Changes to cow diets impact N cycling on dairy farms

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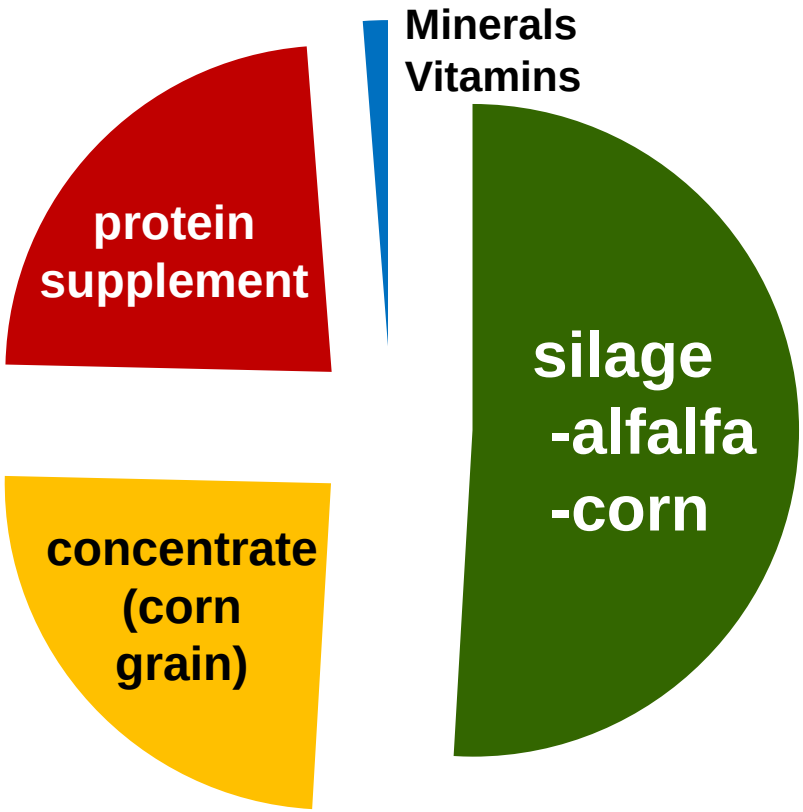
Typical dairy cow ration

confinement farms USA



Changes to rations

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

Less protein
(to reduce feed costs & N emissions)

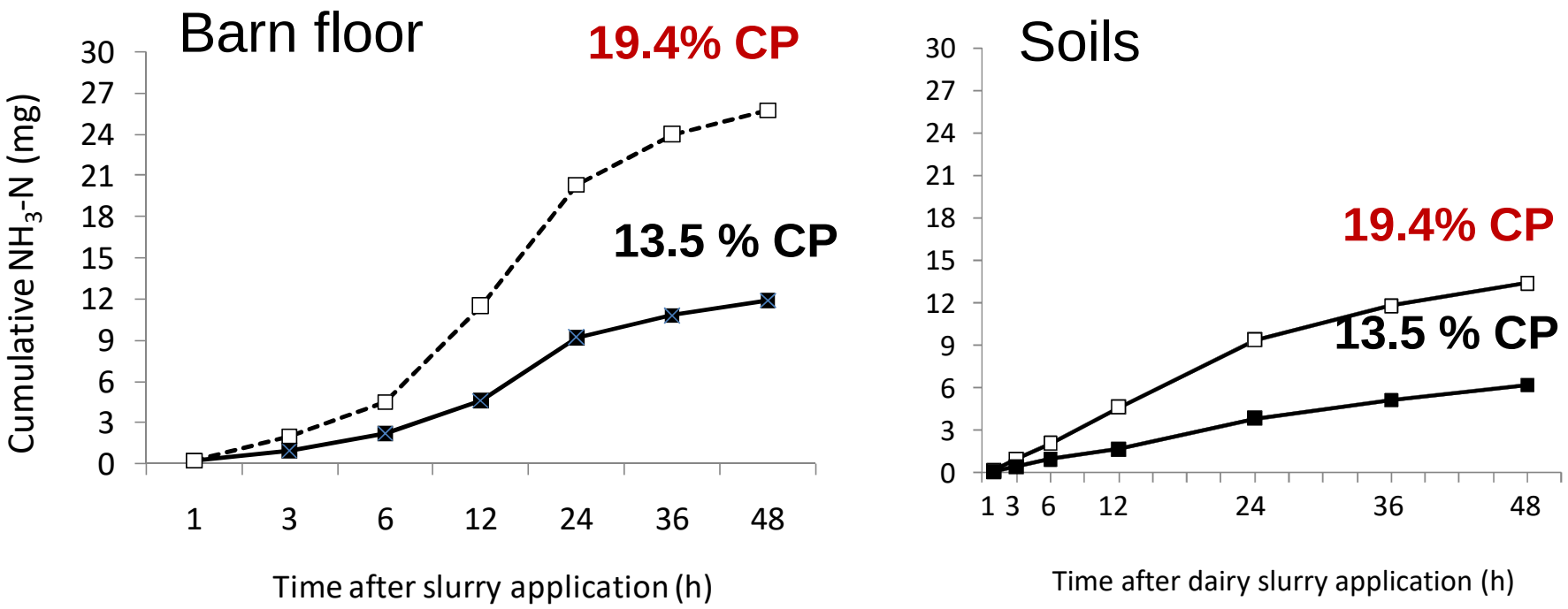
More grain
(to reduce enteric methane)

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

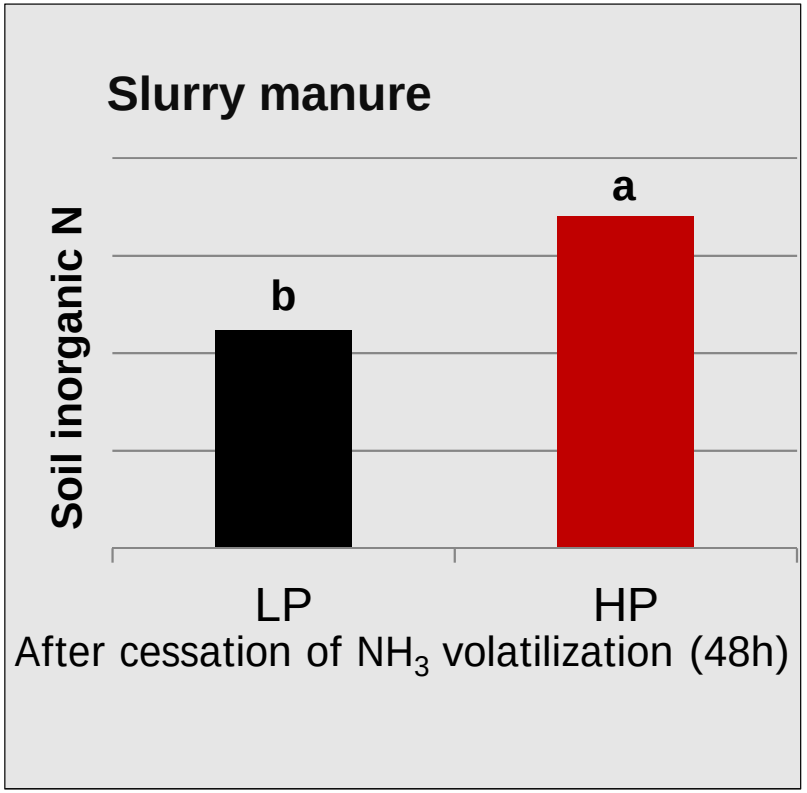
. . . and this decreases NH_3 emissions from dairy barns and manured soils

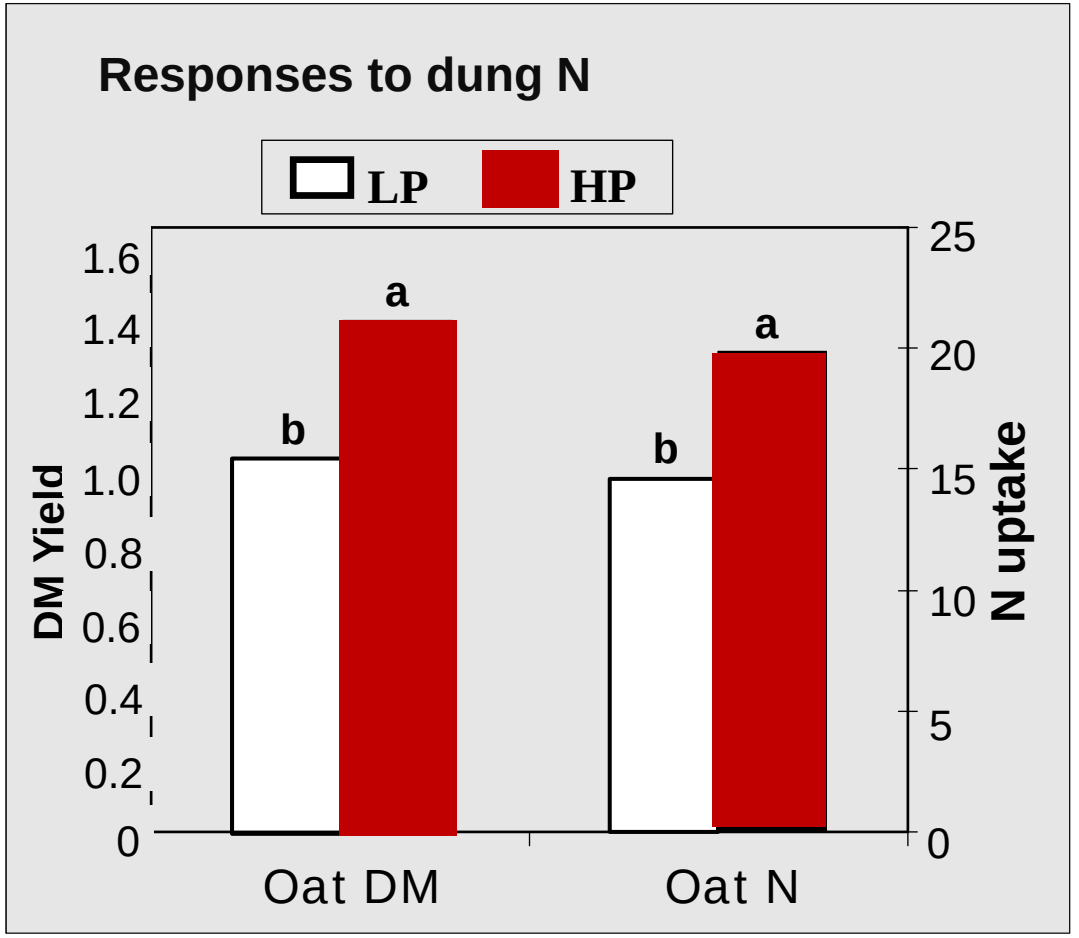


Adapted from Misselbrook et al., 2005

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

Tradeoffs in N use and loss





Substitutions of corn silage, alfalfa silage impact N use and N loss from dairy farms

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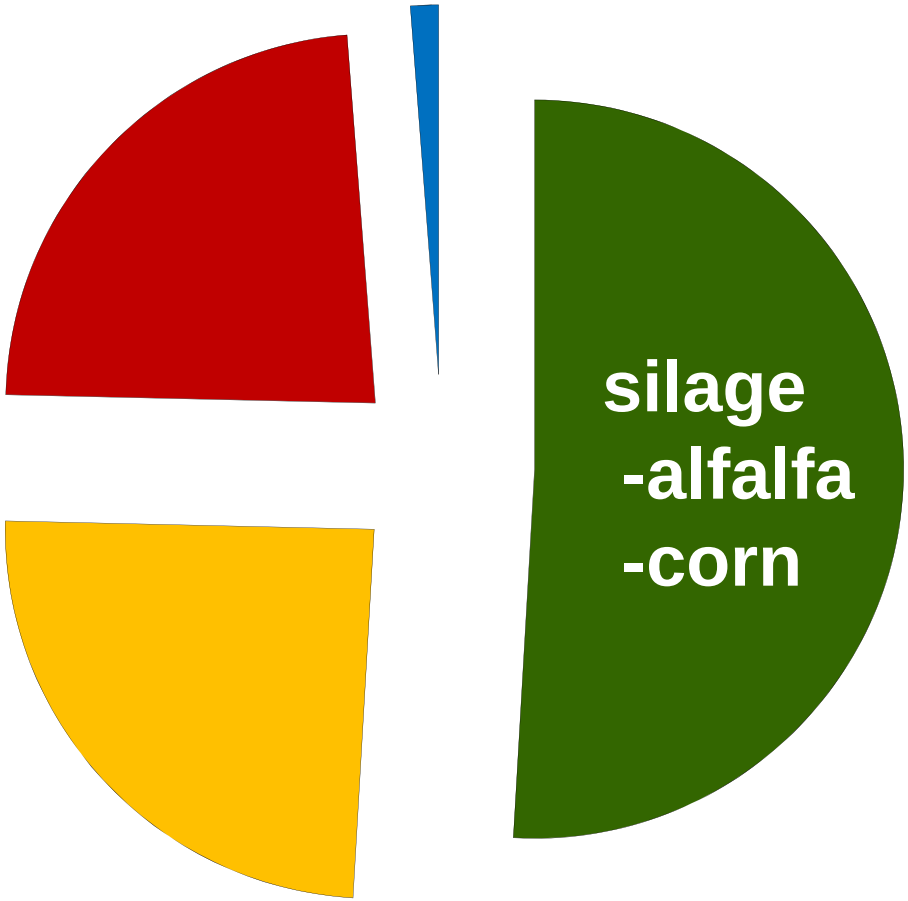
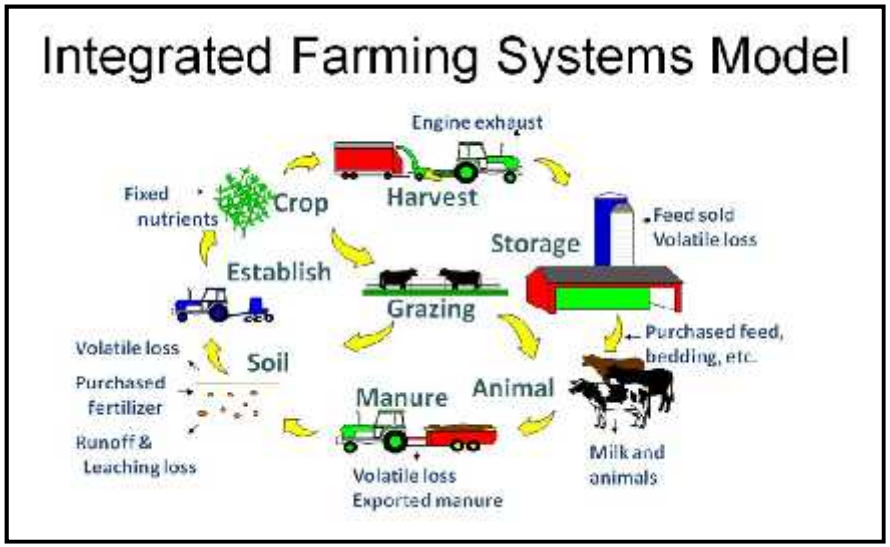


More corn silage

- reduce production costs
- reduce feed costs
- feed more cows



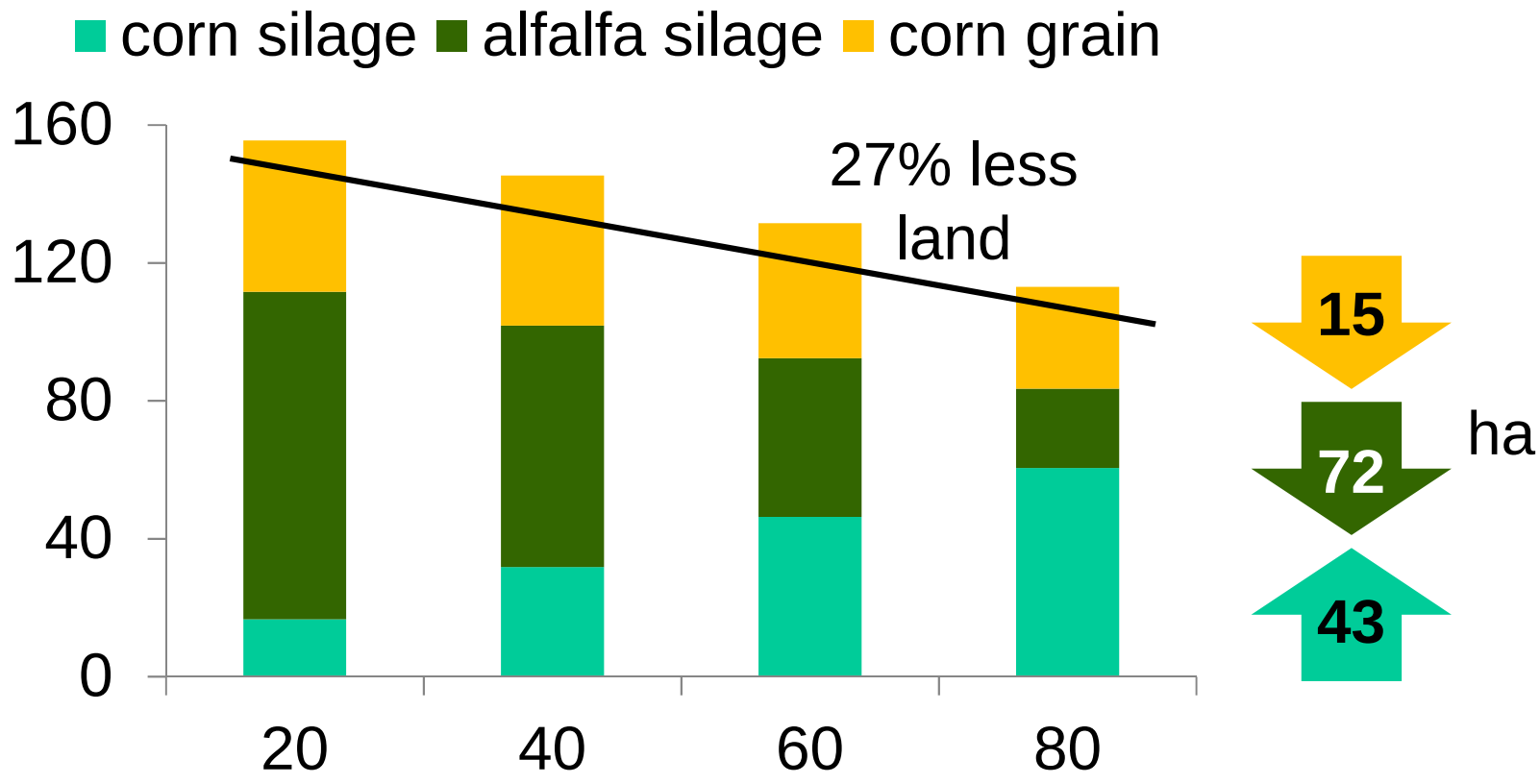
Typical Wisconsin confinement dairy farm
150 cows plus 130 replacement heifers
annual milk production of 10,120 kg/cow

Modeling

corn-alfalfa silage substitutions

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

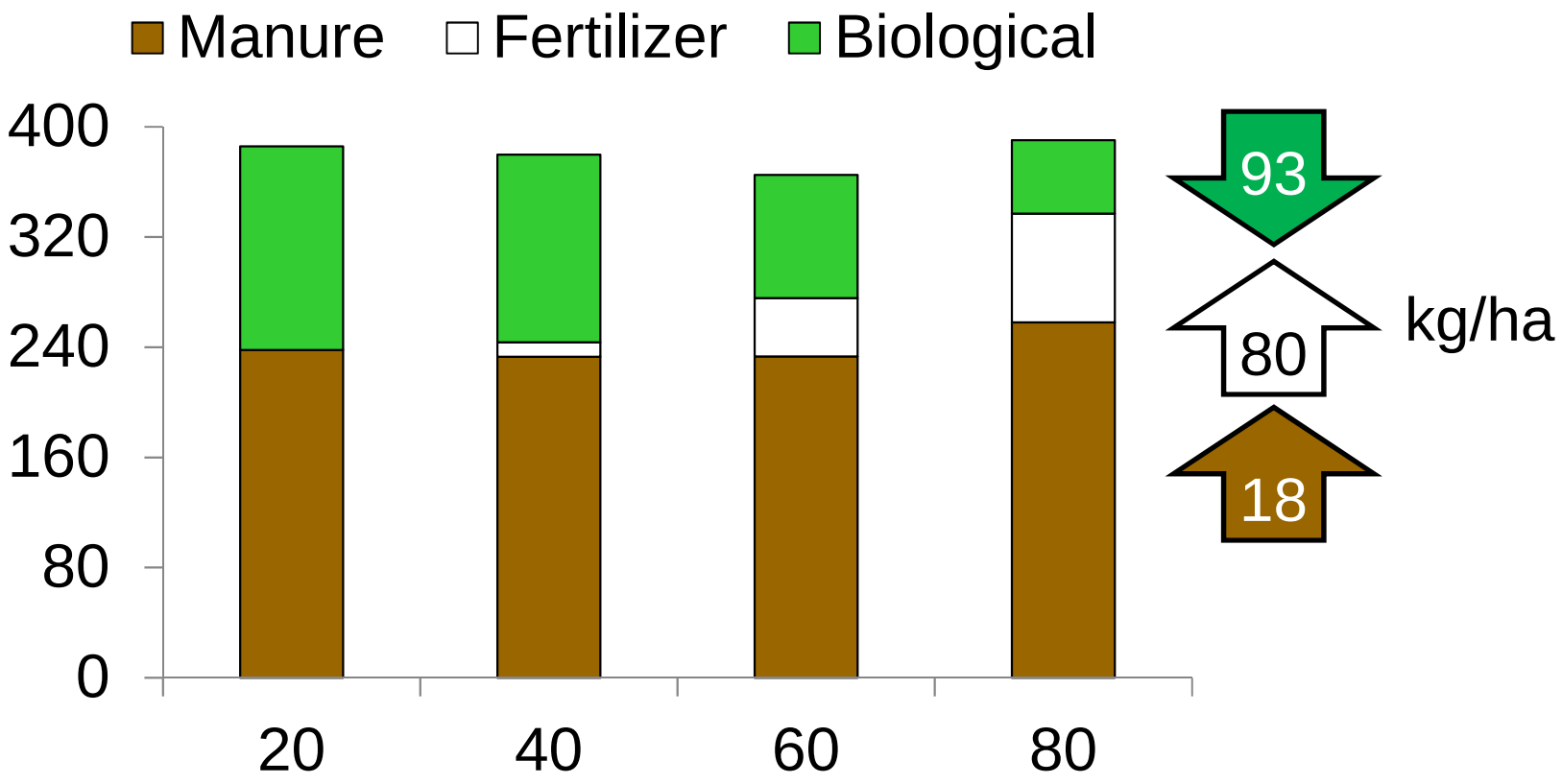
Cropping system (ha)



% corn silage of forage dry matter intake

(forage is 60% of dry matter intake)

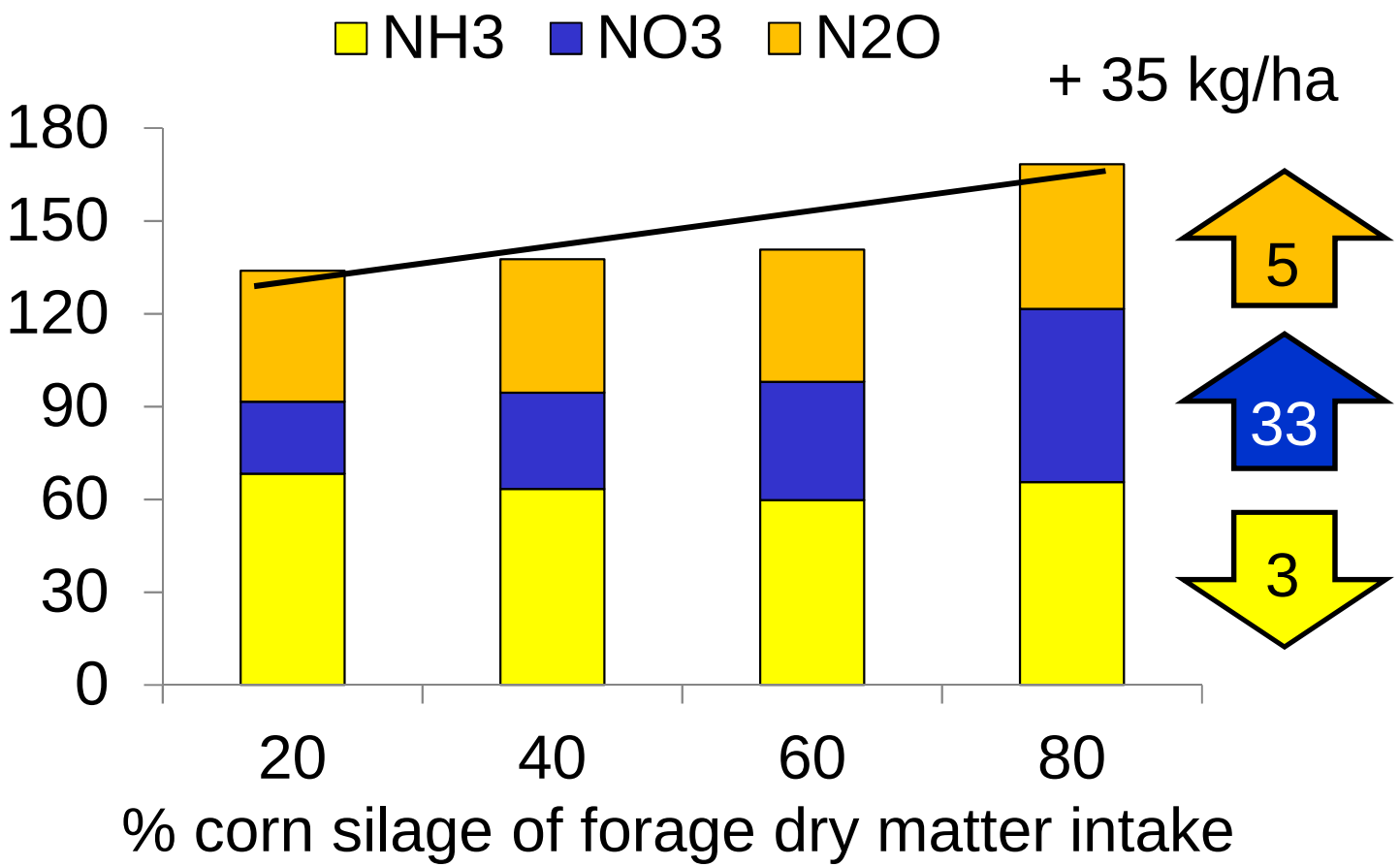
Managed N (kg/ha)



% 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)

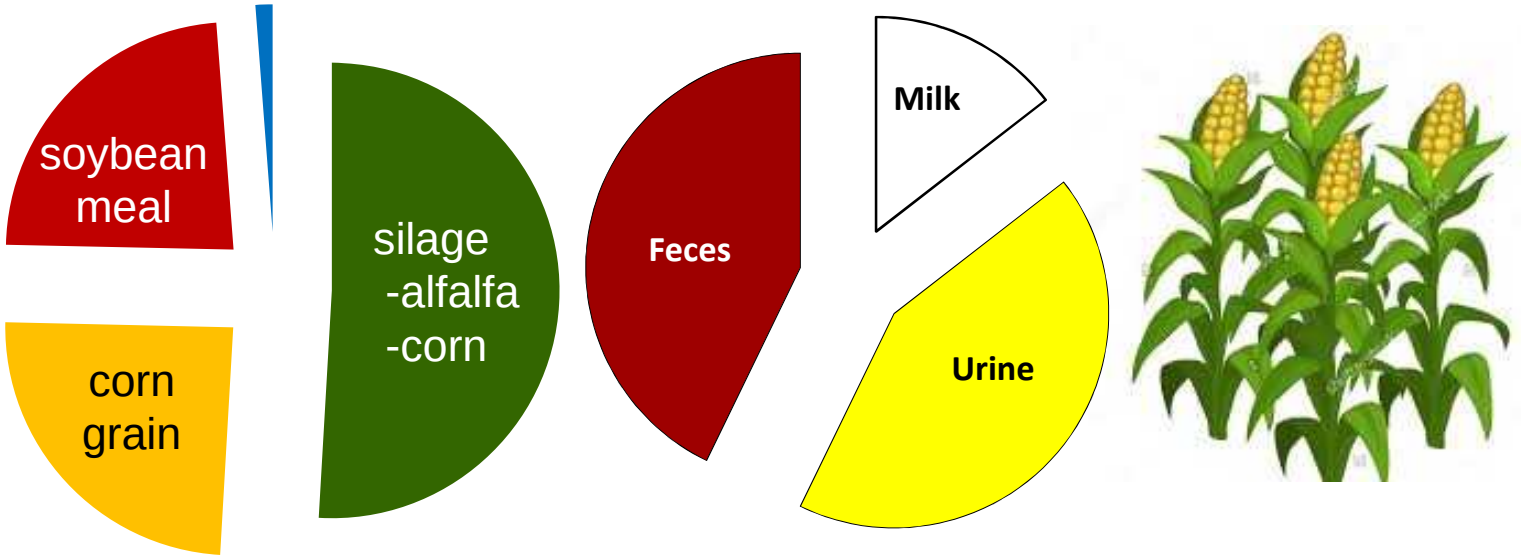
Tradeoffs in N use and loss

Growing more CS and less AS

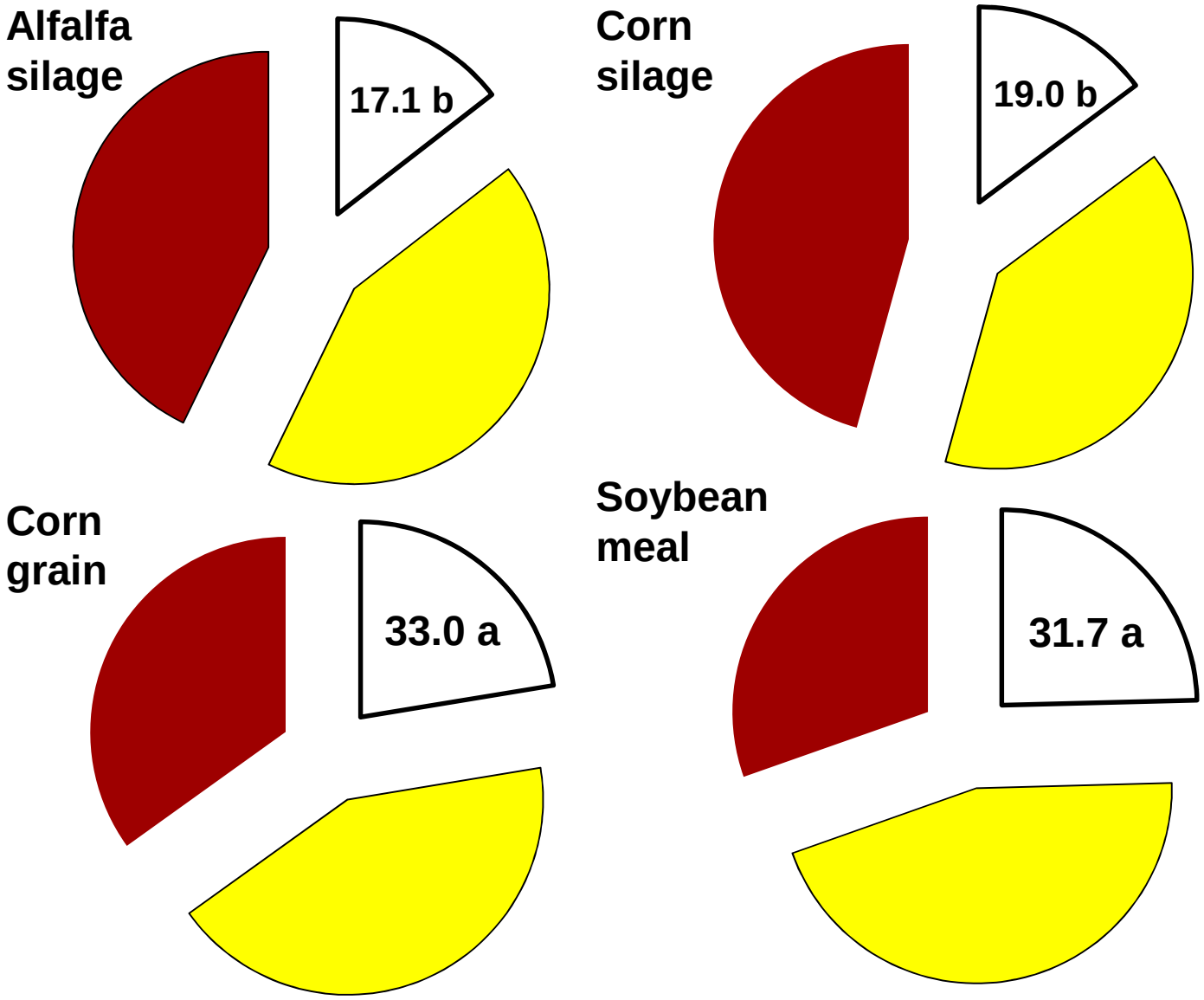
- reduces the land requirement for feed production (feeds more cows) **(+)**
- maintains milk production per cow
- increases herd NUE from 20 to 25% **(+)**
- decreases manure N excretion from 7.6 to 5.9 g N/kg milk **(+)**
- increases NO_3 and N_2O loss **(-)**
- additional fertilizer N also required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

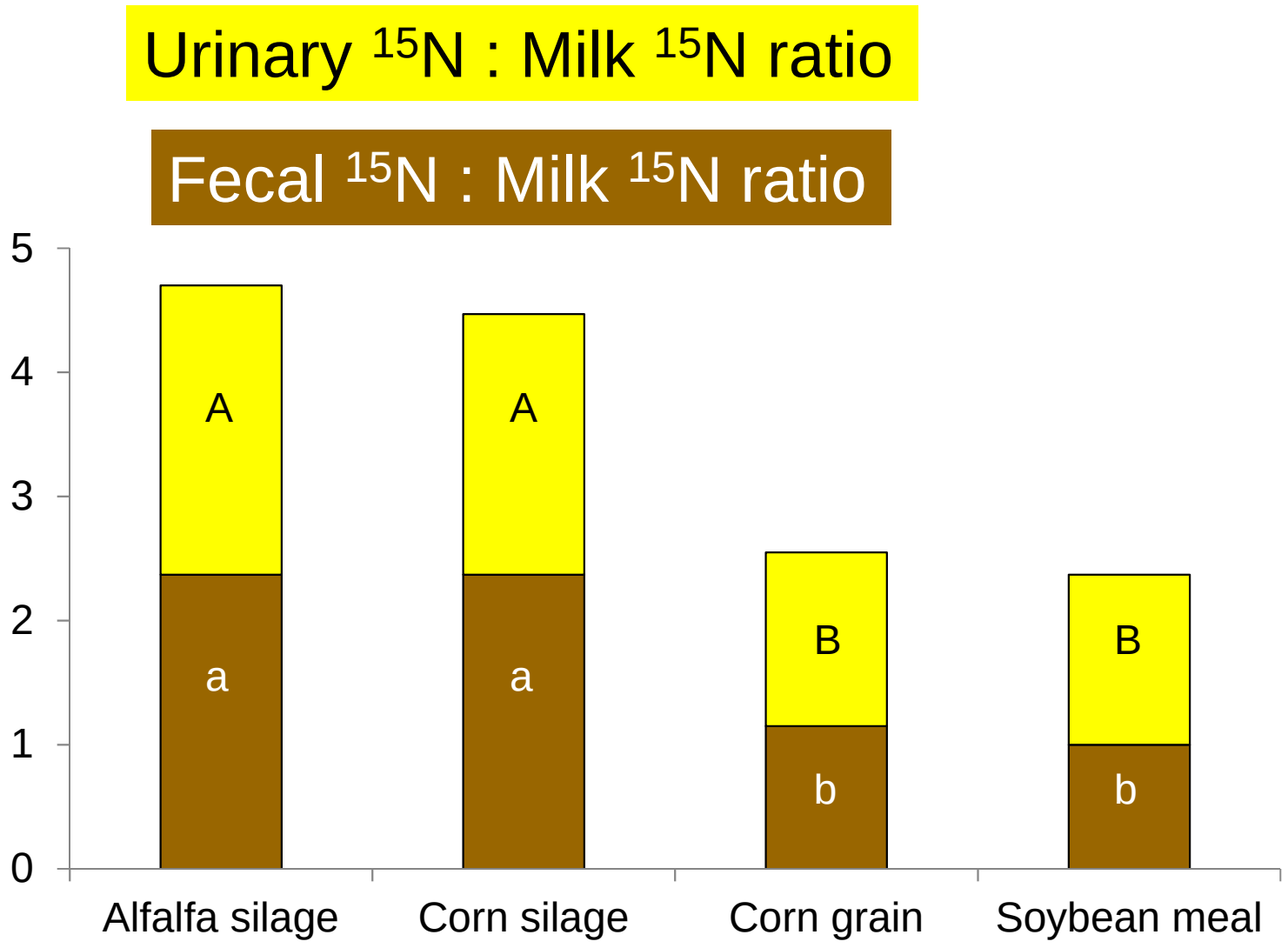
^{15}N transformations of diet components

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



% ^{15}N recovery in milk

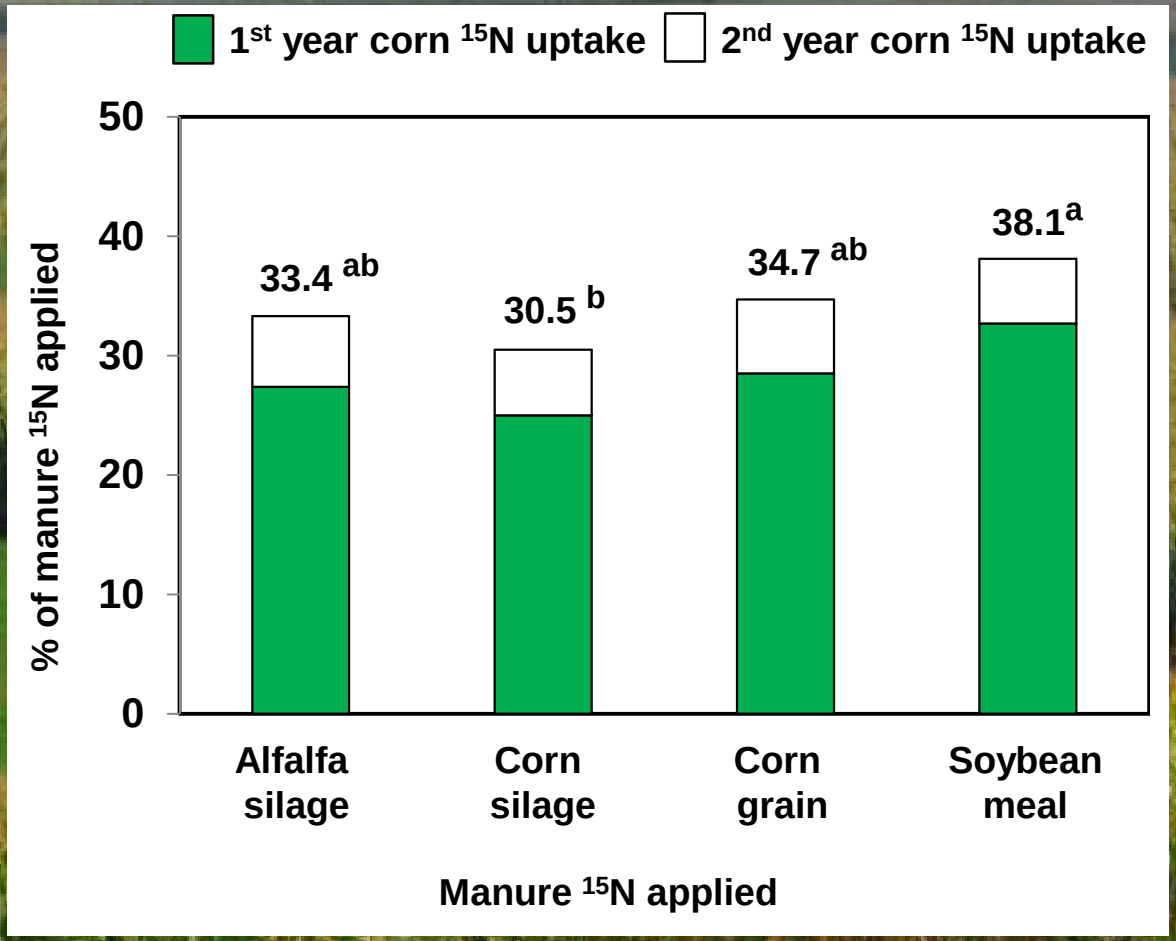



Urinary 15N : Milk 15N ratio
Fecal 15N : Milk 15N ratio
5
4
3
2
1
0
A
a
A
a
B
b
B
b
Alfalfa silage
Corn silage
Corn grain
Soybean meal

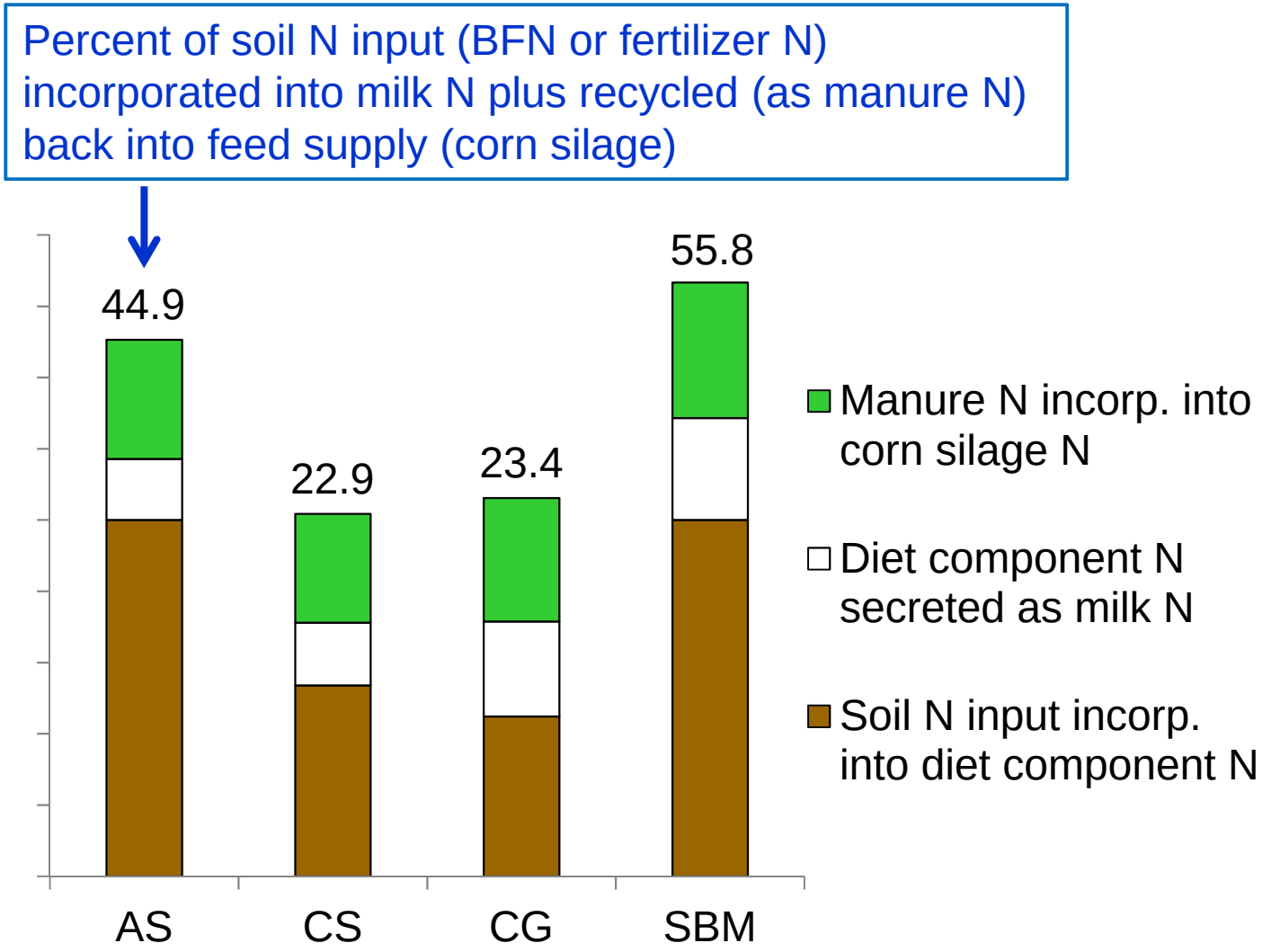
Mixing feces and urine

^{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



Summary

GROWING DIET COMPONENTS

- More CS (less AS) requires more fertilizer N, increases N loss (nitrate, nitrous oxide), and decreases overall NUE (soil-feed-milk-recycled manure N)

FEEDING DIET COMPONENTS

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

Summary

MANURE N RECYCLED

- Manure ^{15}NUE (%) was greatest from SBM (38.2), CG (34.7) and AS (33.4) and lowest from CS (30.5). Corroborates importance of legumes in soil-feed-milk-recycled manure N cycle.

TOTAL NUE

- Total ^{15}NUE (% diet component ^{15}N secreted in milk and % diet component manure ^{15}N recycled back to feed) for AS and SBM (51.6) were more than twice total ^{15}NUE 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)

- **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