Dietary Phosphorus Considerations in Dairy Management

Why be concerned about Phosphorus?

Background

Phosphorus (P) moving from farms to surrounding water bodies has environmental implications. An overabundance of P in lakes and streams causes algae blooms, decreased oxygen supply, and death of fish. While it is important for producers to be concerned about the P content in the manure generated on their dairy farms, they also need to be assured that the dietary P content of the feed is adequate to keep milk production high and ensure reproductive efficiency.

If a producer is required to follow a P-based nutrient management plan, more P in the manure means more acres must be available for spreading. Also, a higher dietary P level, resulting in greater amounts of P excreted in manure, will cause soil test P values to increase more quickly than a diet lower in P. Many Wisconsin soils contain more P than is needed for crop production. Dairy producers have options in their choice of feed supplements. It will be important for them to be informed about the P content of feed in order to make decisions that are mindful of herd health as well as economically and environmentally sound.

Producer concerns

The common practice of overfeeding P to animals, particularly dairy cattle, stems from a widely held belief that high P diets improve animal reproductive performance. While it is true that extremely low dietary P can lower the reproductive fertility of dairy cattle, studies show that this does not happen until dietary P levels reach less than 0.31%. In fact, a review of published research trials showed no indication that feeding P in excess of the National Research Council (NRC) recommendations enhances animal fertility. Dietary P levels on most dairy farms are between 0.45 and 0.50% for high producing herds. Such levels of dietary P are excessive and can be substantially reduced without sacrificing milk production or quality. The U.S. NRC recommends that the typical dairy cow diet contain between 0.32 and 0.38% P, depending on milk production (Table 1).

Table 1. Dietary Recommendations of the National Research Council (January 2001).

Milk Production Level	Dietary P Level
(lbs/day)	(%)
55	0.32
77	0.35
99	0.36
120	0.38

Research on Dietary-P Impacts

Dairy Diets

In a recent Wisconsin study, dairy cattle were fed two diets: one diet contained no supplemental P (low P diet) and the second was supplemented with monosodium phosphate (high P diet). These diets resulted in feed P concentrations of 0.31 and 0.49%, respectively, and produced manures with P concentrations of 0.48 and 1.28% P, respectively (Table 2).

Land Application of Manure

Both manures (low P and high P) were surface applied in the spring at 25 ton/acre rates on silt loam soils covered with corn residue at a southern Wisconsin site. At this rate the high P diet manure supplied 96 lb P/acre and the low P diet manure supplied 36 lb P/acre (Table 2).

Runoff Sample Collection

Simulated rainfall was applied to the plots in June (one week after manure application) and again in October (after harvest) and runoff was collected and analyzed for dissolved P (DP) content. Dissolved P is the form of P that is soluble in water. It is readily available for plant uptake and is the form that can have immediate impact on algae and aquatic vegetation growth. Natural runoff from the same plots was collected from November through July of the following year and analyzed for DP as well.

Results

Results from the study indicate that when manures from dairy cows fed different concentrations of P are land-applied, the high P diet manure releases more P in runoff than the low P diet manure (Fig. 1). In June, DP lost in runoff from the high P diet plots was more than ten times higher (79 vs. 7) than DP from the low P diet plots. In October equivalent manure application rates produced P losses from the high P diet plots that were almost four times higher (37 vs. 10) than the low P diet plots.

Table 2. Description of manures used in the study.

Manure Type	Dietary P	Manure P	Land application rate	Manure-P application rate
	(%)	(%)	(tons/a)	(lb P/a)
High P Diet	0.49	1.28	25	96
Low P Diet	0.31	0.48	25	36

Natural Runoff

Dissolved phosphorus losses in November to July natural runoff (Fig. 2) were lower than those in the simulated rainfall studies, however, trends were the same. High P diet manure released more P to runoff than the low P diet manure. ***Excess P in dairy diets increases the potential for P loss in runoff from land-applied manure.***

Importance to Dairy Producers

Land Requirement for Spreading

In addition to the water quality concerns, excess P in dairy diets can dramatically increase the land requirement for manure application - if a producer is required to meet P-based manure application criteria. One P-based strategy proposed for Wisconsin is a restriction on manure application rates to equal crop P removal rates.

In a Wisconsin farm scenario approximately 1.8 acres of a mixed alfalfa, soybean, corn grain and silage cropping system is required to utilize the manure-P from each lactating cow fed at 0.38% P (Table 3). Raising dietary P from 0.38 to 0.48% increases the cropland area needed per cow by 44%. The trend continues with increasing dietary P levels. The substantial range in Table 3 values of 1.6 to 2.9 acres per cow to meet a P-based manure application strategy reflects the large impact dietary P levels can have on land requirements for manure spreading.

Figure 1. Loss of P from manured fields.

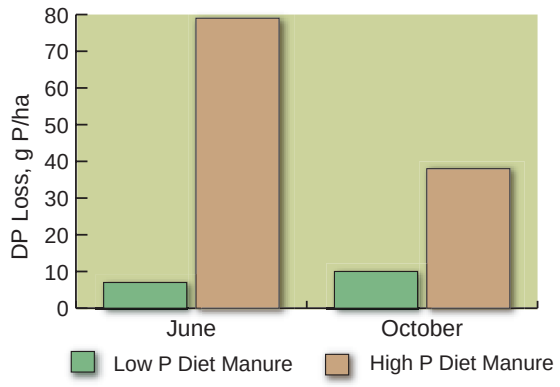


Figure 2. Dissolved P losses in natural runoff.

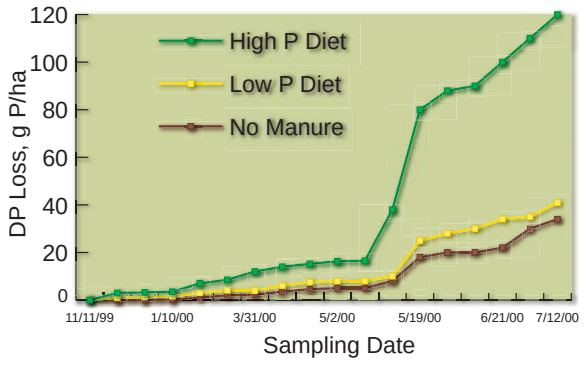
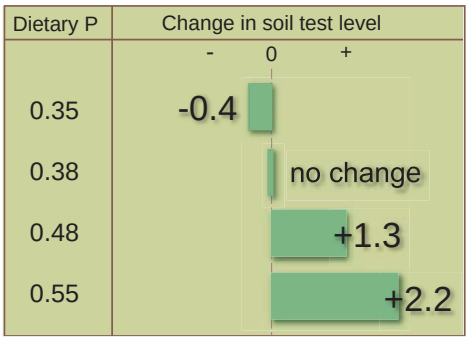


Table 3. Land needed for applying manure from dairy cattle fed various dietary P levels.

Dietary P	Acres Needed for Manure Spreading	Increase in Acres Needed for Manure Speading
(% P)	(acres/cow)	(%)
0.35	1.6	-
0.38	1.8	13
0.48	2.4	57
0.55	2.9	87

Figure 3. Potential changes in soil test P due to manure applied from dairy cattle fed various dietary P levels.



Increase in Soil P Levels

Dietary P supplementation can profoundly affect soil test P levels as well. For example in the same farming system described earlier, if a producer has 1.8 acres of cropland available for spreading per cow, land application of manure from cows fed a diet providing no excess of P (0.38% P) would be sufficient to meet crop needs. Soil test P values would not rise. However, at the 1.8 acres per cow ratio, any amount of supplemental P in excess of the cow requirement would result in manure-P that when applied to cropland would increase soil test P levels - as illustrated in Fig. 3.

Conclusion

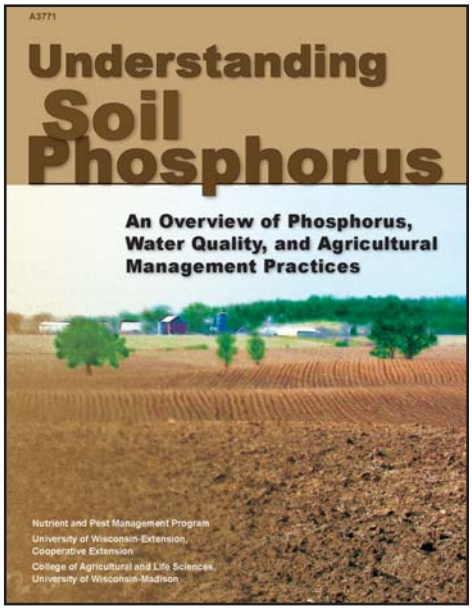
Reducing dietary P intake to recommended levels is an important practice for improving nutrient management on Wisconsin's dairy farms.

A goal of dietary P management should be to avoid overfeeding P which, in turn, avoids the increase in manure-P content. Over-feeding P increases the amount of land required for manure application if P-based manure spreading restrictions are in place. It also accelerates the build-up of soil test P levels of fields. By reducing P supplementation to recommended concentrations, feed costs, manure-P content, and the amount of land required for manure spreading could all potentially decrease on many dairy farms.

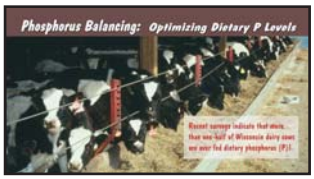
However, the benefits of feeding P at recommended levels must be weighted against the price, convenience, and availability of the feed supplements currently in use on a farm. Many common and affordable protein and mineral supplements contain high levels of P. Livestock operations must consider the economic impacts associated with switching to alternative, low P, feed supplements. ■

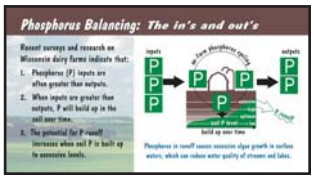
Additional Phosphorus Related Resources Available from the Nutrient and Pest Management (NPM) Program:

Understanding Soil Phosphorus: An Overview of Phosphorus, Water Quality, and Agricultural Management Practices is a new publication available from the NPM Program. The 32 page, color publication summarizes the issues associated with phosphorus (P) and its potential for impact on the environment. Specific topics include the phosphorus cycle, nomenclature, sources, transport, and a summary of agricultural management practices for minimizing the impact of phosphorus on water quality.



A series of four *Phosphorus Balancing* cards are available from the NPM Program. Each card has its own message relative to P management. One card graphically illustrates the balancing of P inputs with farm outputs. Another contains the National Research Council dairy feeding recommendations for P. A third promotes lowering dairy dietary P in order to reduce the acreage required for manure spreading. The final card shows the P content of various protein and feed supplements common to Wisconsin farms. All NPM publications are free of charge. See below for ordering information.





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