How phosphorus in lactating cow rations affects the phosphorus in manure and soils

In an age of environmental regulations and the concern of phosphorus (P) getting into our water resources, producers are asking the question: what can be done to limit manure phosphorus application to cropland? Some general answers are better use of fertilizer and efficient manure application techniques. However, the fundamental way is to reduce the P applied in manure. This can be achieved by reducing the amount of manure applied and/or by reducing the P concentration in the manure.

According to several surveys conducted on U.S. dairy herds over the past few years, the average dietary P level for lactating cows is 0.48%. If this level was reduced to 0.38%, this could result in 30-35% less manure P excretion. It is unfortunate that dry matter intake information is not presented along with the P percents so a more accurate determination could be made on the amount (pounds) being consumed. Pounds are significant because manure is "enriched" by purchased feeds, not farm inputs – that is pounds onto the farm. The emphasis should be on producing high quality forage that can be utilized to it's maximum potential and minimize purchased feeds. At the same time, P levels should be formulated that meet the animal's requirements as recommended by the 2001 NRC. Numerous research studies have demonstrated that feeding P in excess of requirements does NOT enhance production or reproduction. Table 1 illustrates the impact increasing levels of phosphorus can have on manure P.

Table 1. Predicted manure phosphorus (P) for a cow consuming 50 pounds of dry matter per day with various P contents. Assumes a P digestibility of 68% and an average milk production of 75 pounds (22,875 lbs of milk in 305 days).

Dietary P (%)	P intake from feeds (lbs./day)	Manure P			[1]Manure P_2O_5 lbs./ton
		%	lbs./day	lbs./ton	
0.35	0.18	0.62	0.10	1.9	4.4
0.38	0.19	0.69	0.11	2.2	5.1
0.40	0.20	0.74	0.12	2.3	5.3
0.42	0.21	0.78	0.12	2.5	5.8
0.45	0.23	0.85	0.14	2.7	6.2
0.48	0.24	0.93	0.15	2.9	6.7

[1] The factor to convert between elemental and oxide P is 2.3.

Table 2 illustrates the difference in manure phosphorus produced over a lactation and how that affects the acres needed to compensate for feeding phosphorus at 0.24 pounds compared to 0.19 pounds. A producer would need .31 acres per cow more to handle only the extra phosphorus excreted compared to the lower phosphorus diet. If the manure was not applied to the additional area, then soil test phosphorus (STP) could increase over time on this smaller area.

Feeding the high phosphorus ration can result in an increase as high as 4.8 lbs/year in STP if the manure is applied in excess of the crop's requirements in the rotation. If the

starting STP is at optimum (60 lbs. P/A, Mehlich 3), it would take approximately 8 to 11 years to achieve STP levels above optimum (100 lbs. P/A).

Table 2. Land requirement for utilizing manure phosphorus (P) and possible changes in soil test P (STP).

	Dietary P - lb of dry matter	
	0.19	0.24
P intake (lbs./305d)	58.0	73.0
Manure P (lbs./305d)[1]	33.6	45.8
P removal by crops (lb./A/yr)[2]	40.0	40.0
Land needed to utilize manure P (A)[3]	**0.84**	**1.15**
P removed by 0.84 A	33.6	33.6
P in excess of crop removal (lbs./A)[4]	0	14.5
Increase in soil test P (lbs/A/yr)[5]	**-**	**3.7-4.8**
Going from optimum STP to above oprtimum STP (yrs)[6]	-	8.3-10.8

[1] Manure P calculated using values from Table 1.
[2] P removal by crops assumes a cropping system of alfalfa and corn silage where they are fed on a 50:50 basis.
[3] Land needed to recycle manure P = Manure P ÷ P removal by crops.
[4] P in excess of crop removal = (Manure P – P removed by 0.84 A) ÷ 0.84
[5] Seven to nine lbs. P_2O_5/lb STP increase. Example: 14.5 lbs. P/A x 2.3 lbs P_2O_5/lb = 33.4 lbs. P_2O_5 / 7-9 lbs. P_2O_5 = 3.7 – 4.8 lbs./yr.
[6] If starting at optimum STP (60 lbs. P/A) and go to above optimum (100 lbs. P/A), then 40 lbs. P/A in the optimum window. Example: 40 lbs. P/A / 3.7-4.8 STP/A/yr = 8.3 to 10.8 years.

There are some simple management practices that producers can implement to control phosphorus intake and thus control what is excreted. They include:

1. Analyze all forages and supplemental feeds for phosphorus.

   There can be a lot of phosphorus variation between and within feedstuffs. Therefore, routine laboratory analyses of feeds for phosphorus content are necessary for a precise and accurate diet formulation.

2. Develop a database of phosphorus values that reflect the individual farm operation.

   There are software packages available that can make collecting and analyzing this information easy. This practice could help monitor the levels and variation that occur in phosphorus as well as other nutrients.

3. Discontinue free-choice phosphorus containing minerals.

   There is no evidence to show that a cow's appetite for phosphorus and calcium containing supplements coincide with the animals' nutritional requirements.

4. Formulate rations according to the 2001 NRC standards.

   Numerous research studies have been conducted in the past decade that supports the 2001 NRC recommendations for phosphorus. Under normal circumstances, there is no basis for feeding excessive P levels. Discuss this with the farm's nutritionist or consultant.

5. Monitor dry matters on all high moisture ingredients.

   The key to controlling P intake is making sure that cows are being offered the actual dry matter pounds of high moisture forages and feeds that have been formulated.

Dairy producers can feed for high performance and still minimize any negative impact of P excretion on the environment. Simple management practices can be implemented that control the level of phosphorus being consumed and eventually being excreted in the manure. More information on phosphorus is located at http://nutrient.psu.edu. The publication "Reducing Phosphorus in the Dairy Herd" is located on the nutrient management web site under dairy cattle, nutrition.