

Feeding management to reduce phosphorus losses from dairy farms

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Environmental concerns

- If Agricultural practices had remained static, the US would not enjoy its current standard of living.
- This tremendous increase in efficiency has been associated with a variety of environmental problems.
- Our challenge is to continue to progress while avoiding and alleviating these negative effects.

Nutrient balance



- Specialization
- Nutrient Importation
- Nutrient Concentration
- Ground and Surface Water

Environmental concerns

- Phosphorus contamination of surface water
- Role of agriculture
- Public concern, political response
- Phosphorus-based nutrient management planning now the law in Maryland, and required for poultry operations in Virginia.

Response?

- Address the **SOURCE** of the problem: Nutrient imbalance across farms and watersheds.
- **Nutrition: more precise definition of requirements**
 - Less overfeeding for “insurance”
 - Reduce nutrient excretion
 - Minimize nutrient imbalance
 - Reduce potential contamination of ground and surface water

Overview

- **Phosphorus requirements of lactating cows**
 - Phosphorus intake and excretion
 - Phosphorus intake and reproduction
- **Environmental impact of reducing phosphorus excretion**
- **Economic impact of reducing phosphorus excretion**

Phosphorus requirement

- NRC uses a factorial approach to calculating nutrient requirements
- **Maintenance + Growth + Pregnancy + Milk yield = true or net requirement**
- **Phosphorus in feed not 100% available**
- **Net Requirement / availability = total requirement**
- Requirement is for **QUANTITIES**, not concentrations

P requirement

Dietary P requirement, g/d

Country	Year	Feed P Dig, %	kg 4%FCM			
			20	30	40	50
U.S.	1978	55	48.3	64.7	81.1	97.4
U.S.	1989	50	56.8	76.6	96.4	116.2
UK	1980	58	43.6	59.2	74.8	90.4
France	1988	70	62.2	74.7	87.2	99.7
Germany	1993	70	53.4	67.7	91.4	111.7

P requirement

Dietary P requirement, % DM

4% FCM, kg/d	20	30	40	50
Predicted DMI, kg/d	17.4	21.0	24	28.2
U.S. 1978	0.28%	0.31%	0.34%	0.35%
U.S. 1989	0.33%	0.36%	0.40%	0.41%
UK 1980	0.25%	0.28%	0.31%	0.32%
France 1988	0.36%	0.36%	0.36%	0.35%
Germany 1993	0.31%	0.32%	0.38%	0.40%

^a

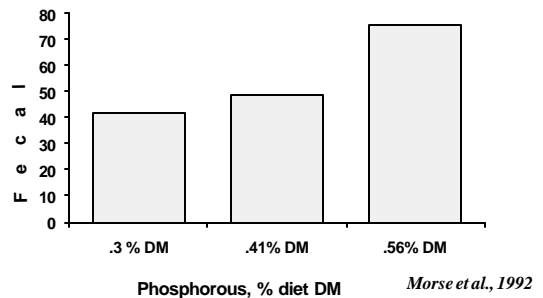
P requirement

- NRC P requirement: ~ .4% DM
- Wisconsin survey of 11 herds: average = .57% P
 - MY range from 50 to 85 lb/d; Herd size: 27 to 198
 - Average dietary [P] = .49%; Range = .35% - .65%
- Virginia survey of 14 herds
 - MY range from 50 to 85 lb/d; Herd size: 27 to 198
 - Average dietary [P] = .49%; Range = .35% - .65%
- Effect on excretion?
- Why overfeed?

P intake and excretion

- Morse et al., 1992
- 12 Holstein cows in mid-lactation
- Fed diets with three concentrations of P
- P concentrations were 80%, 108% and 147% of NRC recommended.

P intake and excretion



P and reproduction

Wisconsin Study:

- 48 cows .35% P vs. 45% P
- Is NRC P requirement too high?
- No significant effect on milk yield across 1st year
 - Low P: 70 lbs/d High P: 65 lbs/d
- No effect on milk yield 150 d into 2nd lactation

P and reproduction

Wisconsin Study:

- Low P cows 1st year:
 - 8 d longer to 1st estrus, but
 - Increased pregnancy rate, so
 - No change in days open!
- Low P cows 2nd year:
 - No change in days to 1st estrus OR days open
- P less than NRC did not impair milk yield OR reproduction.

P and reproduction

From the literature:

- Range fed beef cattle: Dietary [P] = .22 to .25%
- Low P diets also low in energy, protein, etc. etc. etc.
- Tough/impossible to design modern diets this low
- No published data linking P intake to reproductive performance in lactating cows.
 - Is supplementation of P even necessary?

Dietary phosphorus

- Overfeeding STRONGLY linked to excretion
- Field surveys indicate most herds overfeeding by 20 - 40%
- No impact of P on reproductive performance

WHAT'S YOURS?????

Environmental impact

	Dietary P concentration				
	.6	.55	.5	.45	.4
Yearly P excretion					
lbs/cow ¹	82.6	73.3	64.1	54.8	45.6
tons/watershed ²	30960	27493	24026	20558	17091
% change ³				-14.4	-28.9

¹Assumes DMI of 50 lb/d, Milk yield of 60 lb/d

²750,000 dairy cows in the Chesapeake Bay watershed

³Assumes current dietary concentration of .50%

Economic impact

- Unlike many "BMP's", this one doesn't cost, it pays.
- Economic benefits vary with regulatory environment.
- No P-based management: Feed cost savings
- P-based management: Value escalates

Economic impact

Feed costs, \$ / year vs. .4% P

Milk yield, lbs/d	DMI, lbs/d	Dietary [P]		
		.45	.5	.55
60	45.6	\$754	\$1500	\$2260
70	48.4	\$798	\$1603	\$2402
80	51.2	\$850	\$1693	\$2542

*Assumes 100 cow herd, and increased inclusion of DiCaIP @\$350/ton

Economic impact

Under P-based nutrient management

- Dairy and dairy-poultry operations of various sizes in Rockingham County, VA
- Impact of various nutrient management policies on nutrient losses and net farm income
- P limit policy would reduce P losses by 28-43% BUT
- Also would reduce net farm income by 11-23%

Pease et al., 1998

Decision Case

	Dietary P concentration			
	.4	.45	.5	.55
Minimum acres for given herd size?				
65 cows	61	73	86	98
135 cows	126	151	178	204
500 cows	465	560	660	755
Maximum cows on 318 acres?				
50% corn, 50% alfalfa	296	248	216	191

*Assumes milk yield of 80 lb/d, DMI predicted from NRC 1989 and a cropping program of 50% corn, 50% alfalfa

Research needs

- Net P requirements
 - How low can we go?
 - Reproduction?
- Availability of P in feedstuffs, as influenced by
 - feeds
 - physiological state of the cow
 - interactions with other dietary factors

Conclusions

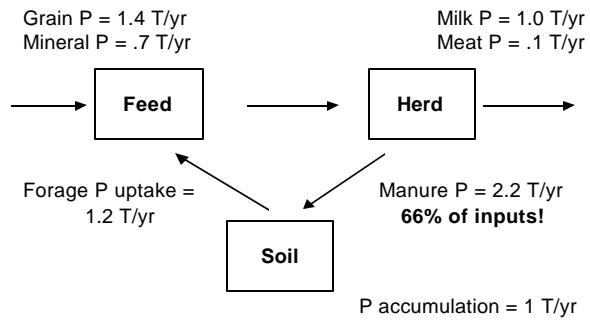
- Can't ignore a real public concern
- Current NRC requirements reflect a sound, conservative interpretation of published literature
- Real opportunity to reduce nutrient losses with nutrition
 - Reduce P content of diets to NRC
- This is a powerful, cost-effective approach to protecting water quality.

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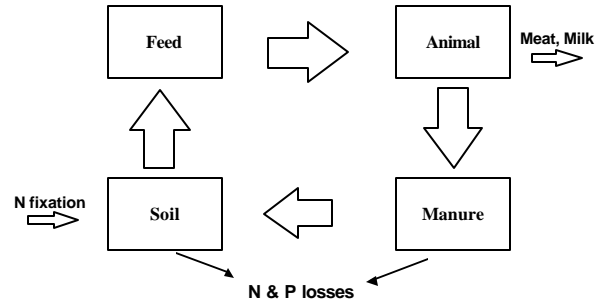
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P balance on farms



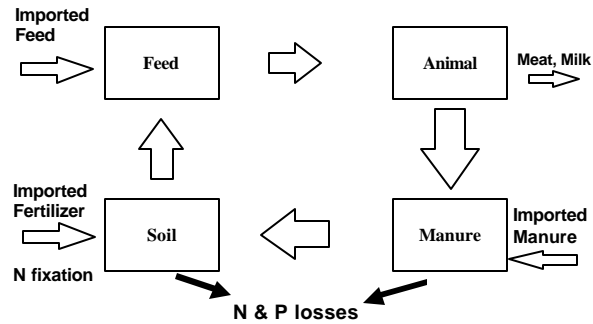
Nutrient cycling

1700's to 1940's:

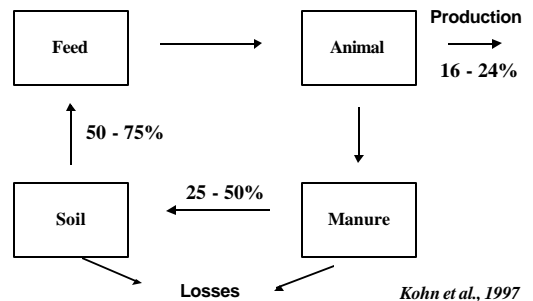


Nutrient cycling

Today:



Nutrient cycling

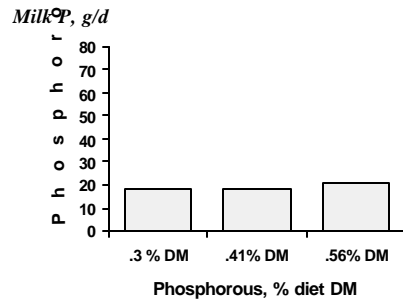


Nutrient cycling

Item	Improved efficiencies				
	Low Effic.	Herd	Crop	Manure	All
N loss, t	44.1	44.1	27.3	18.9	10.5
N loss / product N	4.6	2.8	4.3	3.9	2.0
Product N, % of Input N	18%	27%	19%	20%	34%

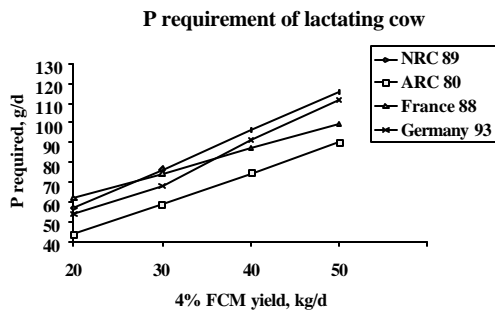
Kohn et al., 1997

Phosphorus



Morse et al., 1992

P requirement



Nutrient imbalance



P requirement

Variation among systems

System	Year	Net req't for maintenance	Net req't, a/kg FCM
NRC	1978	14.3 mg/kg BW	.90
NRC	1989	14.3 mg/kg BW	.99
ARC	1980	12 mg/kg BW	.905
France	1988	43.4 m/kg BW	.875
Germany	1987	24 mg/kg BW	1.0
Germany	1993	1 mg/kg DMI	1.0

Response?

- Don't panic - Prepare.
- Housekeeping, neighbor relations, media relations
- Change management practices to reduce nutrient losses from the farm system
 - Manure management, runoff control
- Address the SOURCE of the problem: Nutrient imbalance across farms and watersheds.
 - Nutrition

Phosphorus

- Discounting P content of forages and cereal grains?
- Don't - Bioavailability of phytate P is high
- P content highly variable - Analyze grains
- NIR analysis no good for P

Decision Case

Impact of P intake on maximum cow #'s

	Dietary P concentration			
	.4	.45	.5	.55
50% corn, 50% alfalfa	296	248	216	191
50% corn, 25% grass hay, 25% alfalfa	273	232	200	178
50% corn, 25% small grains, 25% alfalfa	232	197	172	150

*Assumes 318 acres and milk yield of 80 lbs/d. DMI prediction from NRC 1989

Environmental impact

- Assumed availability of feed P has a strong impact on feeding recommendations
- Current NRC assumes 50%. Other systems worldwide assume 58-70% availability
- Are there ways to increase availability of feed P to ruminants?

Environmental impact

- 750,000 cows in Chesapeake Bay watershed
- Fed to meet current NRC net P requirements
- Increase availability of P in diet by 5 units allows net requirements to be met with reduced P intake
- Reduced P excretion by 15%, or 3500 to 4000 tons of P_2O_5 per year