Phosphorus and Manure

Discussion materials used at the Florida Dairy Production Conference
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Phosphorus applications to soils from manure is now becoming a greater focal point for environmental regulation. In the process of developing Comprehensive Nutrient Management Plans (CNMP), dairy farmers will make an assessment on a field by field basis as to whether or not those fields are sufficiently vulnerable to off-site movement of phosphorus to require limitations on the amount of phosphorus applied. Some regions with high risk of phosphorus movement have been identified by legislation that limits phosphorus fertilizer use. In other regions, the decision of whether manure applications must be limited based on the amount of phosphorus applied is likely to be based on a phosphorus index (PI). See the description of this index in the paper by Winston Tooke with the Natural Resources and Conservation Service (pages).

Whatever the basis for assessment, most dairy farmers will be monitoring manure phosphorus applications to fields in the future. If manure applications must be based on phosphorus instead of nitrogen, most dairies will be required to make major changes in their manure management programs because manures usually are very rich in phosphorus relative to nitrogen. One step that many can take to reduce the amount of manure phosphorus is to reduce the amount of phosphorus in the ration to the lowest level possible.

In a meeting arranged by Art Darling at Belleview on December 8, 1999, implications of new phosphorus standards for surface runoff waters from dairies were discussed. Representatives from DEP, SFWMD, dairy farmers, industry consultants, IFAS extension, and IFAS research participated. The focus was on what dairy farmers might be able to do to meet compliance standards. No clear-cut answer emerged.

Afterward, Rick Lundquist asked Art if the dairy farmers would consider adopting a policy recommending reduction in ration phosphorus content to the lowest level that was acceptable to meet phosphorus requirement of cows or, if feed ingredients chosen because they were low-cost energy and fiber sources resulted in phosphorus content above minimum, to recommend no supplemental phosphorus. Subsequently, a meeting was held on February 16, 2000 at the Southeastern Milk, Inc. offices in Belleview to discuss this further. It was decided then to incorporate this discussion into the Florida Dairy Production Conference program. These materials are prepared to focus on how ration recommendations facilitating lower dietary phosphorus and, hence, lower manure phosphorus might be referenced.

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The goals and benefits of a policy recommending low-phosphorus rations include:

1. Reduce phosphorus intake and, hence, excretion while having the discretion to adjust dietary phosphorus if necessary.

2. Eliminate all supplemental (inorganic) phosphorus additions to rations, if possible. In many cases, the industry already is there, especially when high-phosphorus by-products are fed.

3. Reduce feed cost by eliminating unnecessary phosphorus feeding.

4. Inform the public that, in addition to reducing dietary phosphorus, the dairy industry is reducing overall environmental loading of phosphorus by recycling phosphorus from by-product feeds derived from the processing of foods for people.

The policy statement that was proposed to dairymen is one of principle and does not commit dairymen to feed phosphorus at levels that might be detrimental to the health of their cows. Subsequent to the discussion at the Dairy Production Conference on May 3, the Southeast Milk, Inc. board adopted the following recommended policy to their members:

> *It is the policy of Southeastern Milk, Inc. that our members supply their herds' rations with the lowest level of phosphorus possible consistent with animal health and productivity. We urge our members to request their nutrition consultants to formulate herd rations based on national and state research and consensus recommendations bearing in mind that minimizing dietary phosphorus will reduce manure phosphorus excretions to the greatest practical extent.*

Dietary phosphorus recommendations usually are discussed on the basis of *percent of dietary dry matter (% of DM)* while requirements really are for a *quantity* that needs to be absorbed from the digestive tract. .Thus, percentages can be misleading. For example, 100 grams of dietary phosphorus (P) is an amount that might be considered a requirement for cows producing 100 lb of milk per day (*Nutrient Requirements of Dairy Cattle,* National Research Council (NRC), 1989). The amount of dry matter that cows are eating in which the 100 grams of P is incorporated has a big effect on the needed percentage of dietary P. This is illustrated in the table on the next page.

We are not trying to imply that cows might need dietary phosphorus as high as .50 or .55% of DM at times. Likely, they would not produce 100 lb milk per day with dry matter intakes (DMI) that low. However, DMI does need to be taken into consideration.

Lb DMI	% phosphorus in diet to supply 100 grams intake
55	.40%
54	.41%
53	.415%
52	.42%
51	.43%
50	.44%
49	.45%
48	.46%
47	.47%
46	.48%
45	.49%
44	.50%
43	.51%
42	.52%
41	.54%
40	.55%

To what levels can dairymen reduce dietary phosphorus and not compromise the health and productivity of their cows? We are proposing that DMI for high producing cows usually is sufficient to permit lowering of dietary phosphorus percentage of DM to .38 to .40% if some depletion of body stores of phosphorus is accepted in early lactation and if primary ration ingredients selected to meet energy, protein, and fiber needs of cows economically do not bring dietary phosphorus above these amounts with no supplemental inorganic phosphorus. The publication *Nutrient Requirements of Dairy Cattle* published by the National Research Council in 1989 is currently under revision. Recommendations that will be made by the national committee based on available international research literature will lower phosphorus recommendations somewhat from the last publication because of environmental costs that come from recommendations that might be higher than actually needed to be safe for cow health and productivity.

Until the new NRC requirements are published, we suggest that the tables on the following page be used as guidelines for ration formulation by Florida dairymen. We believe the tables reflect requirements (grams/day) that are needed by dairy cows, realistic ranges in dietary P percentages with realistic ranges in DMI, and scenarios with dietary P at .38% or .40% of DM that recognize that modest depletion of bone stores of P in early lactation are normal and unavoidable.

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How much can we change dietary P to help balance whole-farm nutrient budgets?

Variation in P% needed in DM assuming no P depletion[1]

	Milk yield (lb/day)				
DMI	40	60	80	100	120
45	0.30	0.37	0.43		
50	0.27	0.33	0.38	0.44	
55		0.30	0.35	0.40	0.45
60				0.37	0.41
65					0.38

[1]Maintenance fixed 24 g/d, milk P at .09%, P absorption .65.

[2]Cows mobilize 500 to 600 g P from bone stores without detriment in early lactation. This permits feeding about .04% of DM less than table amounts for 60 days in early lactation. This amount needs to be added to required amounts in late lactation for repletion such that one level for the total lactation can be selected, e.g., .38 to .40%.

Required grams[1] to compute DM%

Milk		Maint.	Required g [2]	
lb/d	g P	g P	Absorbed	Diet
40	16	24	40	62
60	24	24	48	75
80	33	24	57	87
100	41	24	65	100
120	49	24	73	112

[1]Milk was assumed to be .09% P, maintenance was fixed at 24 g per day (1400 lb cow).

[2]Diet grams (g) is amount needed to supply absorbed requirement if 65% of dietary P is absorbed.

Effects of .38% or .40% P in DM on cumulative P balance for cow peaking at 100 lb/d

	Days in milk (DIM)								
	10	20	40	60	90	150	210	270	330
MY, lb/d	50	70	90	100	90	80	70	60	50
DMI (lb/d)	35	45	50	55	55	50	50	45	40
P required, g/d	68	81	93	100	93	87	81	75	68
P intake (.38%), g/d	60	78	86	95	95	86	86	78	69
P intake (.40%), g/d	64	82	91	100	100	91	91	82	73
Cum P bal (.38% P), g	-80	-136	-242	-364	-417	-405	-275	-27	80
Cum P bal (.40% P), g	-48	-68	-88	-114	-18	280	682	1188	1527
Cumulative MY (lb)	500	1100	2700	4600	7450	12550	17050	20950	24250
Cumulative DMI (lb)	350	750	1700	2750	4400	7550	10550	13400	15950
Cumulative MY:DMI	1.43	1.47	1.59	1.67	1.69	1.66	1.62	1.56	1.52

In early lactation, the cow mobilizes calcium (Ca) from bone to meet her mineral needs. Phosphorus (P) is mobilized with Ca because they exist together in the bone's structure. The cow uses the mobilized bone P to meet requirements. Feeding high levels of Ca or P in early lactation does not limit the amount of bone mobilized. The P stores in bone are similar to body condition: we expect that the cow will normally use stores of P and energy in early lactation to meet requirements. The P and energy stores are "refilled" by the end of the lactation, to support good performance in the following lactation.