Nitrogen cycling on dairy farms
(feed management update)

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Measures of Nitrogen Use Efficiency and Nitrogen Loss from Dairy Production Systems

(1) Forage plus grain farm

1.4 cows/ha

Imports only protein

(2) Forage only farm

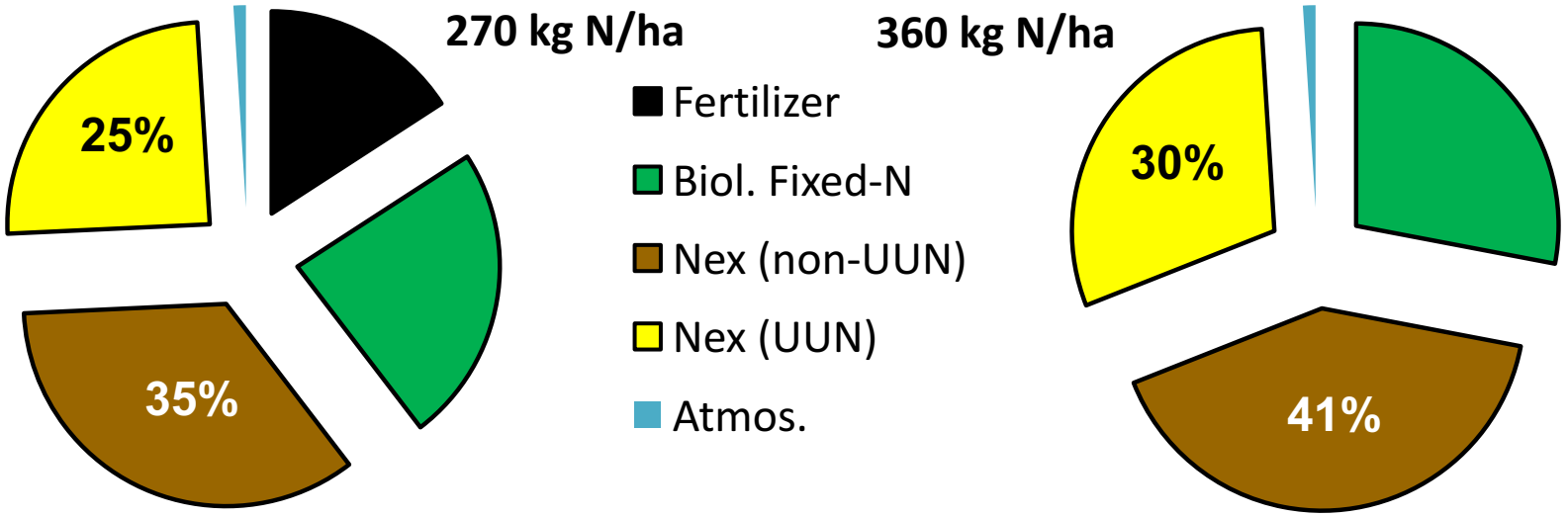
2.2 cows/ha

Imports grain and protein

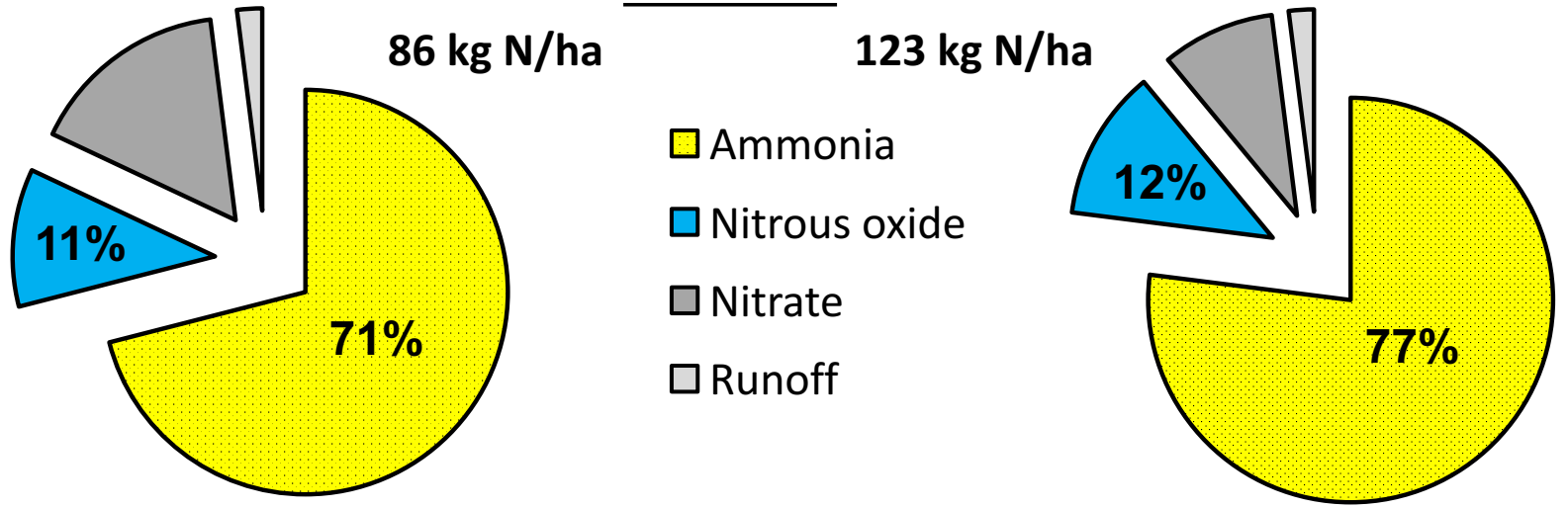
Forage plus grain farm
1.4 cows/ha

Forage only farm
2.2 cows/ha

N sources

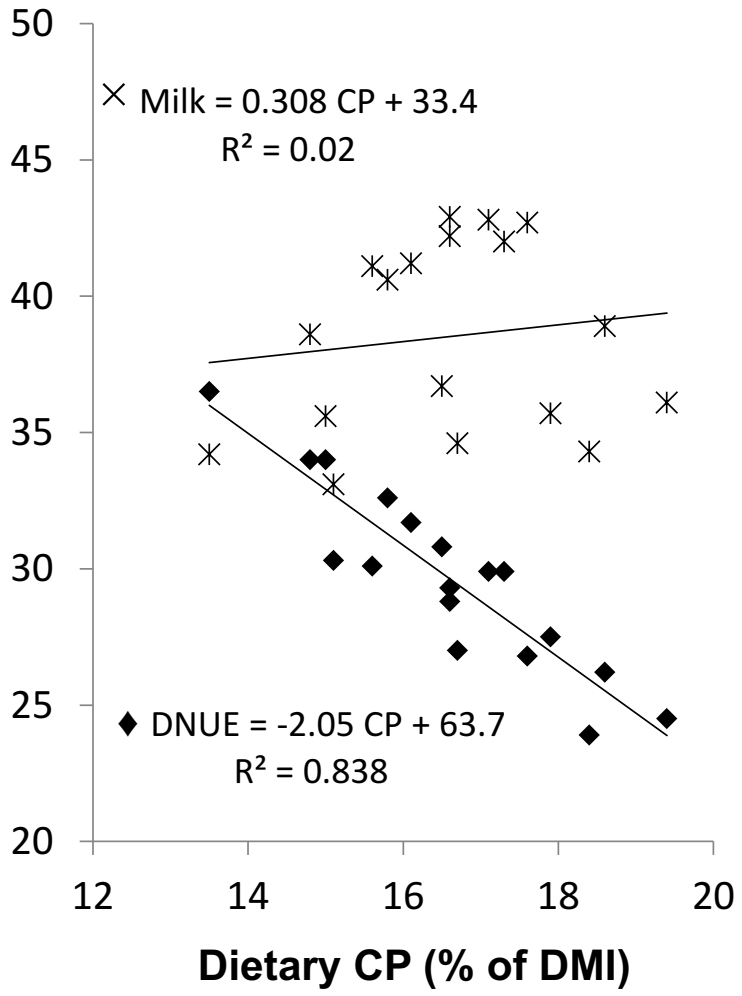


N losses



Summary of 5 dairy nutrition trials
(Wattiaux et al., 2011)
18 dietary CP levels fed to 207 cows

Milk production
DNUE (milk protein:feed protein)



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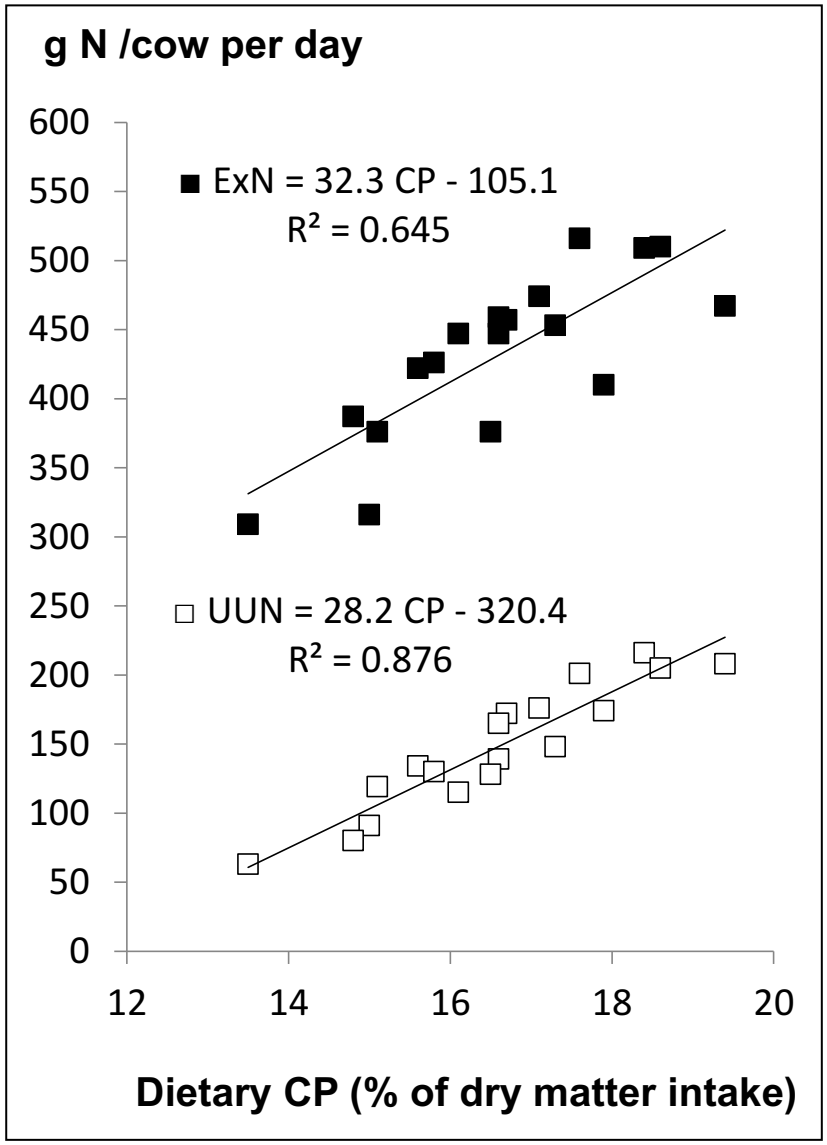
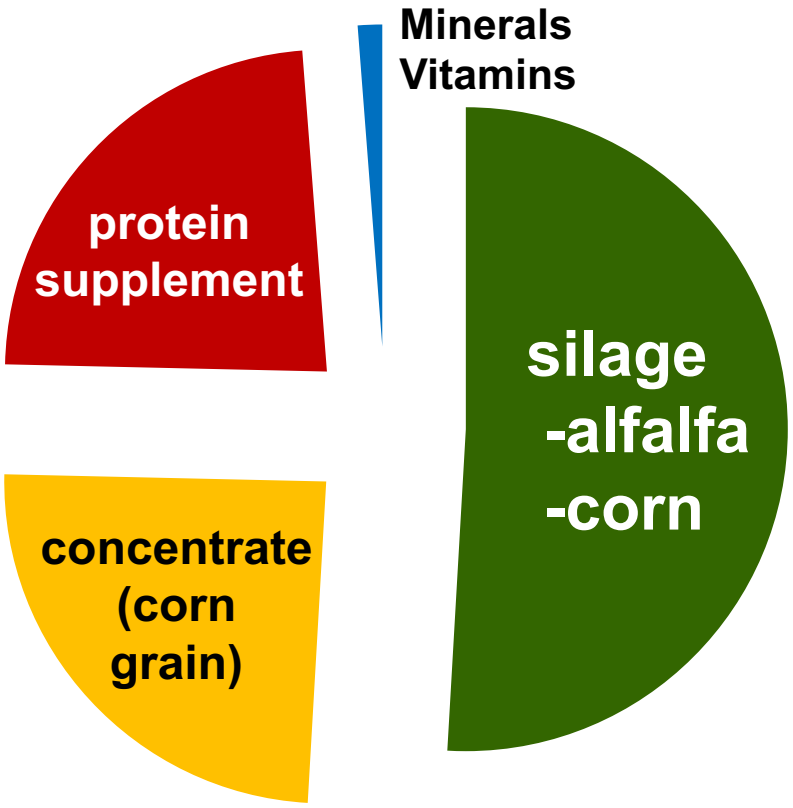


typical ration dry matter

Lactating cows
Wisconsin confinement farm



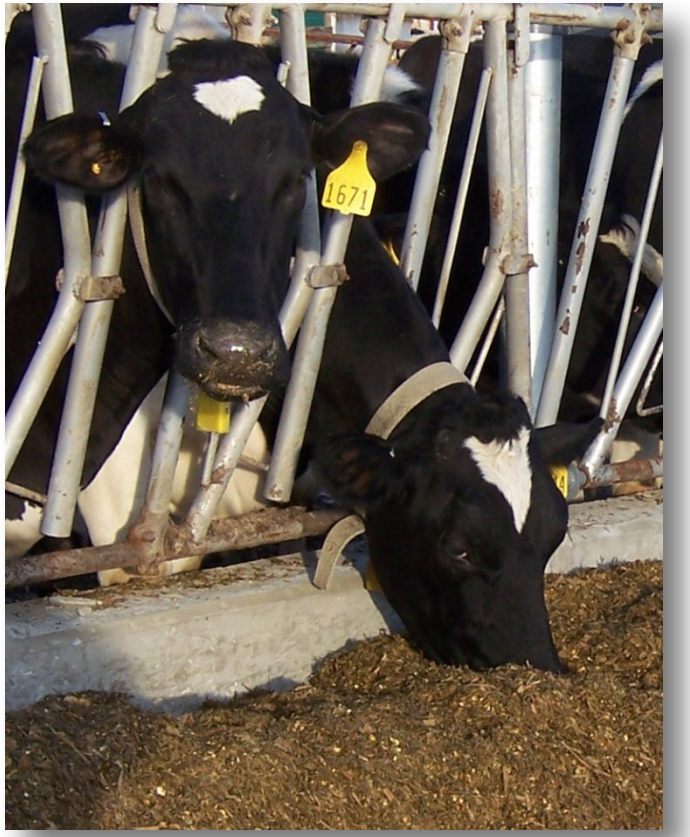
Changes to rations

Less protein
(to reduce feed costs & N emissions)

More grain
(to enhance ration energy & reduce enteric methane)

More corn silage
(to reduce production & feed costs, feed more cows)

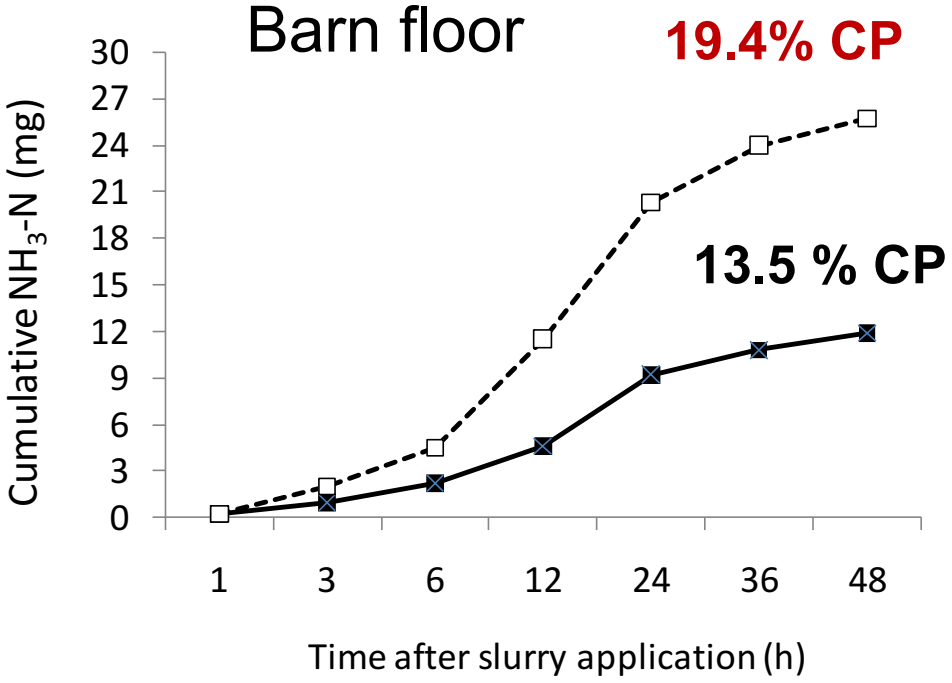
Less protein (soybean meal) reduces N excretion in manure, especially urinary N

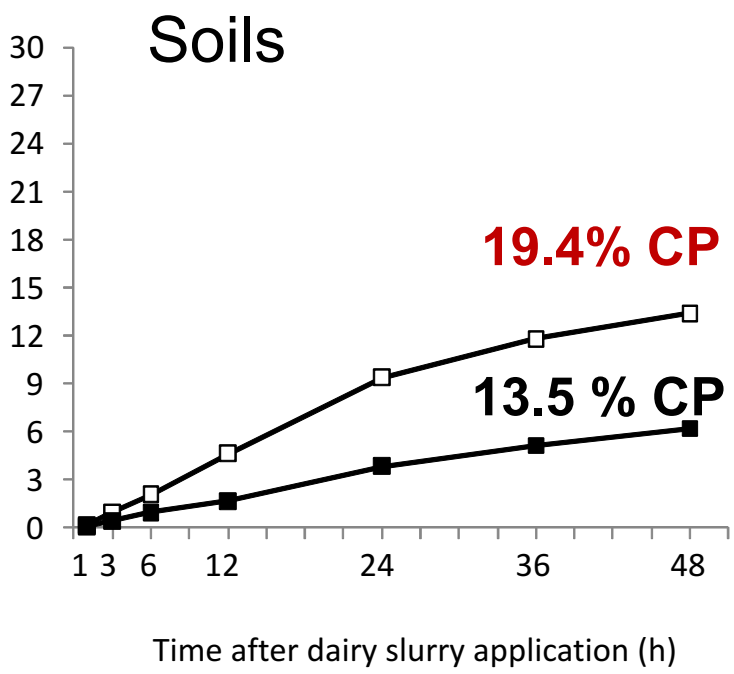


	19.4% CP SBM 16.0% of DMI	13.5% CP SBM 2.4 % of DMI
Excreted N g/cow/d	467	309
% Urine N	55	37
% Fecal N	45	63

Adapted from Colmenero and Broderick, 2006

. . . and this decreases NH_3 emissions from dairy barns and manured soils

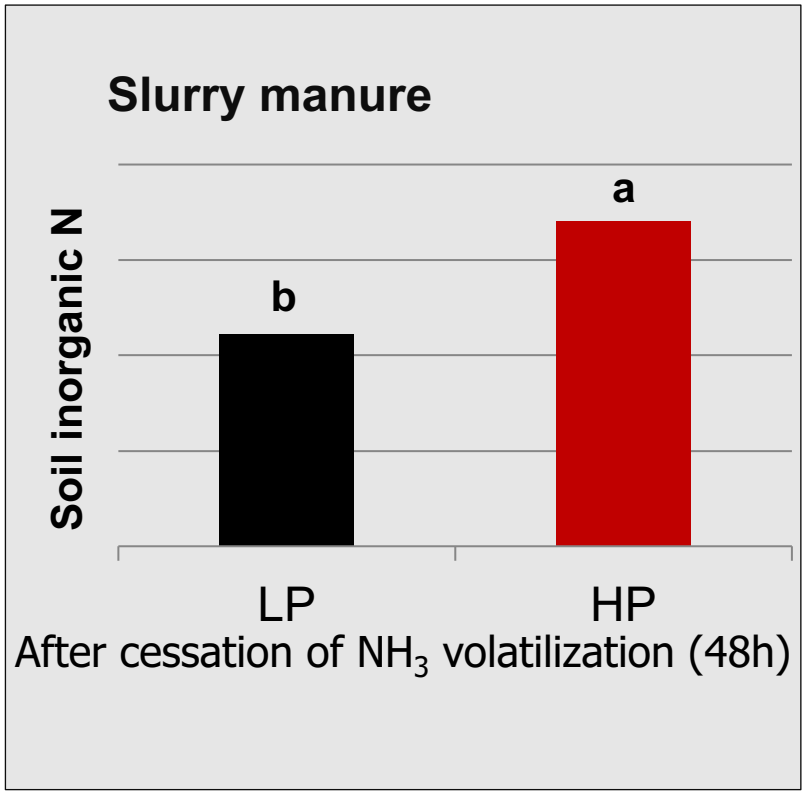


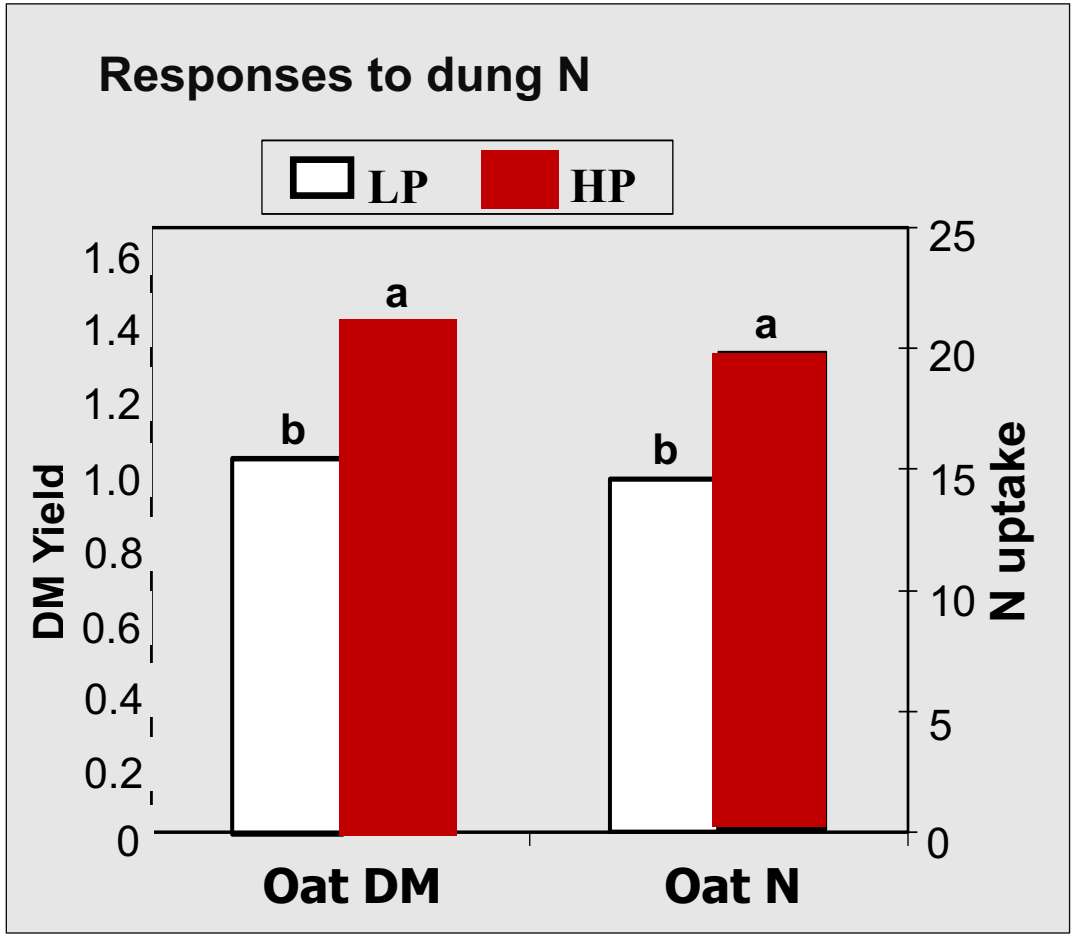


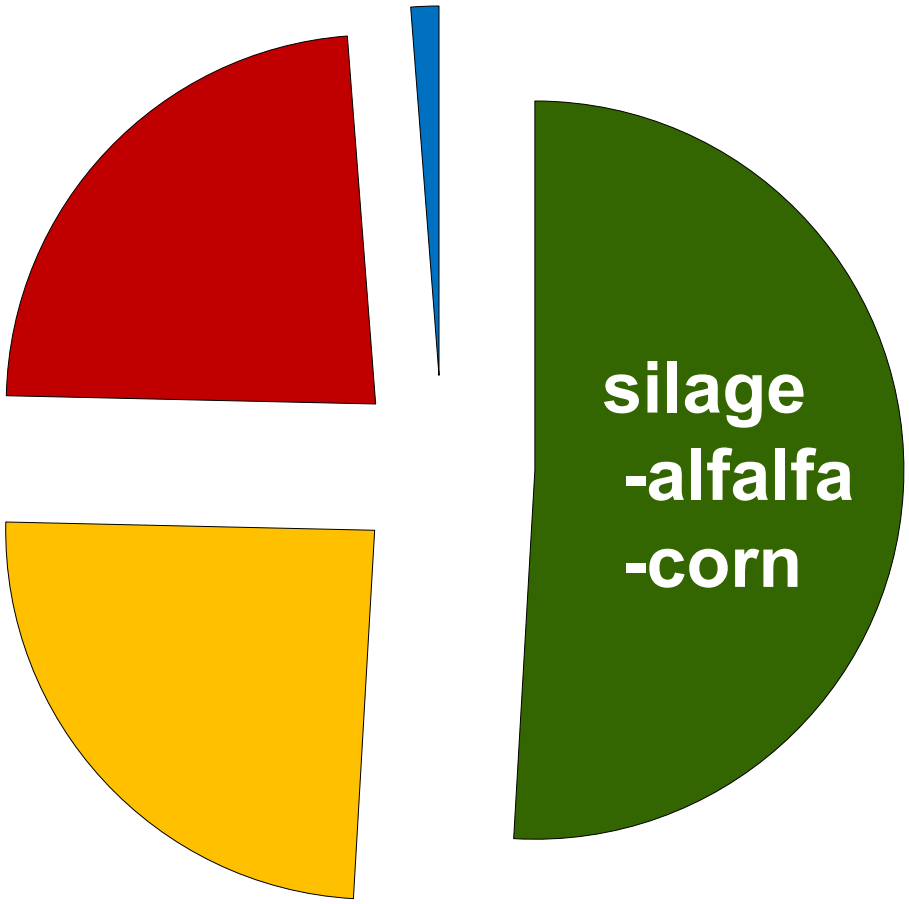
Adapted from Misselbrook et al., 2005

Tradeoffs in N use and loss

BUT…..less SBM decreases manure N availability to plants

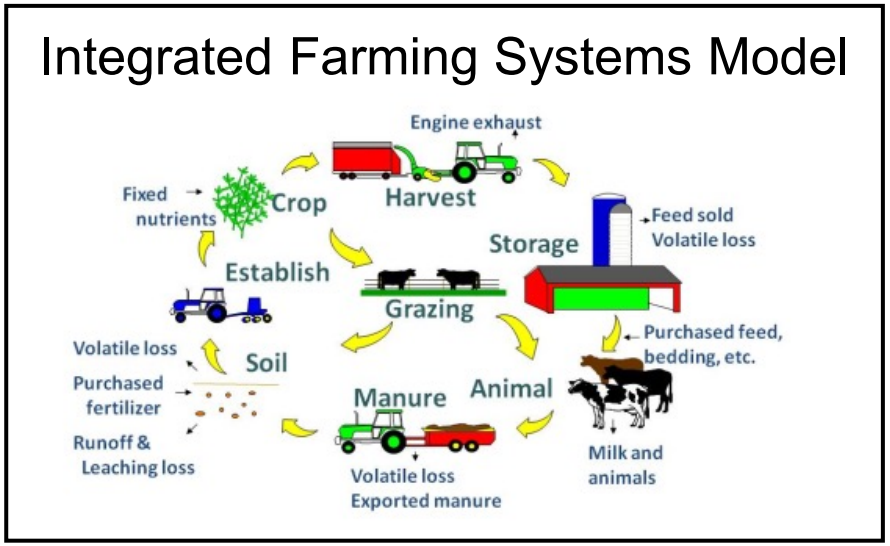






More corn silage

- reduces production costs
- reduces feed costs
- feeds more cows



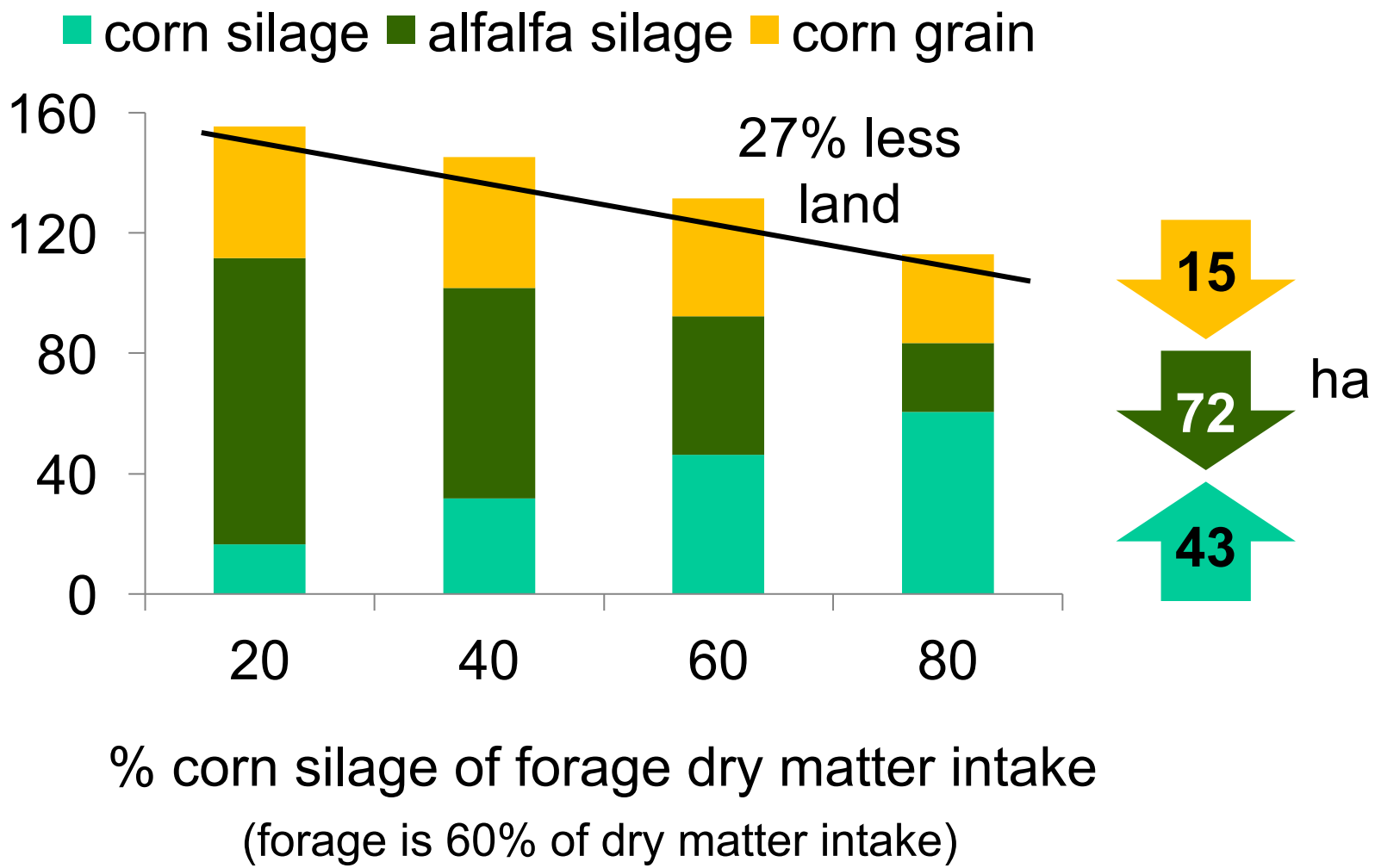
Typical Wisconsin confinement dairy farm
25 y simulation, 150 cows (+130 heifers)
Milk production 22,300 lbs/cow/year

Modeling

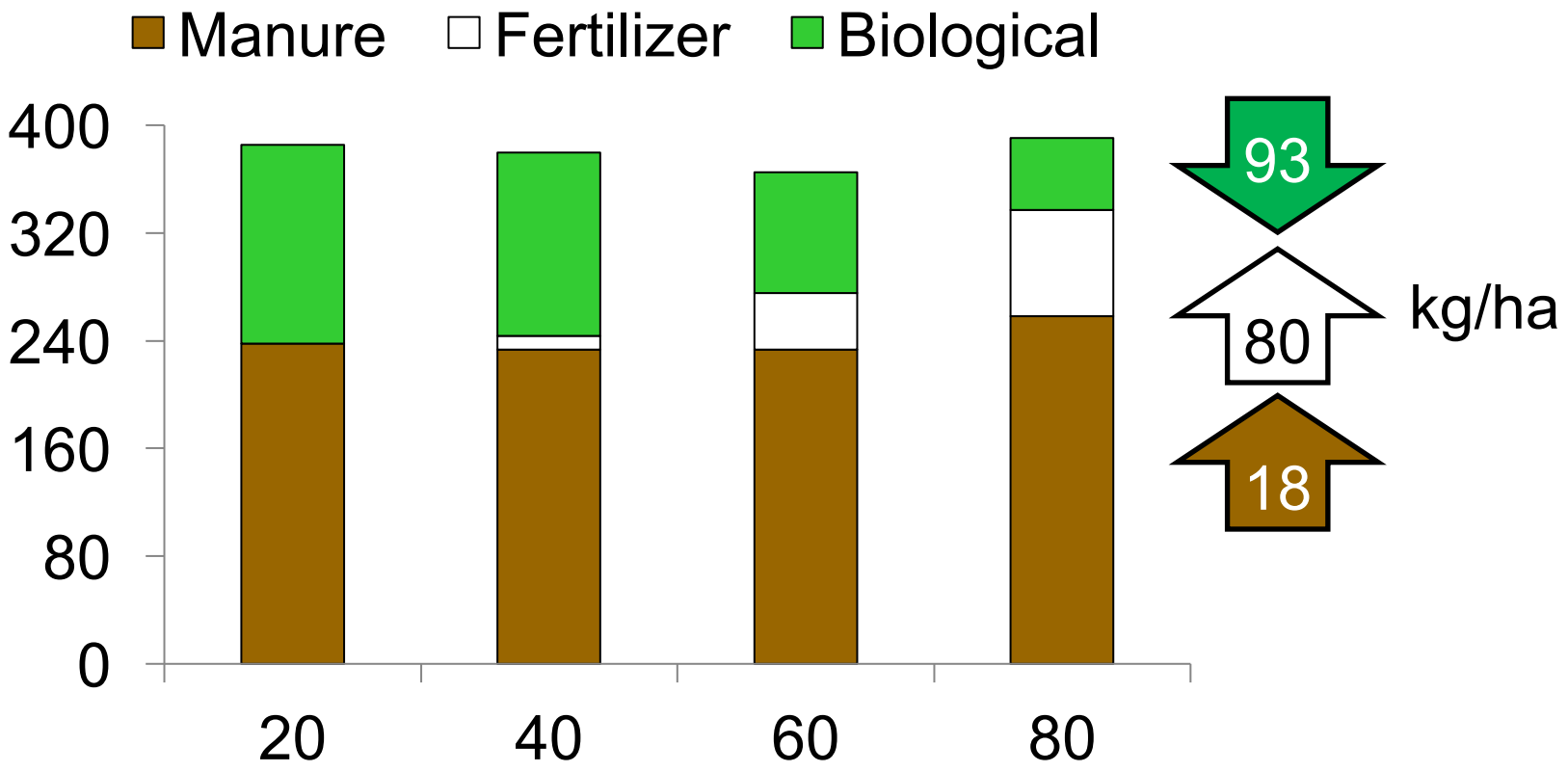
corn-alfalfa silage substitutions

- Cropping system
- Managed N
- N use efficiency
- N loss

Cropping system (ha)



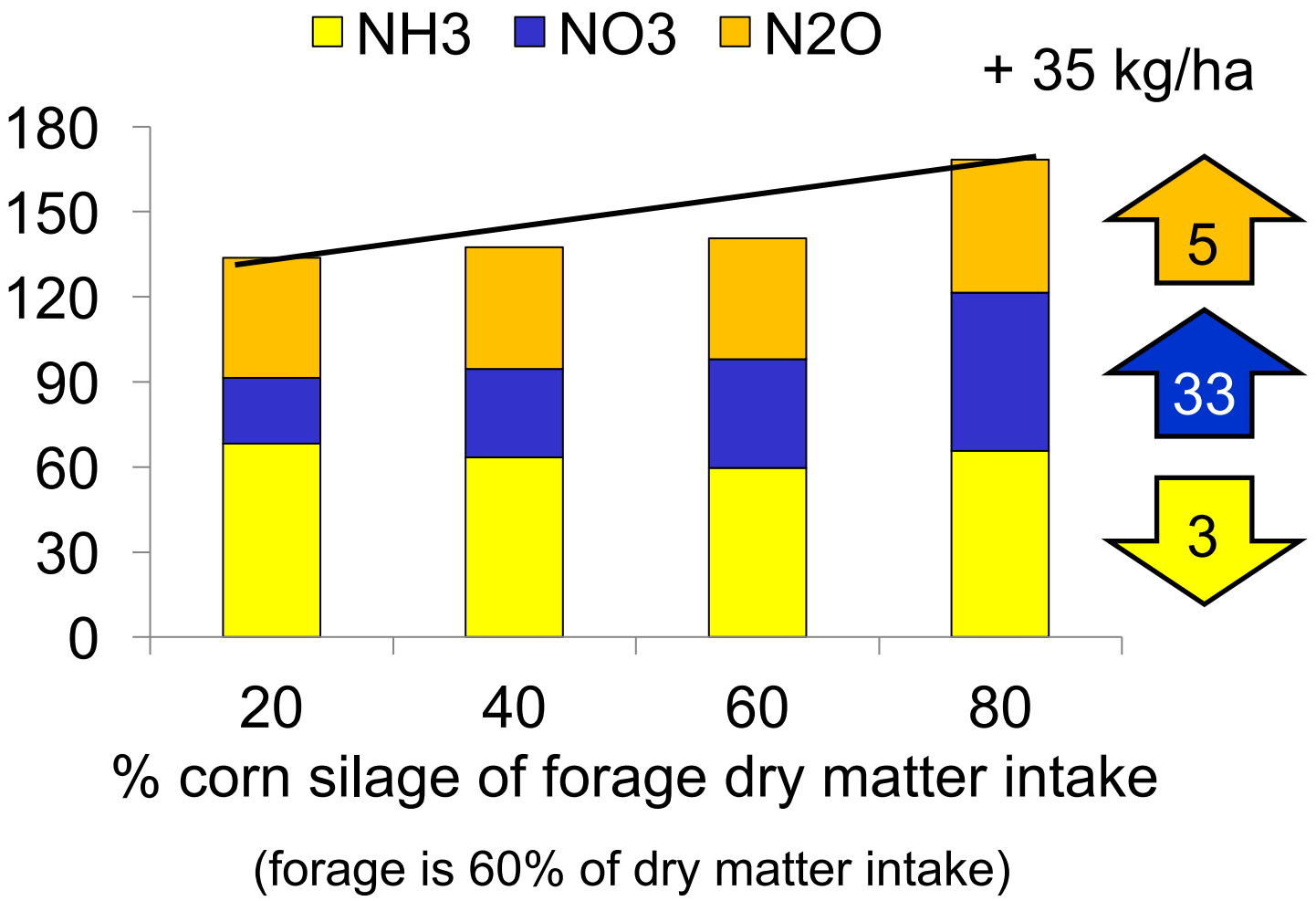
Managed N (kg/ha)



% corn silage of forage dry matter intake

(forage is 60% of dry matter intake)

N loss (kg/ha)



(forage is 60% of dry matter intake)

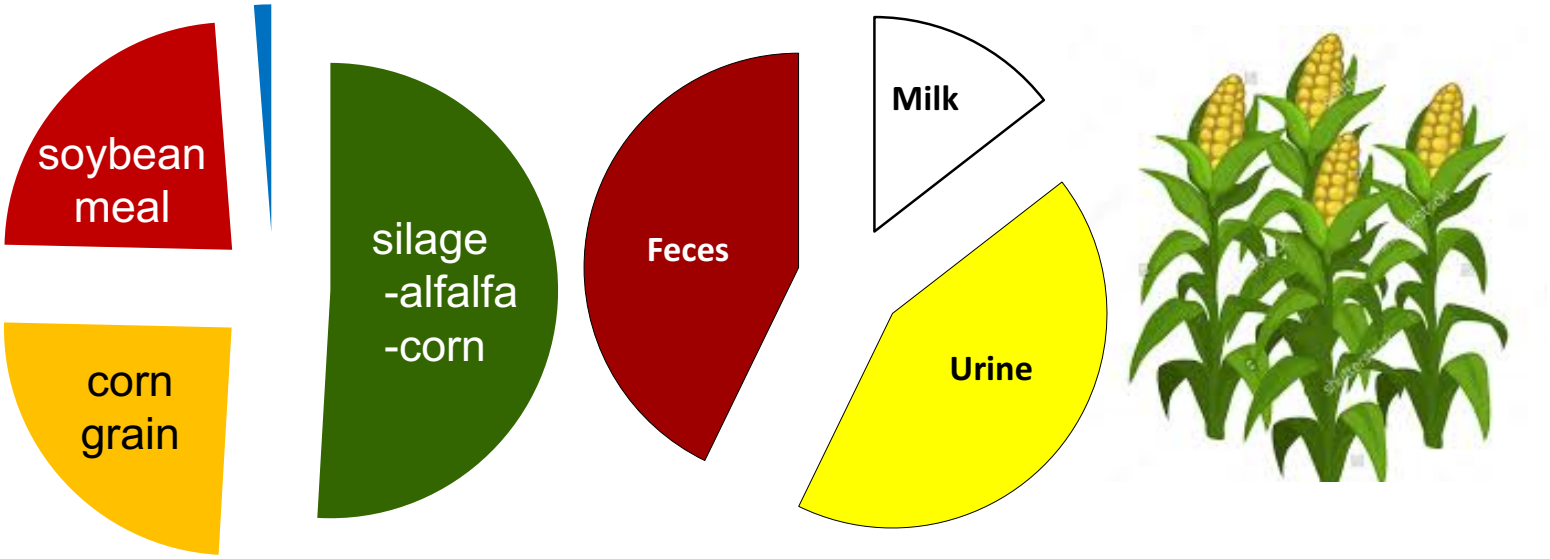
Tradeoffs in N use and loss

Growing more CS and less AS

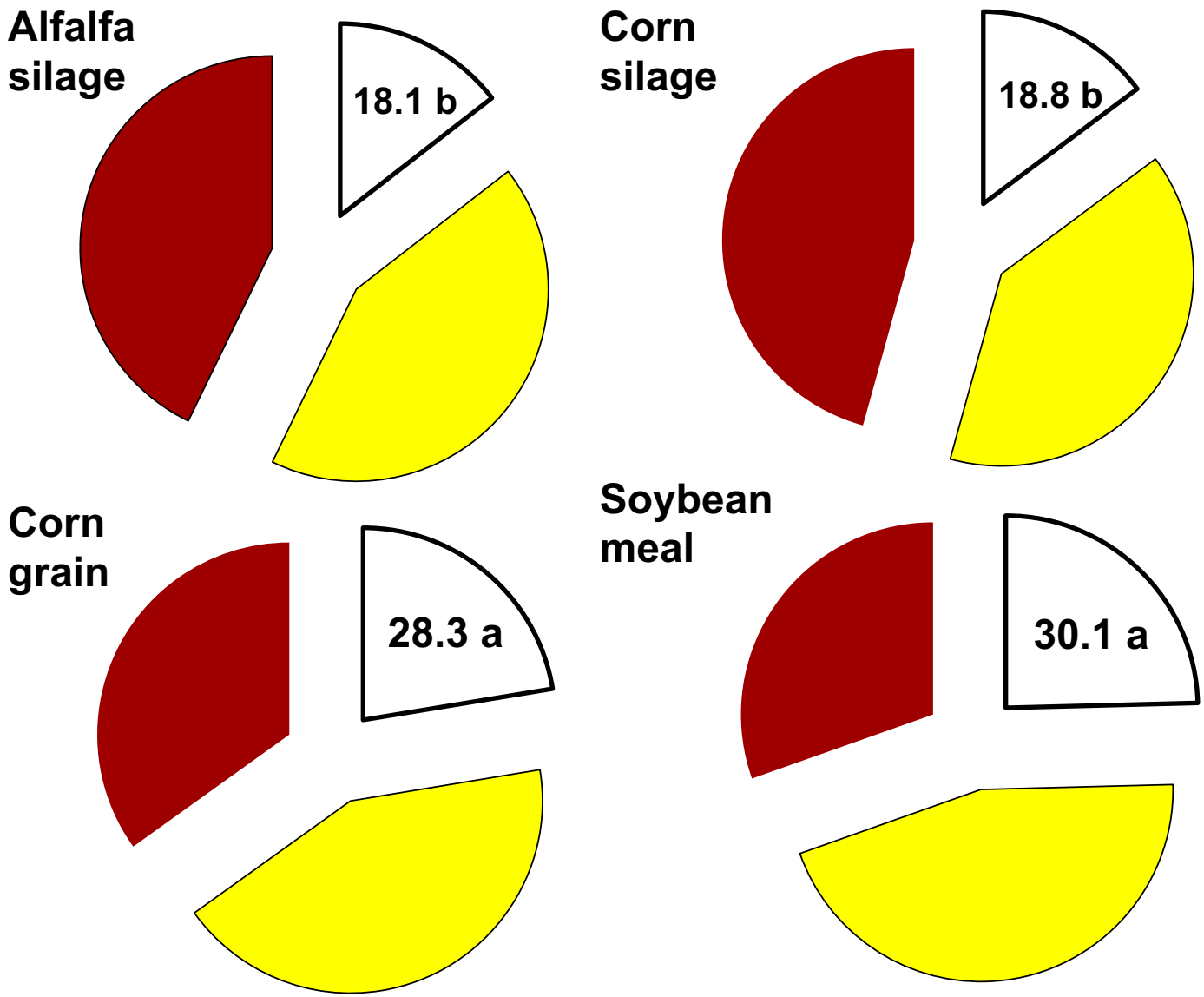
- reduces the land requirement for feed production (feeds more cows) **(+)**
- maintains milk production per cow
- increases herd NUE from 20 to 25% **(+)**
- decreases manure N excretion from 7.6 to 5.9 g N/kg milk **(+)**
- increases NO_3 and N_2O loss **(-)**
- additional fertilizer N also required to offset soil N immobilization by manure from cows fed high levels of CS **(-)**

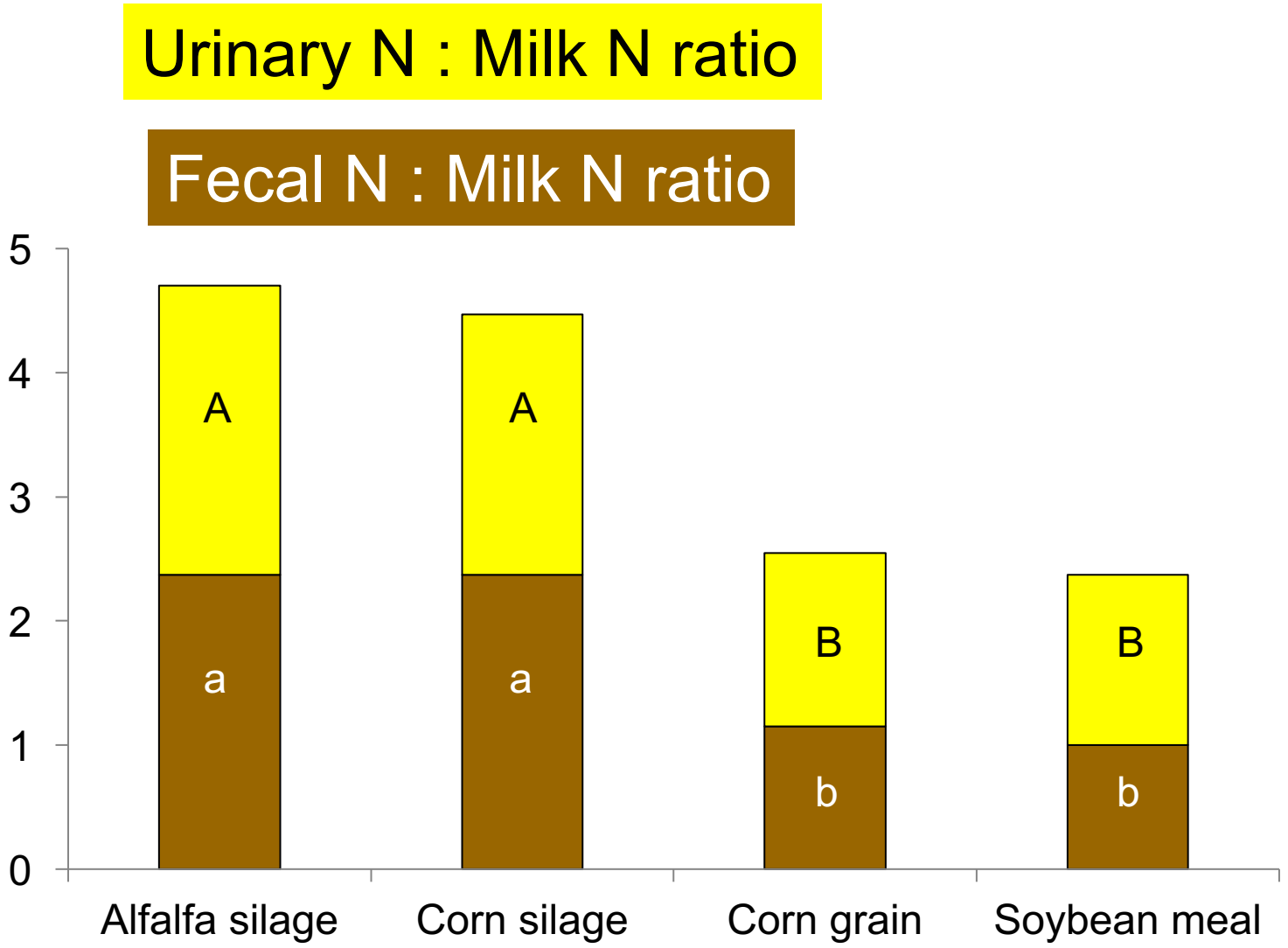
^{15}N transformations of diet components

Component ^{15}N labeling → Feed ^{15}N in TMRs → ^{15}N in milk, urine, feces → ^{15}N manure recycled



% ^{15}N recovery in milk

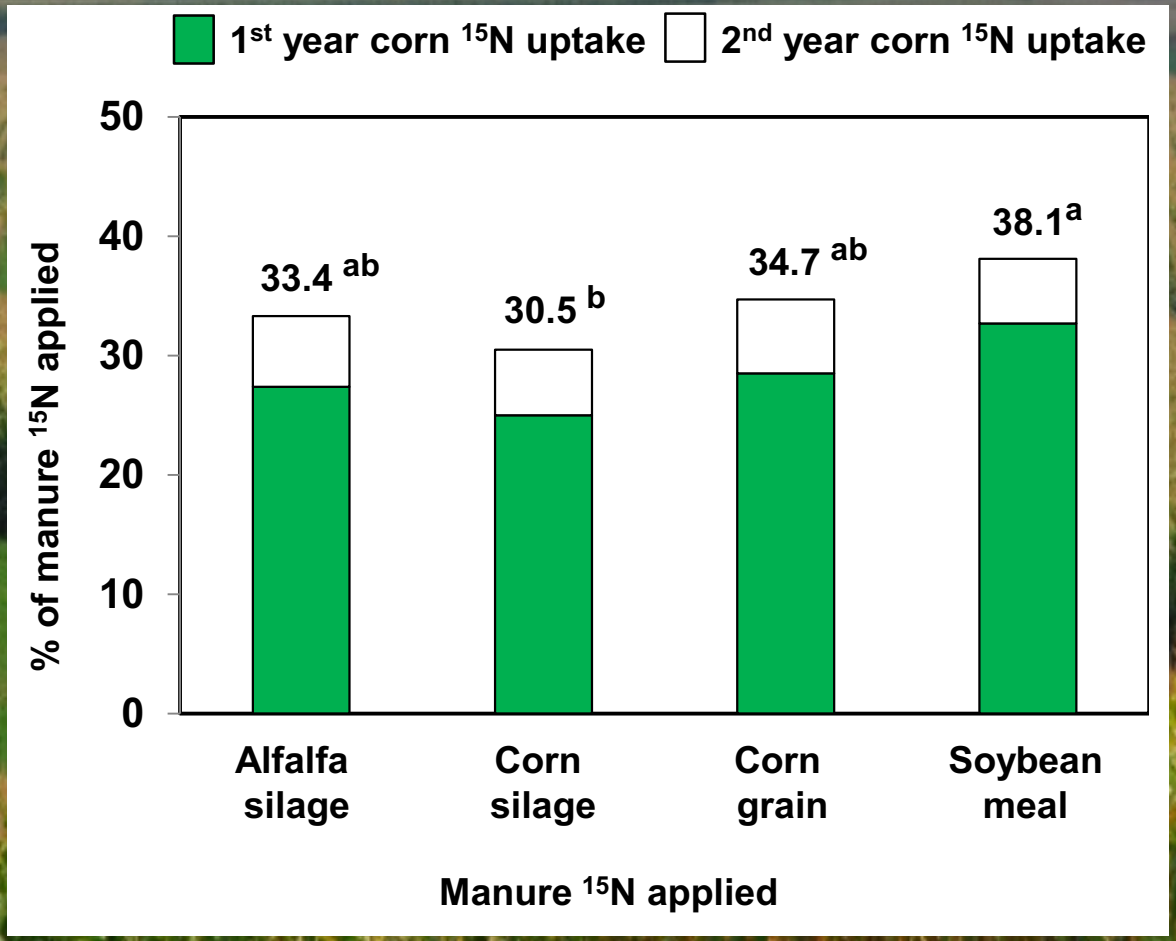



Urinary N : Milk N ratio
Fecal N : Milk N ratio
5
4
3
2
1
0
A
a
A
a
B
b
B
b
Alfalfa silage
Corn silage
Corn grain
Soybean meal

Mixing feces and urine

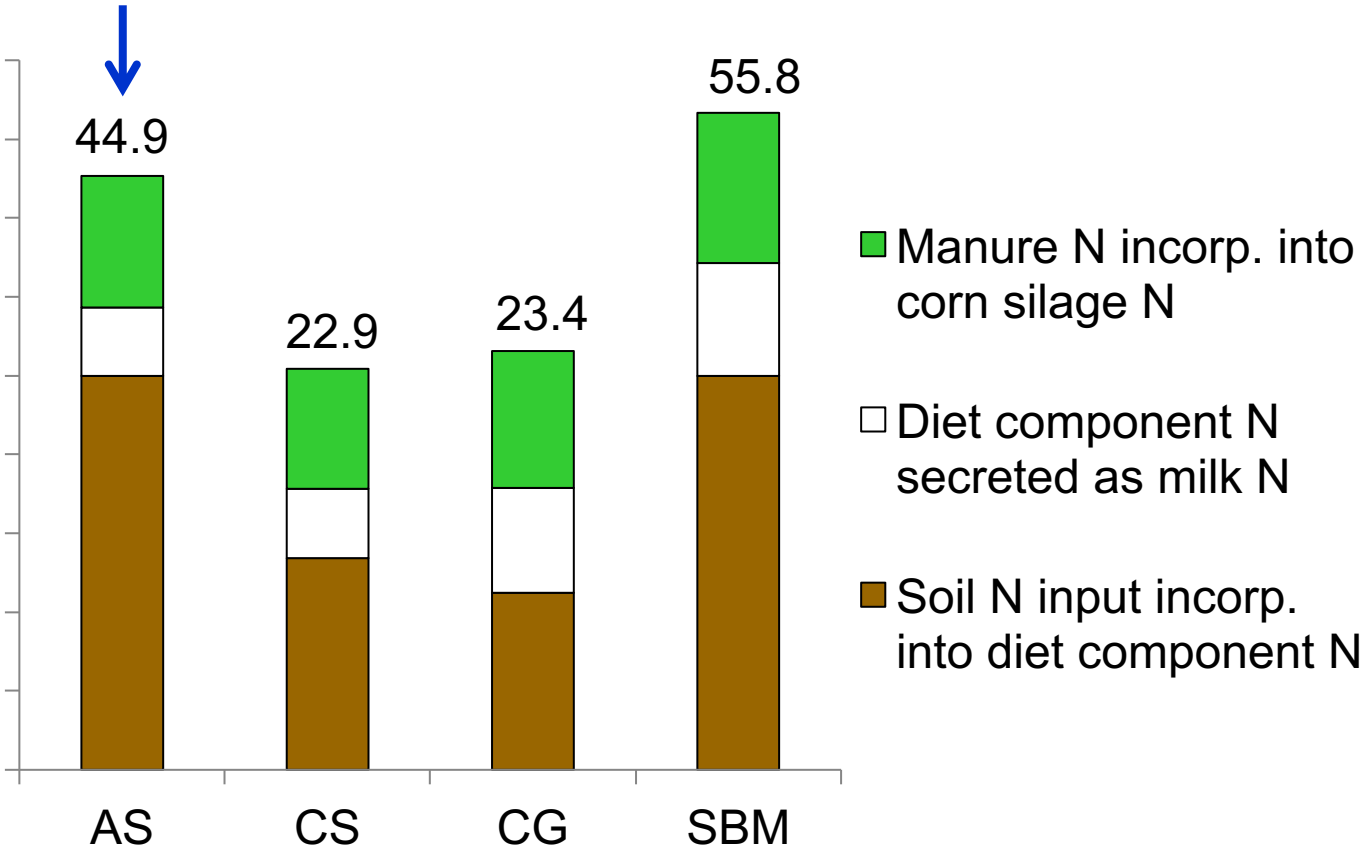
^{15}N manure application and tillage

Corn silage uptake of ^{15}N manure



Relative NUEs to grow, feed and recycle the manure from the diet components

Percent of soil N input (BFN or fertilizer N) incorporated into milk N plus recycled (as manure N) back into feed supply (corn silage)



Summary

GROWING DIET COMPONENTS

- More CS (less AS)
  more fertilizer N and more N loss (NO_3^-, N_2O)

FEEDING DIET COMPONENTS

- The ^{15}N in milk (%)
  greater for CG and SBM (32.3)
  than for AS and CS (18.0)
- Manure ^{15}N excretion (g/g milk N)
  lower for CG and SBM (2.5)
  than for AS and CS (4.6).

Summary

MANURE NITROGEN RECYCLED

- Manure ^{15}NUE (% of applied N)

  SBM (38.2), CG (34.7), AS (33.4)
  lowest from CS (30.5)

  Corroborates importance of legumes
  in soil-feed-milk-recycled manure N cycle.

Summary

TOTAL NUE

- (% diet component ^{15}N secreted in milk and % diet component manure ^{15}N recycled back to feed)

  AS and SBM (51.6)
  more than twice for CS and CG (23.0)

Other considerations

- **A balance between cereals** (corn) **and legumes** (alfalfa and soybeans) in dairy cropping system enhances NUE in feed and milk production, and captures many other benefits of cereal-legume rotations (e.g., provides BFN to cereals in rotations)

- **Long term environmental impacts** (e.g., soil erosion and soil health) associated with land use changes to grow different diet components will likely be more important than the observed short-term impacts of dietary components on cow N use and manure N recycling


Thanks
for
your attention!
corn-alfalfa rotation
Wisconsin dairy farm