

# **Manure Nitrogen Transformations in Air, Soil and Crops on Dairy Farms**

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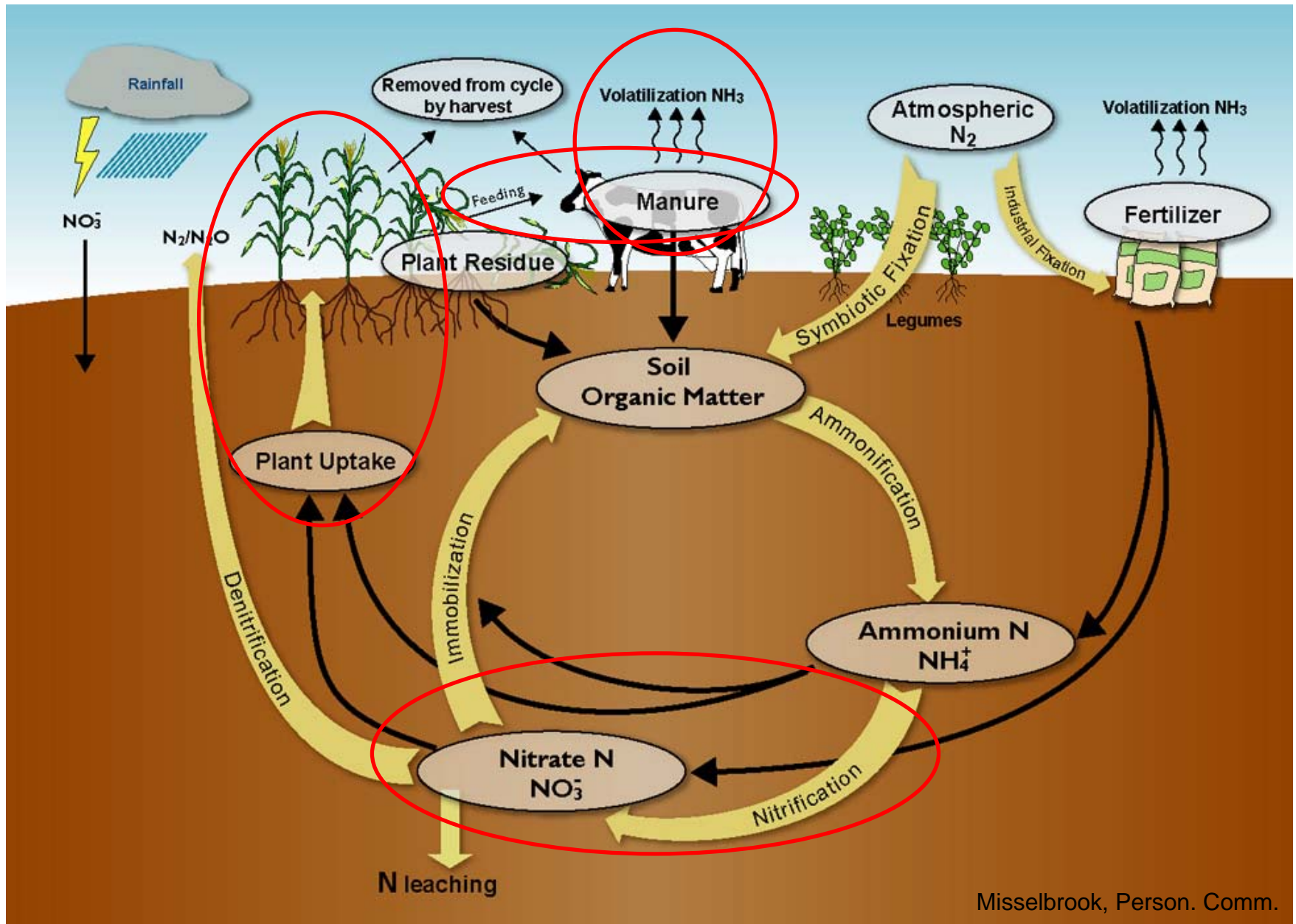
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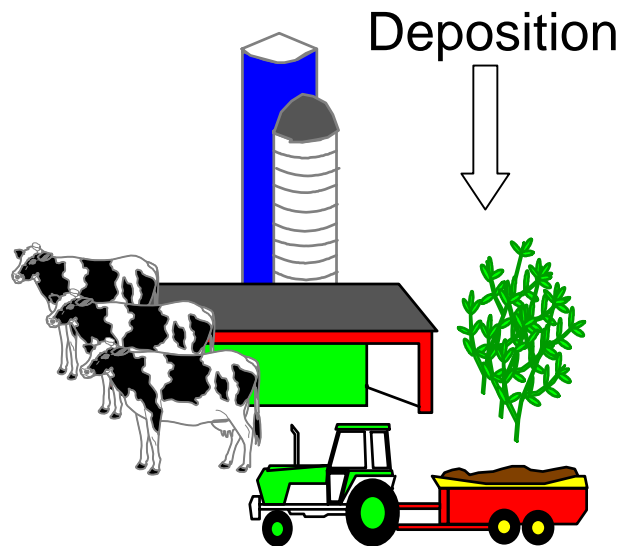
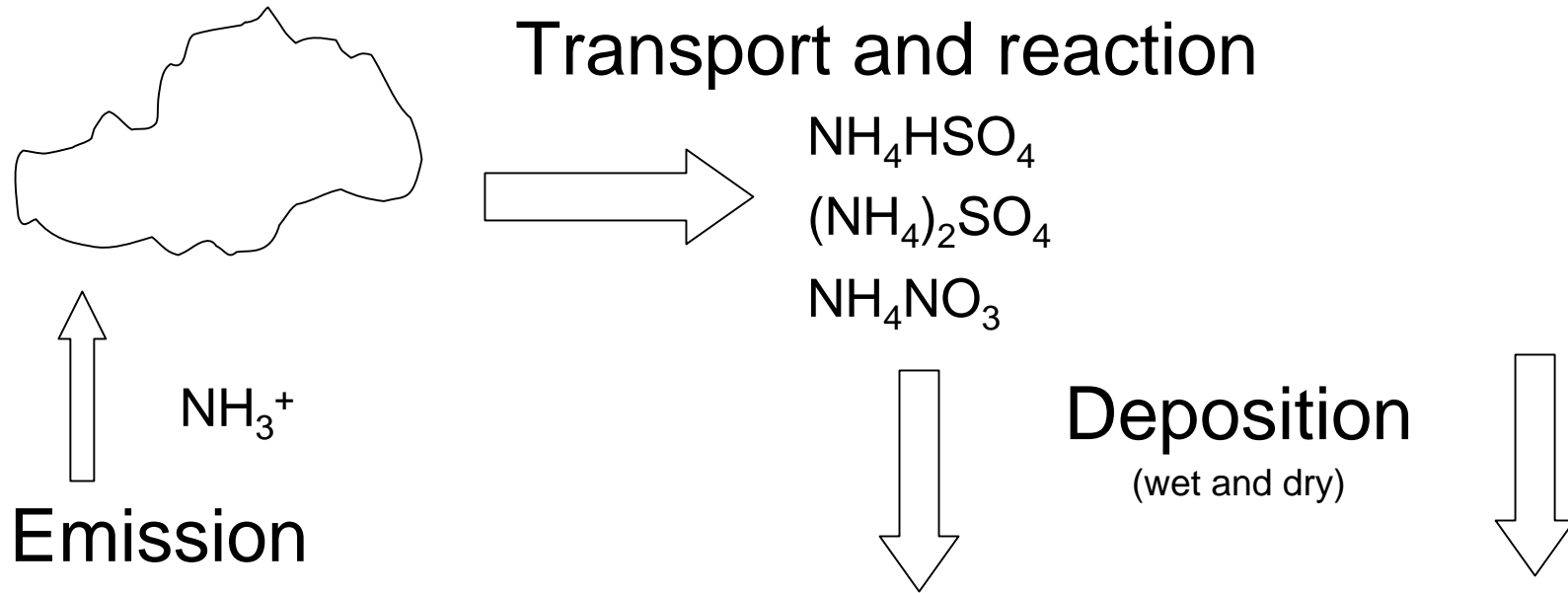
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# Dairy farming and manure N cycles



# Ammonia cycle



- Haze, visibility
- Human health



- Fertilization & Acidification
- Eutrophication
- Loss of biodiversity



# What happens to manure N?

(% of excreted N)

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

# Manure Nitrogen Transformations in Air, Soil and Crops on Dairy Farms

## Factors affecting manure N production

- Feed N - Manure N Linkages

### Overall Feed N use efficiencies

- milk N/feed N
- milk N/manure N

# Manure Nitrogen Transformations in Air, Soil and Crops on Dairy Farms

## Factors affecting manure N collection

- Farm size and housing impacts on manure collection
- Herd management impacts on manure N capture and recycling in crop-soil continuum
- Bedding impacts on urine N capture and recycling

# Manure Nitrogen Transformations in Air, Soil and Crops on Dairy Farms

## Manure N recycling through soils-crops

Dairy diet CP levels and forage type impact

- Urine N production and ammonia loss
- Fecal N chemical composition, mineralization in soils, and crop N uptake

# **Factors affecting manure N production**



# Management impacts on milk production and feed N use efficiency (FNUE)

54 Wisconsin dairy farms

Practice	Use	Milk Production (kg/cow/d)	FNUE (%)
TMR	Yes	33.5a	27.0a
	No	26.1b	24.1b

# Management impacts on milk production and feed N use efficiency (FNUE)

54 Wisconsin dairy farms

Practice	Use	Milk Production (kg/cow/d)	FNUE (%)
Balance rations $\geq 4x/y$	Yes	30.6a	26.5a
	No	24.7b	21.0b

# Management impacts on milk production and feed N use efficiency (FNUE)

54 Wisconsin dairy farms

Practice	Use	Milk Production (kg/cow/d)	FNUE (%)
Milk thrice daily	Yes	40.2a	32.6a
	No	28.8b	24.9b

# Management impacts on milk production and feed N use efficiency (FNUE)

54 Wisconsin dairy farms

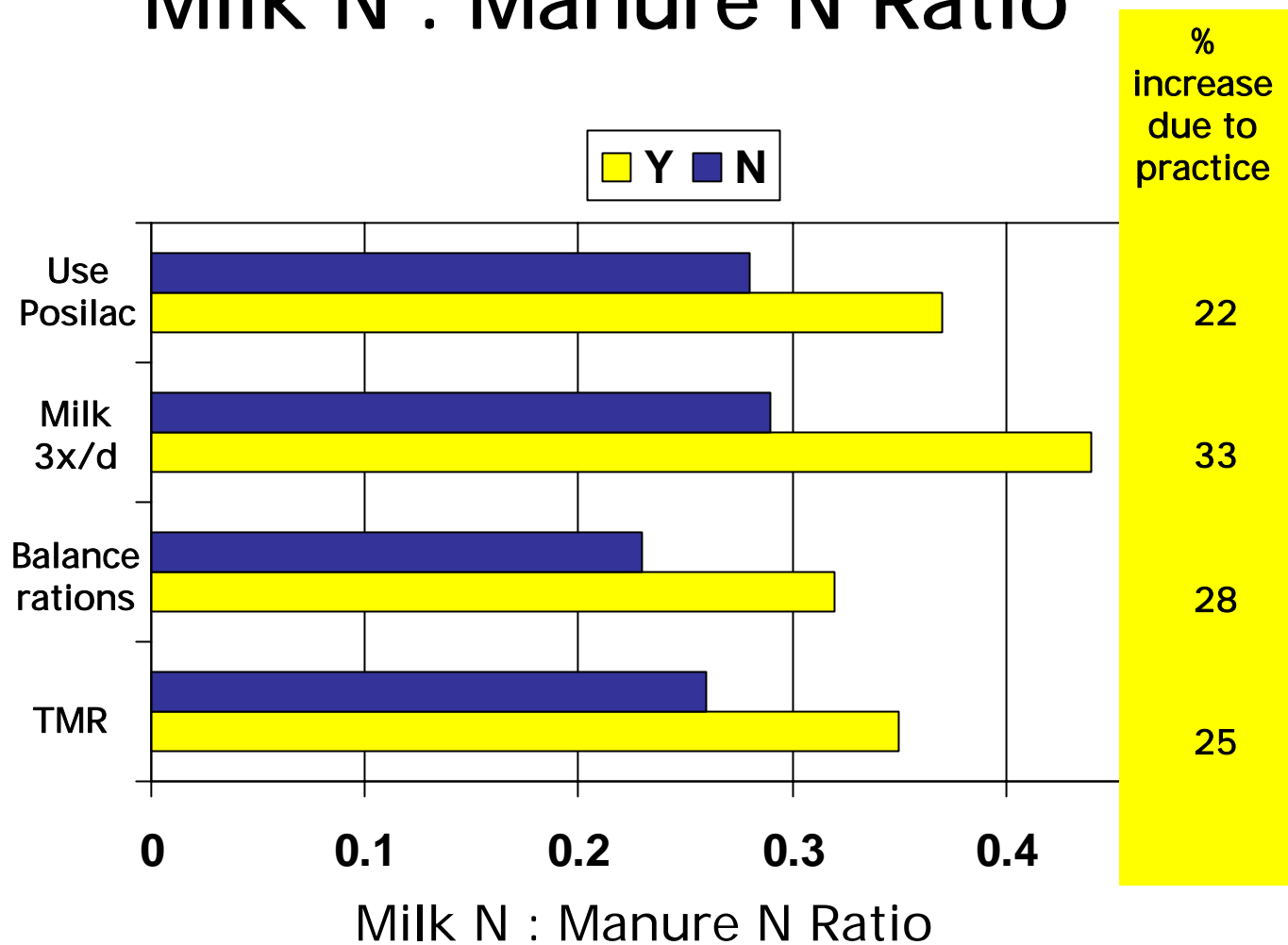
Practice	Use	Milk Production (kg/cow/d)	FNUE (%)
Use Posilac®	Yes	37.1a	29.0a
	No	27.7b	24.6b

# Herd size impacts on milk production and feed N use efficiency (FNUE)

54 Wisconsin dairy farms

Lactating cows/farm	Milk Production (kg/cow/d)	FNUE (%)
1-29	20.0c	18.2c
30-49	27.4b	24.2b
50-99	29.7b	26.6b
100-199	33.1ab	24.3b
200+	38.7a	32.6a

# Dairy management impacts on Milk N : Manure N Ratio



# Factors affecting manure N collection

- Farm size and housing

# Where dairy farmers collect manure



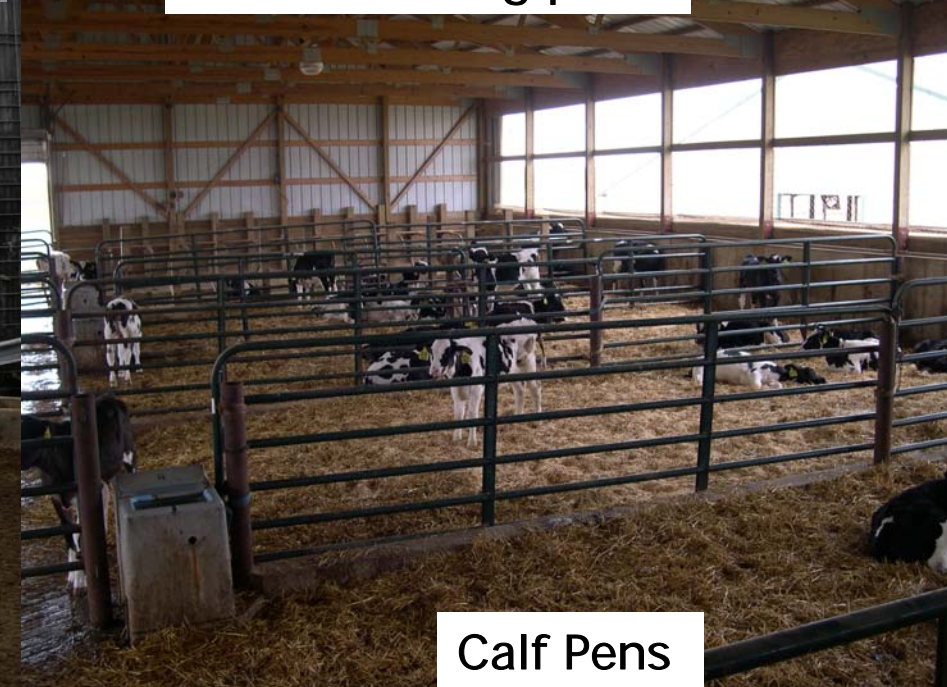
Barn



Heifer bedding pack



Barnyard



Calf Pens



# Where manure goes uncollected

Pastures



Feed bunk areas



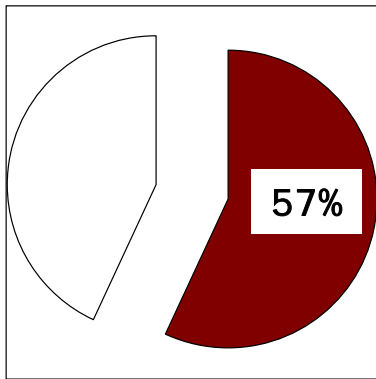
Barnyards



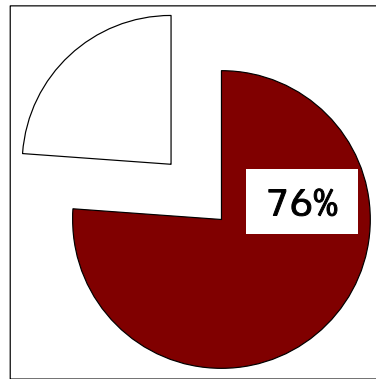
# Herd size differences in manure collection on 54 Wisconsin dairy farms

Number of lactating cows on a farm

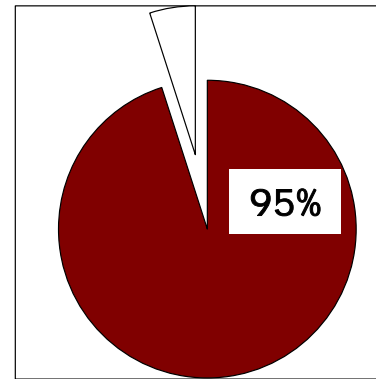
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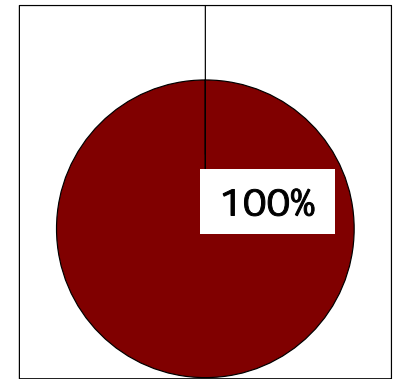
<50-99



<100-199



200+



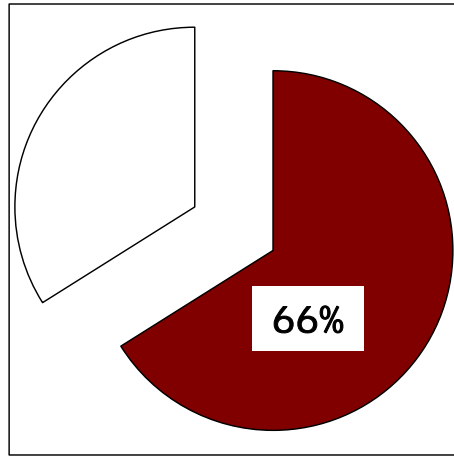
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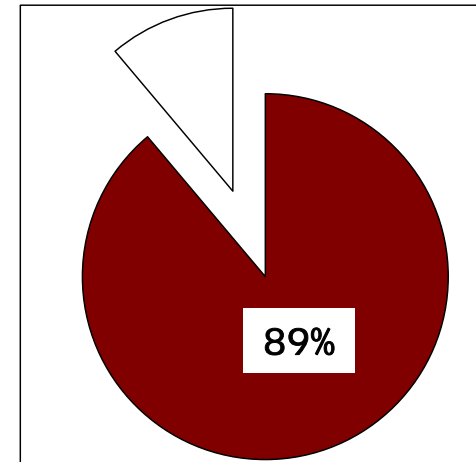
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■ Collected □ Not Collected

# Housing differences in manure collection on 54 Wisconsin dairy farms



Stanchions



Free-stalls

■ Collected □ Not Collected

■ Collected □ Not Collected



# **Factors affecting manure N collection**

- Herd management

# Dairy herd management impacts

- Where manure N is voided affects manure N capture and recycling

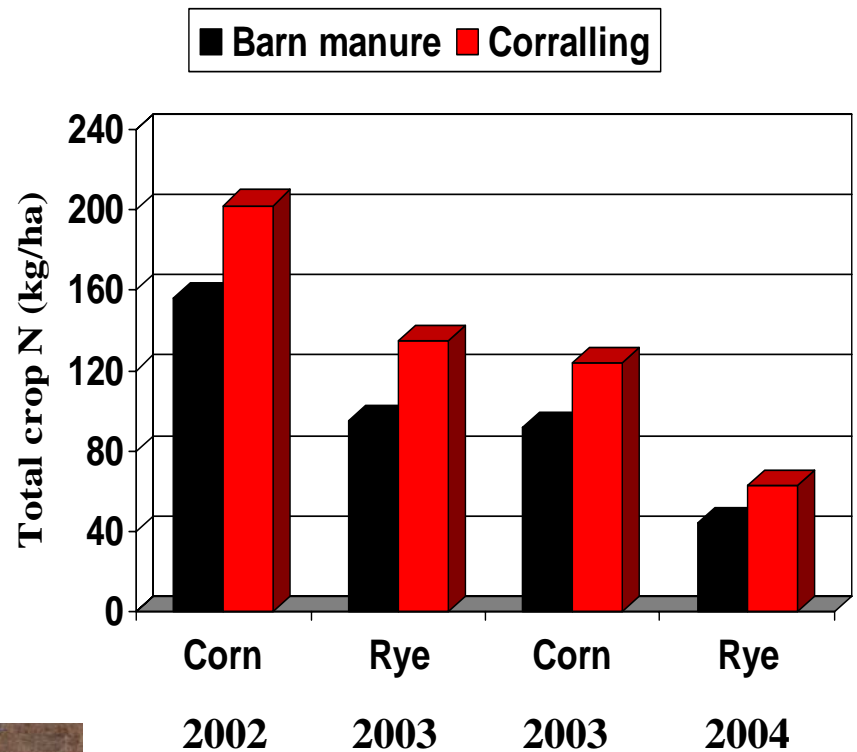


# Herd management impacts

## Manure N capture and recycling



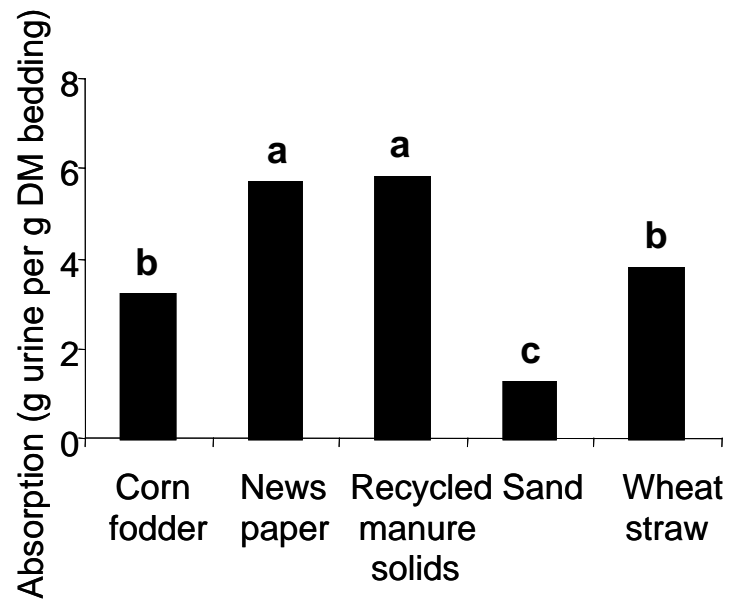
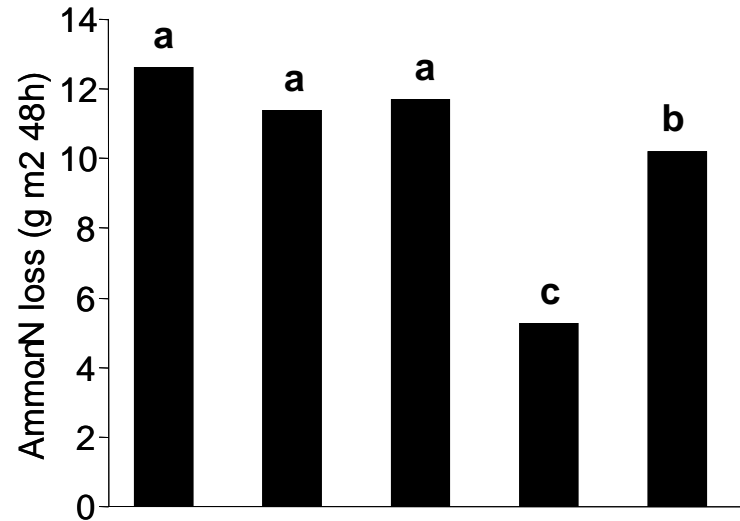
A five-year field study



# Factors affecting manure N collection

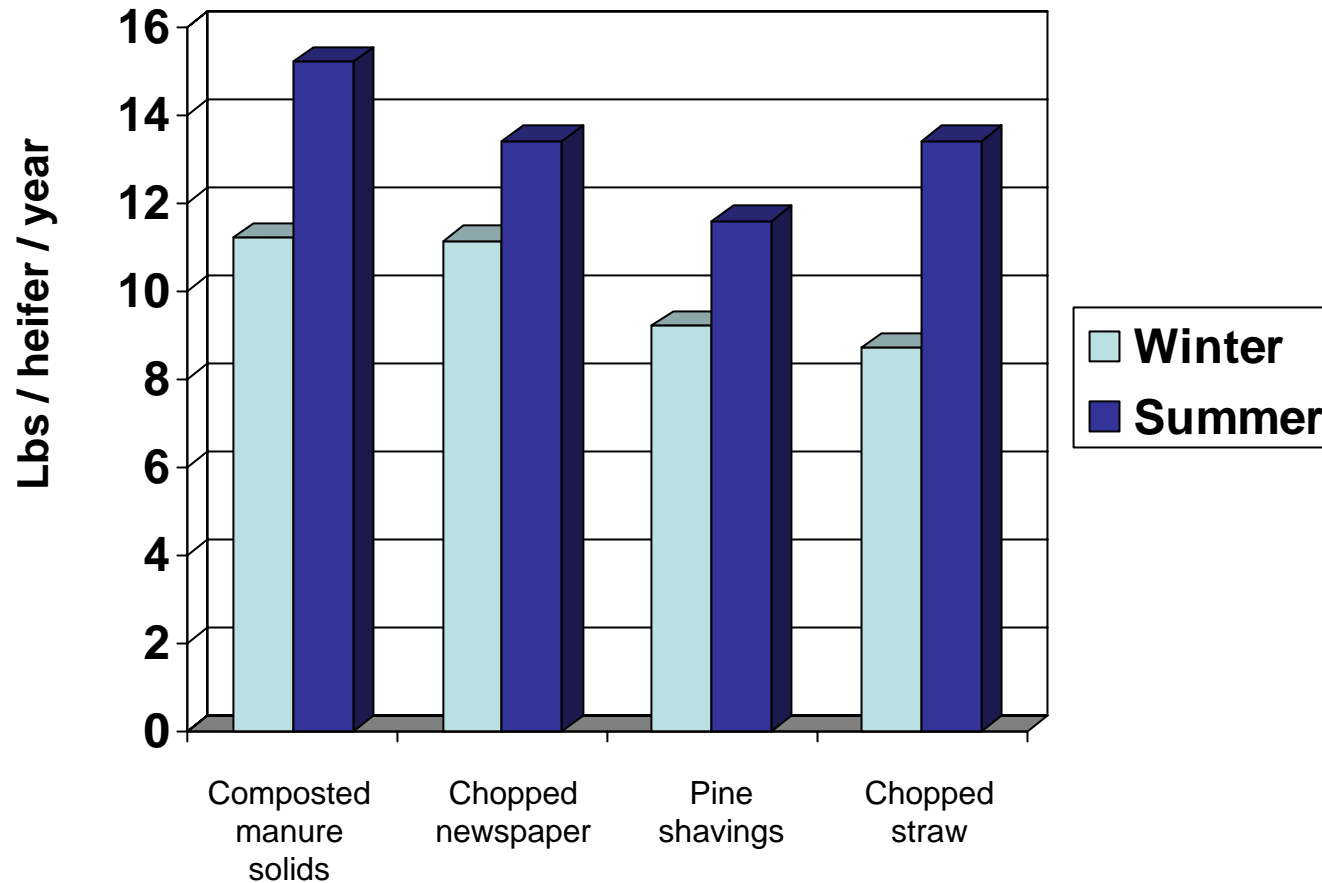
- Bedding impacts urine N capture

# Beddings that absorb urine lose it as ammonia





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



Ammonia emissions are 20-55% greater during summer than winter

# Manure N recycling through soil-crops

## Dairy diet CP level and forage type impact

- Urine N production and ammonia loss
- Fecal N chemical composition, mineralization in soils, and crop N uptake

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



10 to 40 %



# What happens to manure N?

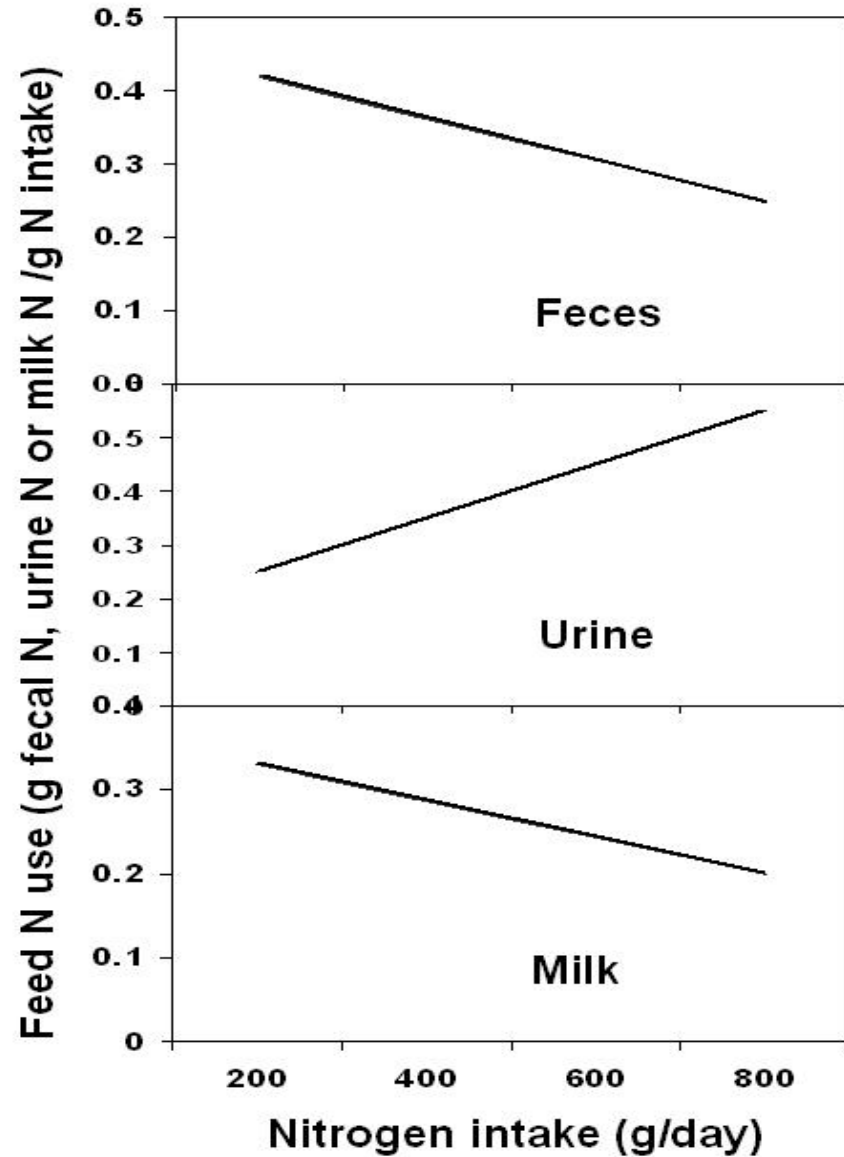
(% of excreted N)

- Lost as ammonia (20-40%)
- Taken up by plants (20-40%)
- Lost via nitrate leaching (10-20%)
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- Immobilized by soil microorganisms (?)

# Impact of dairy diets

Crude protein fed  
in excess of  
requirements

- Decreases  
Milk N  
Fecal N
- Increases  
Urinary N



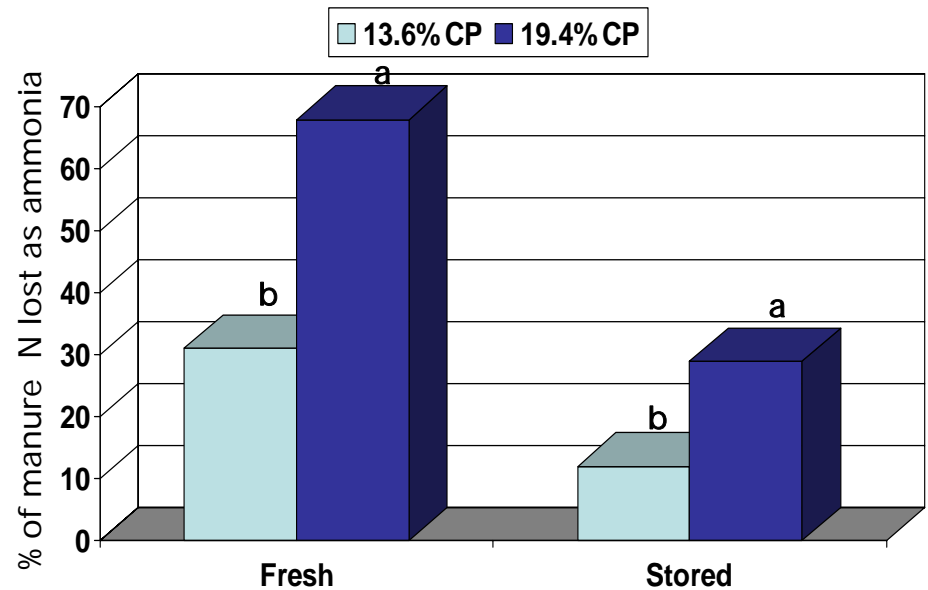
As urine N ↑ Ammonia N ↑

# Diet CP impacts

## Urine N production

	13.6% CP	19.4% CP
Manure N g/cow/d	300	380
% Fecal N	52 <sup>a</sup>	68 <sup>a</sup>
% Urine N	48 <sup>b</sup>	32 <sup>b</sup>

## Ammonia emissions after manure application to soil

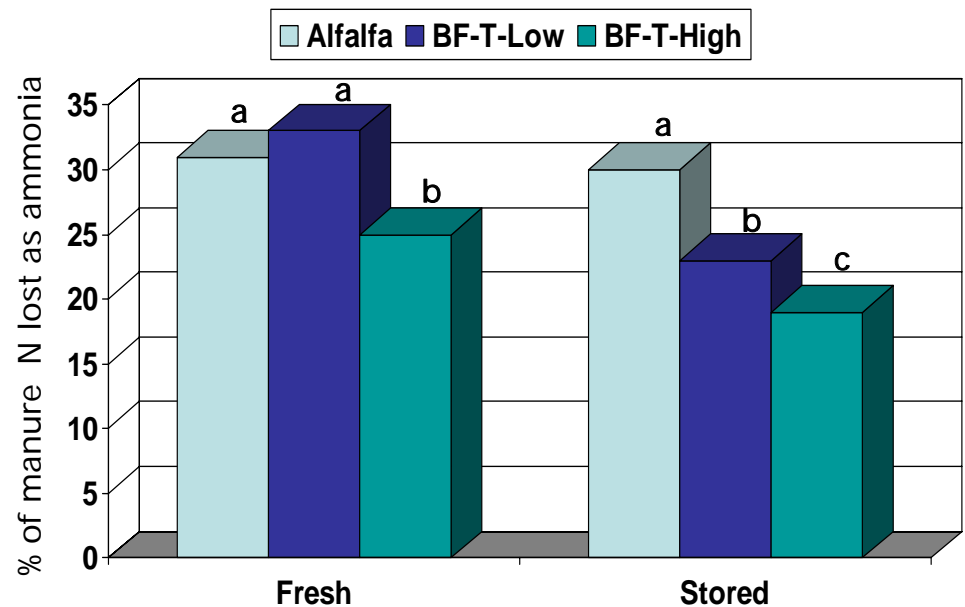


# Forage type impacts

## Ammonia emissions after manure application to soil

### Urine N production

	Alf	BF-T-Low	BF-T-High
Manure N g/cow/d	300	380	410
% Fecal N	55 a	60 a	40 b
% Urine N	45 b	40 b	60 a



# Dairy diet CP and fiber (F) level impact fecal chemistry

Feed components		TC	TN	NDF	NDIN	C:N
LCP	HF	451	27.0	571	6.5	17.8
HCP	HF	447	29.4	564	7.3	14.7
LCP	MF	462	27.6	538	6.6	16.0
HCP	MF	453	29.4	599	7.8	16.5
LCP	LF	457	28.6	526	6.6	11.7
HCP	LF	460	30.5	512	506	14.5



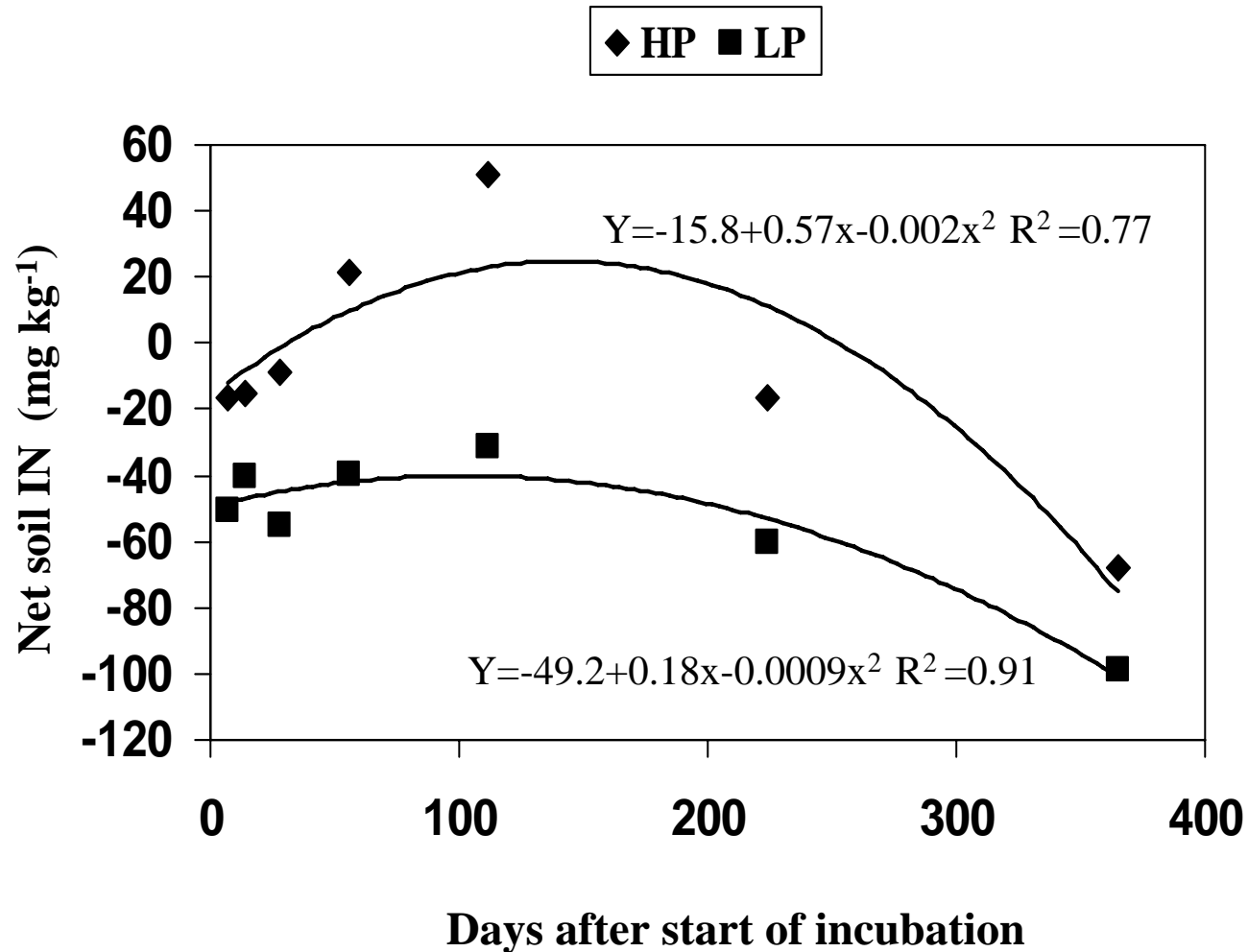
# Dairy diet forage type and level impact fecal chemistry

Feed components		TC	TN	NDF	NDIN	C:N
100CS		452	29.0	545	8.0	15.8
75CS	25AH	461	30.3	528	7.8	16.1
75CS	25AS	457	29.7	505	8.4	14.5
50CS	50AS	474	32.2	501	7.6	15.0

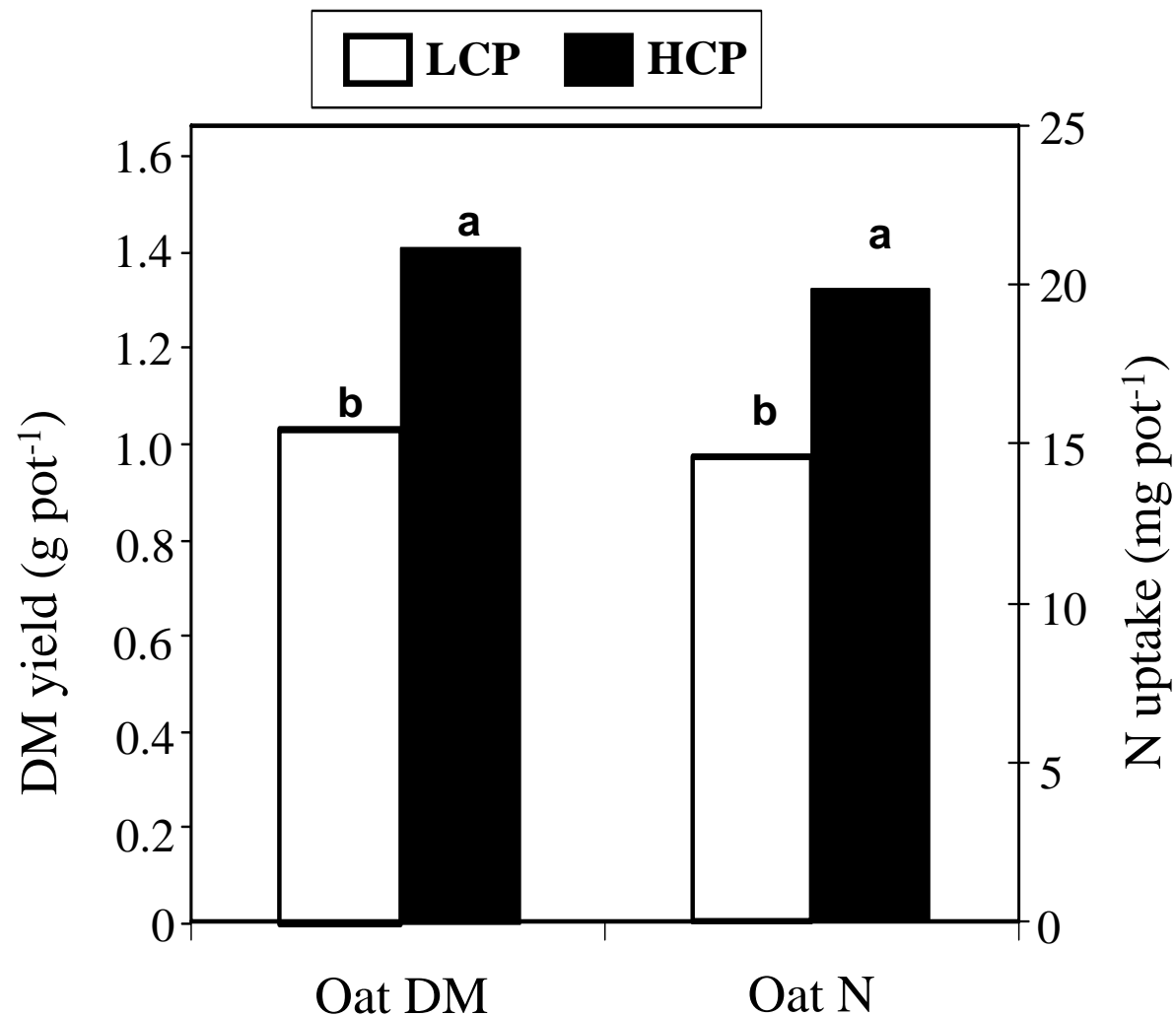
# Dairy diet forage type and CP level impact fecal chemistry

Feed components		TC	TN	NDF	NDIN	C:N
CS	LP	448	28.4	570	8.3	15.5
CS	HP	454	28.2	537	6.4	14.8
AS	LP	444	24.4	545	4.8	18.3
AS	HP	439	24.4	561	5.3	18.1

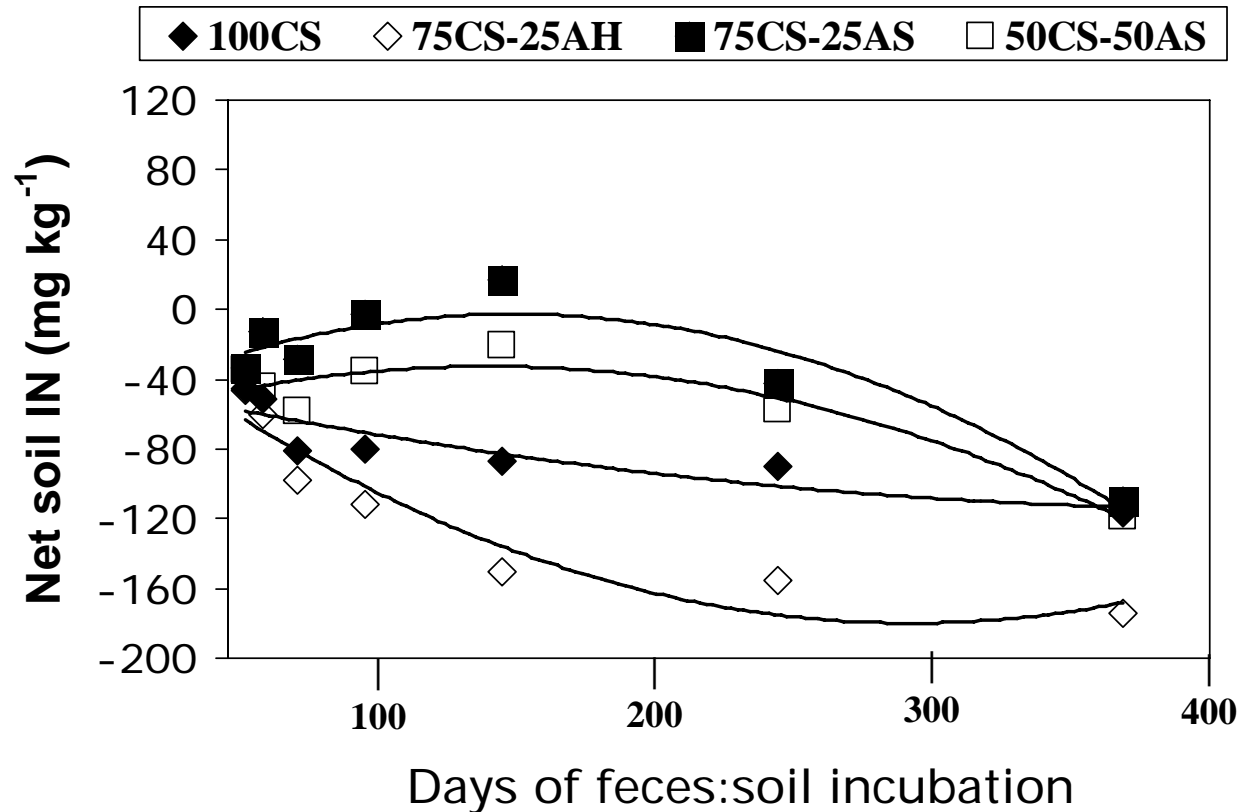
# Diet CP level impacts Fecal N mineralization in soils



# Diet CP level impacts Fecal N availability to crops

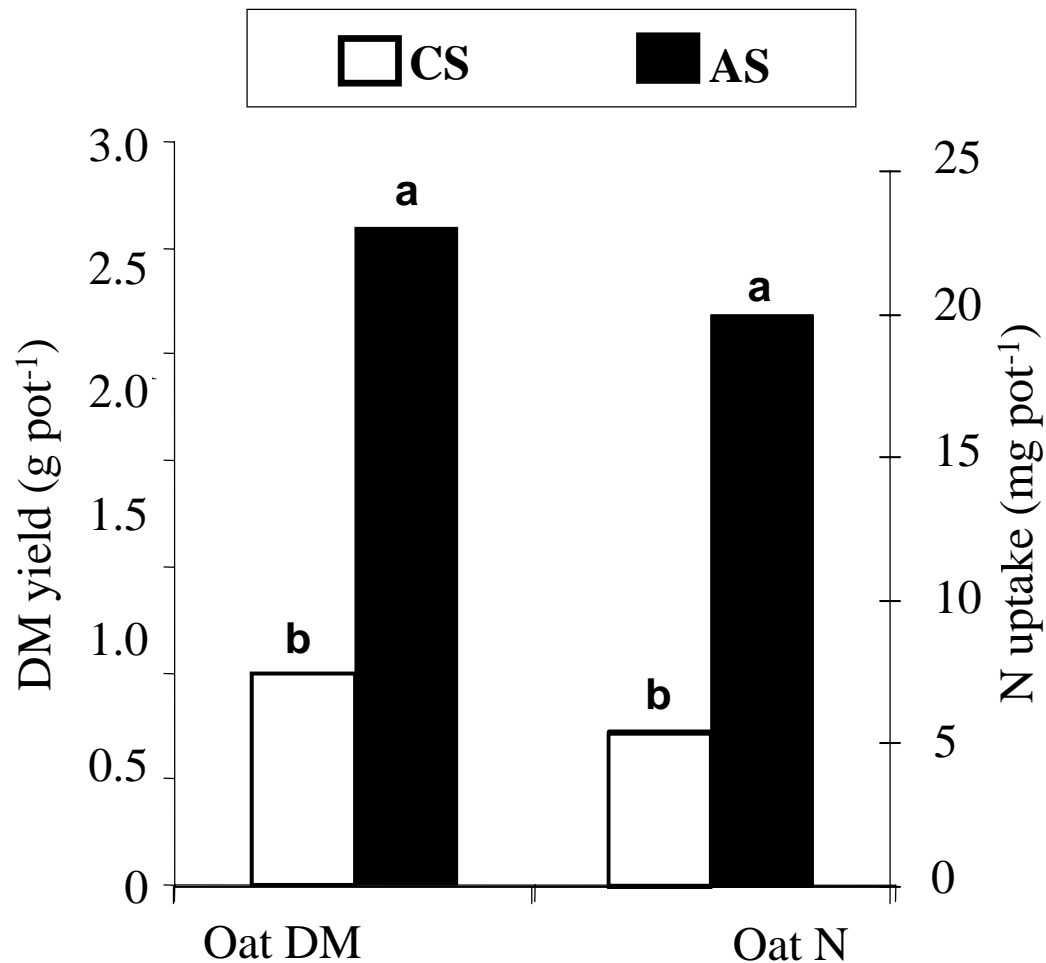


# Forage type impacts Fecal N mineralization in soils

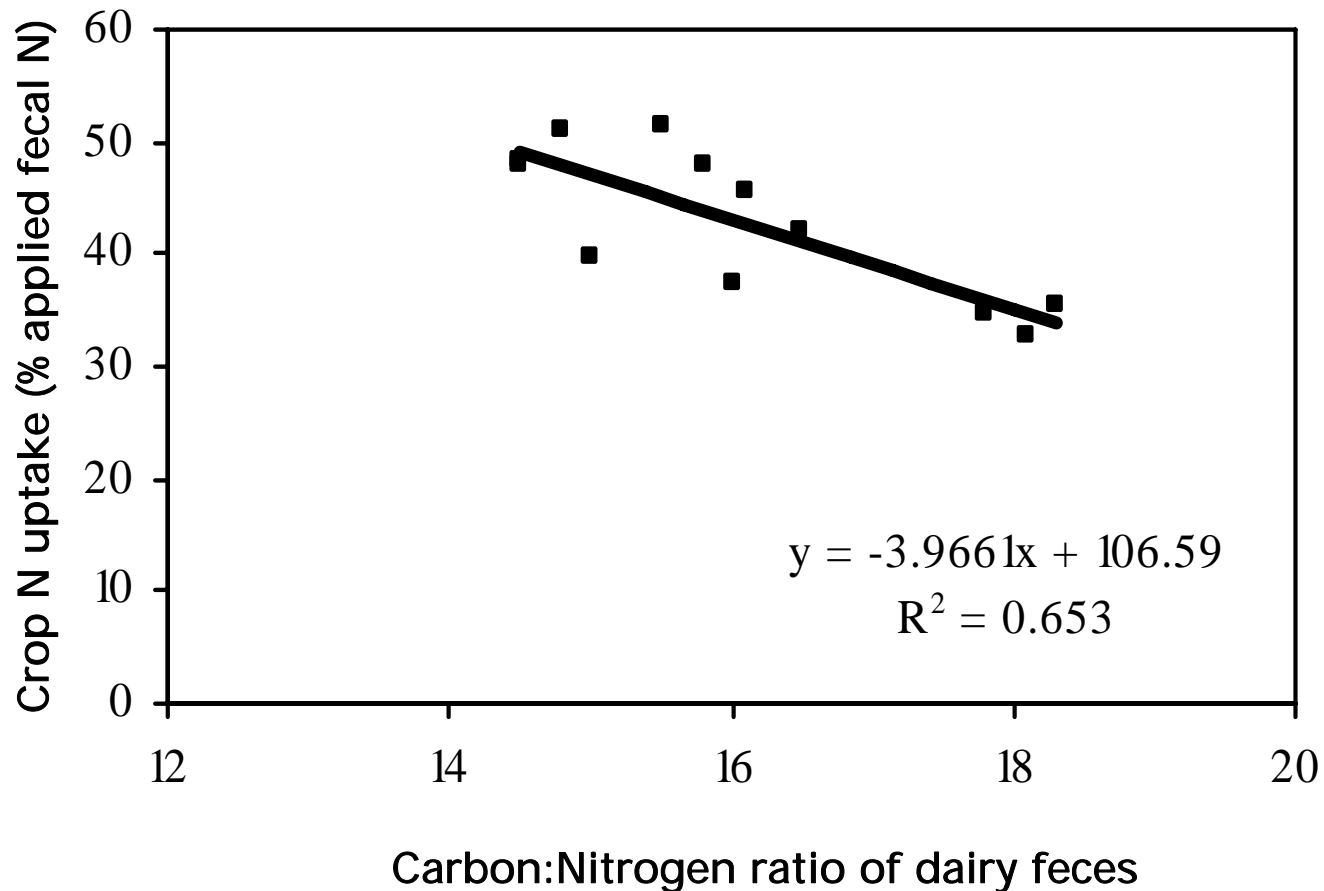


# Forage type impacts

## Fecal N availability to crops



Relationship between Carbon:Nitrogen ratio of dairy feces and net crop N uptake in silt loam soil  
(each data point = one diet)



# **Summary: Manure N Transformations in Air, Soil and Crops on Dairy Farms**

## **Factors affecting manure N production**

- Management impacts feed N use efficiency

## **Factors affecting manure N collection**

- Farm size and housing
- Herd management
- Bedding impacts



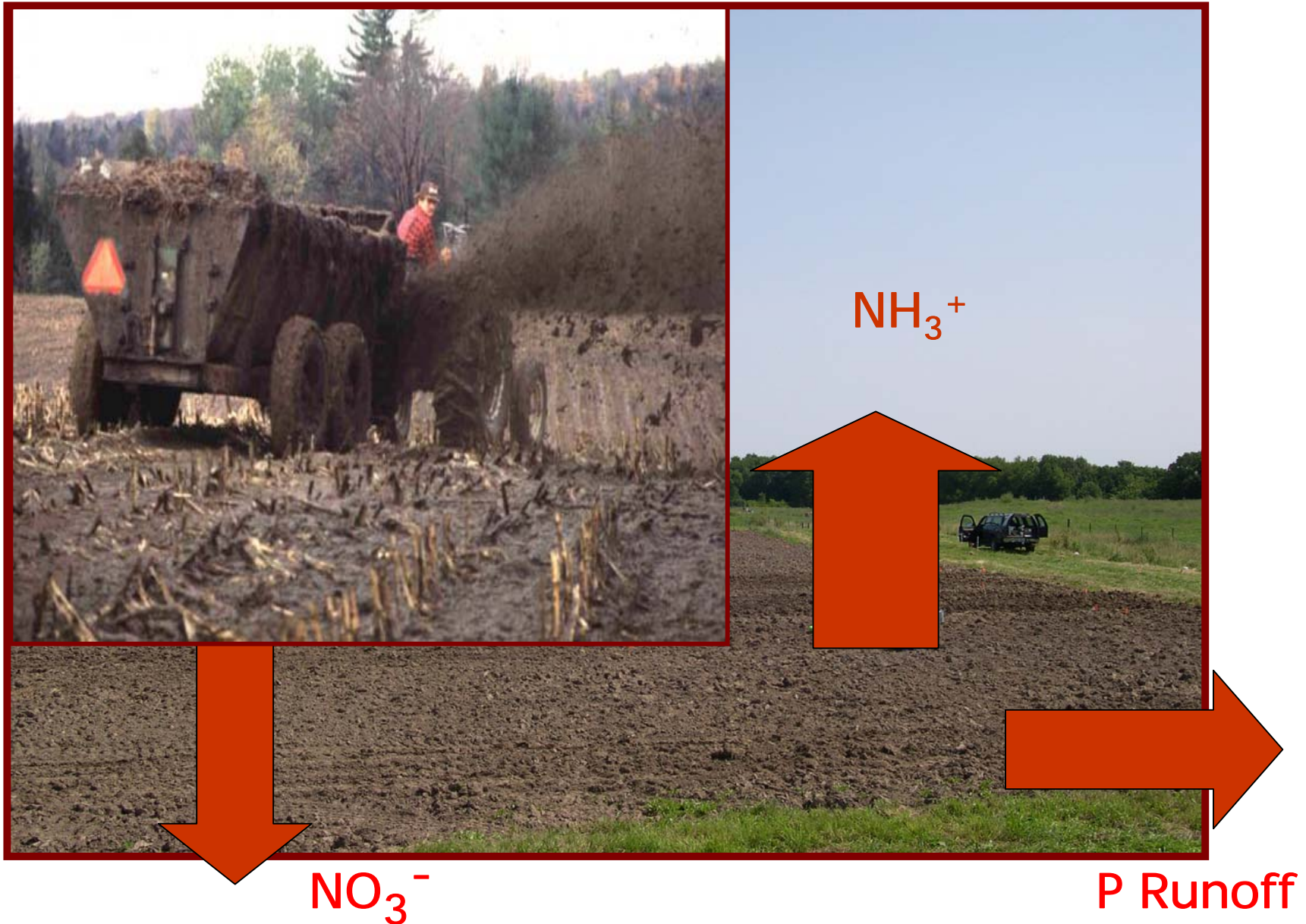
# Manure N recycling through soil-crops

- CP level and forage type in dairy diets
  - Impact urine N production, and ammonia loss from land-applied manure
  - Fecal N chemistry, N mineralization in soils, and crop N uptake

# Future research

- Can dairy diets be formulated to meet herd production requirements, and produce manure less susceptible to N (P and pathogen) losses?
- Are there production sacrifices associated with such feed practices?
- Are alternative herding practices available that enhance manure N capture & recycling?
- Do in-barn practices (e.g., bedding, floor design, manure scrape interval) impact manure N (and pathogen) concentrations and loss during manure handling, storage and land application?

# Future research



Questions?

