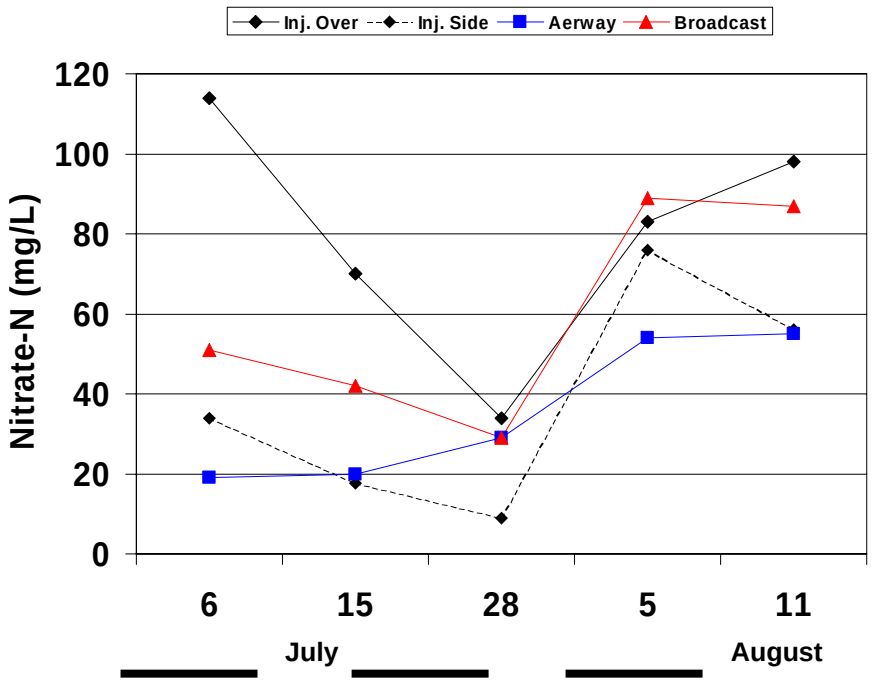
Injection<Aerway<Broadcast

Nitrate loss (in general)

Aerway=Broadcast<<Injection

Initial results: Ammonia-N losses





Quiz time:

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%

Improvements due to reductions in ammonia production and loss through:

***land application

** diet manipulation

* bedding, scraping interval

Summary

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.

This means that an additional 70-80 lbs N per cow would be available annually for application to field crops.

At a fertilizer N value of $0.34/lb N, this can mean annual savings of

$2,300 to $2,700 per 100 dairy cows

on fertilizer costs.


Questions?