Feeding management to reduce phosphorus losses from dairy farms

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Overview

- **Environmental concerns**
- **Phosphorus requirements of lactating cows**
- **Phosphorus intake and excretion**
- **Survey results**
- **Phosphorus intake and reproduction**
- **Research needs**

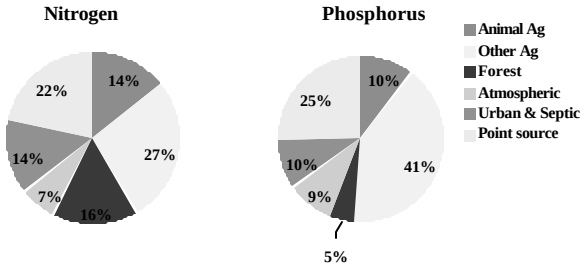
Environmental concerns

- **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**

Sources of pollution



Ag the source of ~40% of N and ~50% of P loadings to the Bay

Chesapeake Bay Program, 1996

Chesapeake Bay Watershed

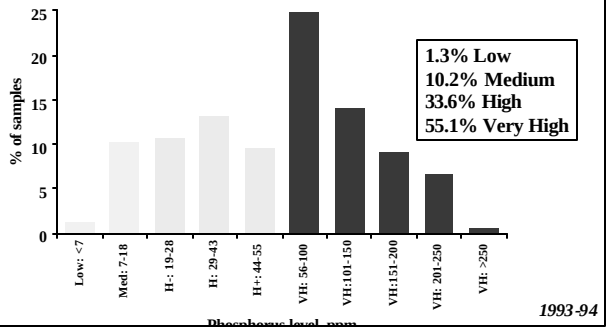
- Va livestock industry is concentrated in CBW
  - 70,000 dairy cows
  - poultry industry
- Intensive livestock operations generate manure in excess of crop needs
  - Excess may contaminate ground and surface water.
- Public concern = political response
  - More stringent regulations are coming.

Nutrient management

N-based	P-based
• Manure application based on N needs of crop • N and P in imbalance in livestock manure relative to crop needs • N based application = excess P application • Phosphorus accumulates and may runoff, even without erosion	• Manure application limited to P needs of crop • Will fall short of N needs • If high/very high soil test P, crop needs will be met by soil P

P-based nutrient management

Soil test P in Augusta & Rockingham counties, VA



1993-94

P-based nutrient management

Economic impact

- **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

Response?

- **Media relations, public relations, neighbor relations**
- **Implementation of best management practices**
  - **alternative watering sources**
  - **adequate manure storage**
  - **treat waste flow from barnyards w/buffer strips**
  - **rotational loafing lot systems**

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**

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

		Feed P	kg 4%FCM			
Country	Year	Dig, %	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

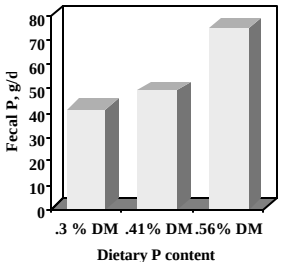
P requirement

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%

P intake and excretion

- Relationship between P intake and excretion?
  - 12 mid-lactation cows
  - Fed diets containing one of 3 levels of dietary P
  - Dietary P concentrations were 80%, 108%, and 147% of requirements
  - Total collection study (milk, urine, feces)
- Direct, linear relationship



Morse et al., 1992

P-based planning

		P based: Dietary [P]		
	N base	.45	.5	.55
Minimum acres for given herd size?				
65 cows	31	73	86	98
135 cows	65	151	178	204
500 cows	242	560	660	755
Maximum cows on 300 acres?				
50% corn, 50% alfalfa	619	269	229	199

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

Knowlton et al., 1999

Survey

Fall 1998:

- Determined average P intake on VA dairy farms
- Surveyed 33 herds in Rockingham, Franklin, and Augusta counties
  - Feed samples, ration info, milk yield, cow #'s
- Calculated effect of overfeeding P on
  - feed costs
  - ability to meet future environmental regulations

Sink et al., 2000 (submitted)

Survey results

	Req't	Mean	High
Dietary %P	.34	.49	.65

Knowlton et al., 1999

Survey results

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Dietary %P	.34	.49	.65
Increased feed cost $/100 cow herd/year[1]	-	$1059	$2701

[1]Assumed replacement of Dical ($350/ton) with limestone ($164/ton)

Knowlton et al., 1999

Survey results

	Req't	Mean	High
Dietary %P	.34	.49	.65
Increased feed cost $/100 cow herd/year[1]	-	$1059	$2701
Acreage req't[2]	-	+69%	+242%

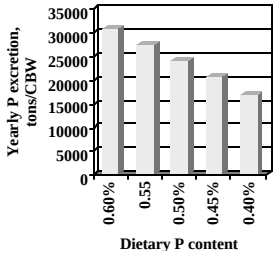
[1]Assumed replacement of Dical ($350/ton) with limestone ($164/ton)

[2]Assumed manure application limited to crop P uptake, mean MY of 27 kg/d and cropping strategy of 50% corn silage, 50% alfalfa

Knowlton et al., 1999

Environmental impact

- Impact on overfeeding within Chesapeake Bay watershed?
  - 750,000 cows
- Overfeeding dietary P
  - To .45% from .40% = increases P excretion by 20%, 3500 tons/yr
  - To .50% to .40% = 41% increase in P excretion, potential P losses



Knowlton et al., 1999

Why overfeed?

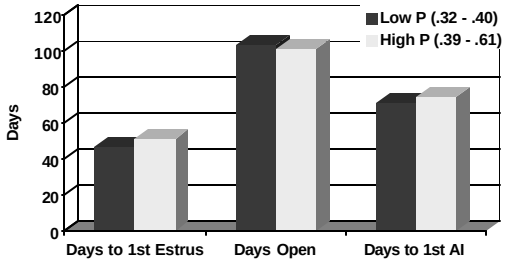
Wisconsin Study:

- 48 cows .35% P vs. .45% P, 2 years
- Is the current NRC P requirement too high?

Satter and Wu, 1999

P and reproduction

Summary of 13 trials, 785 cows



Satter and Wu, 1999

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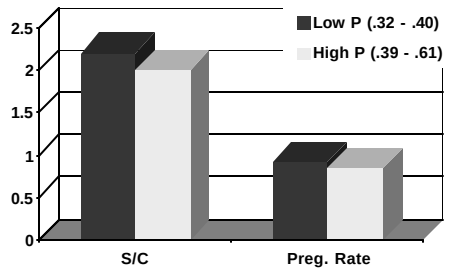


Satter and Wu, 1999

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 45% or more**
  - **Actual P requirement lower than you think!!**
- **No impact of overfeeding P on reproductive performance**

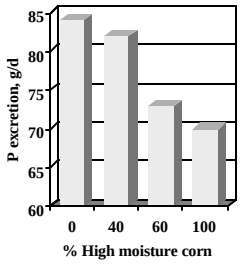
WHAT'S YOURS?????

Research needs

- **Net P requirements**
  - **How low can we go?**
  - **Reproduction?**
- **Need an indicator of overfeeding**
  - **fractionate fecal P**
- **Need greater understanding of P metabolism**
- **Availability of P in feedstuffs, as influenced by**
  - **feeds**
  - **physiological state of the cow**
  - **interactions with other dietary factors**

Starch digestion & P excretion

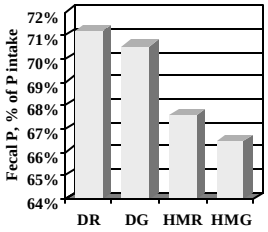
- 4 mid lactation cows
- Alfalfa based diet
- Varying proportions of dry and HM corn: 100:0, 60:40, 40:60, 0:100
- Total tract starch digestion increased with increasing proportions of HM corn



Glenn et al., 1998

Starch digestion & P excretion

- 6 early lactation cows
- Alfalfa silage based diet
- HM or dry corn, ground or rolled
- HM corn increased starch digestion in the rumen, small intestine, total tract
- HM corn had greater NEl, greater tissue energy than dry corn



Knowlton et al., unpublished

Conclusions

- As an industry, we can't ignore valid public concerns
- Real opportunity to reduce nutrient losses with nutrition now
  - Dietary P in excess of NRC 89 common, but unnecessary, expensive
  - Increased starch digestion may decrease P excretion
  - Easily measured, rapid indicator of overfeeding would improve adoption of these techniques
- Powerful, cost-effective approaches to protecting water quality.

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