Phosphorus and Dairy Manure

Texas Animal Nutrition Council
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Manure application to soils is becoming a greater focal point for environmental regulations. This is due, in part, to phosphorus (P) being the nutrient limiting growth of most aquatic plant life. When manure P is applied to land, it is adsorbed onto soil particulates; improperly balanced with cropping schemes and there is a concern of long-term soil P accumulation. Erosion of high P soils into waterways can be a significant source of P input to downstream waters. In addition to the environmental concern, P is also relatively easy to measure as it does not volatilize or leach away as does much of the manure nitrogen applied to land. The combination of these two issues has brought significant attention to long-term P management in areas with concentrated animal feeding operations.

Current Texas Natural Resource Conservation Commission (TNRCC) regulations require dairy producers in Erath, Comanche, Hamilton, Hopkins, Johnson, Rains, and Wood Counties with greater than 200 mature head of dairy cattle to annually sample and maintain a log of soil nutrient levels in waste application fields. Application of manure or wastewater to these fields is dependent on soil P levels. Current TNRCC (07/27/99) regulations state that *"where annual soil sampling analysis for extractable phosphorus indicates a level greater than 200 ppm of extractable phosphorus (reported as P) in Zone 1 (0-6 inches for land application areas where the waste is incorporated directly into the soil or 0-2 inches for land application areas where the waste is not incorporated into the soil) for a particular application field, the operator may apply wastewater to the affected application area only in accordance with a detailed nutrient utilization plan developed by NRCS, the Texas State Soil and Water Conservation Board, Texas Agricultural Extension Service, an agronomist, or soil scientist on full-time staff at an accredited university located in the State of Texas, or any professional agronomist or certified soil scientist."*

Manures are a very rich source of nutrients for plants; however, nutrient ratios of nitrogen, phosphorus, and potassium in manure usually do not match the nutrient requirements of crops. Cattle manure tends to be high in P relative to nitrogen for plant growth, thus targeting P as the nutrient regulating application rate. One approach dairy producers can take to reduce the manure P loadings is to reduce the amount of dietary P to the lowest level possible. By increasing P efficiency in the herd, dairy producers can reduce the acreage per animal required for waste disposal.

In early lactation, the cow mobilizes both calcium and P from her bone to meet requirements. Feeding high levels of either mineral in early lactation does not necessarily limit this resorption. Bone P stores are similar to body condition, in that they are resorbed in early lactation and repleted by the end of lactation. A survey conducted in 1997 among nutritionists in the Mid-South (Sansinena et al., 1999) reported an average formulation of .52% phosphorus in the diets of lactating cows. This is approximately

30% over NRC recommendations. Research has shown that once the P needs of the cow have been met by the diet, most of the extra P fed will be excreted in the feces and urine. Field demonstrations in Texas have shown the potential for manipulating the manure nutrient content through the ration fed to the herd (Jordan and Stokes, 1998). In evaluating individual herds, the manure phosphorus content did reflect dietary phosphorus intake (the higher the dietary P intake, the higher the level of manure P concentration). Data from this demonstration suggests reducing dietary phosphorus intake from .52% to .45% can reduce manure P as much as 16%; additional savings in feed costs (1000-cow dairy) of $14,000 per year are also realized. Further lowering of phosphorus supplementation to .40% will decrease manure P excretion by 27% and reduce ration cost by over $23,000 per year (1000-cow dairy).

Reduction in dietary P transfers through the system and influences manure P and waste application levels. Goals and benefits of a policy recommending low-P rations include:

1. Reduce P intake and, hence, manure P excretion while having the discretion to adjust dietary P if necessary.
2. Eliminate all supplemental (inorganic) P additions to rations, if possible. In many cases, the industry is already there, especially when high-P by-products are fed.
3. Reduce feed costs by eliminating unnecessary P feeding.
4. Inform the public that, in addition to reducing dietary P, the dairy industry is reducing overall environmental loading of P by recycling P from by-product feeds derived from the processing of foods for people.

The Texas Animal Nutrition Council hereby adopts the following recommended position to their clients:

> *It is the position of the Texas Animal Nutrition Council that our members formulate rations for their clients' herds with the lowest level of P possible consistent with animal health and productivity. This is based on state and national research demonstrating that minimizing dietary P will reduce manure P excretion without being detrimental to animal health and production.*

This position statement is one of principle and *does not* commit dairy producers to feed P at levels that might be detrimental to the health or productivity of their cows. Nor is this statement intended to be used for regulatory or legal purposes.

Dietary P recommendations usually are discussed on the basis of percent of dietary dry matter (% of DM). In reality, the requirements are for a quantity (g) absorbed from the digestive tract. Thus, dietary percentages can be misleading as both feed intake level and P source will influence dietary P percentage. For example, 69 grams of

absorbed P is the requirement for cows producing 100 pounds of milk per day. This value is from recommendations given in the *Nutrient Requirements of Dairy Cattle*, published by the National Research Council (NRC) in 2000. Feedstuff absorption coefficients for P differ by category. While nearly two-thirds of the P found in common feedstuffs in unavailable to the nonruminant animal, rumen microbes are very effective in breaking down feedstuff P to make a significant proportion of dietary P moderate to highly available to the dairy cow. Current NRC coefficients include 64% for forages, 70% for concentrates, and >70% for inorganic sources. Table 1 illustrates three ration scenarios that consider both dry matter intake and P source: (1) all P supplied from forages with the lowest absorption coefficient, (2) P supplied from concentrates with moderate absorption coefficients, and (3) P supplied from inorganic sources having high absorption coefficients.

TABLE 1. Dietary phosphorus concentrations (% of dry matter) required to supply 69 grams of absorbed phosphorus at different dry matter intakes.

	% P in diet		
Dry matter intake (lbs/day)	*SCENARIO 1:* P supplied through forages[1]	*SCENARIO 2:* P supplied through concentrates[2]	*SCENARIO 3:* P supplied through inorganic sources[3]
60	0.396	0.362	0.338
59	0.403	0.368	0.344
58	0.410	0.375	0.349
57	0.417	0.381	0.356
56	0.424	0.388	0.362
55	0.432	0.395	0.369
54	0.440	0.402	0.375
53	0.448	0.410	0.382
52	0.457	0.418	0.390
51	0.466	0.426	0.397
50	0.475	0.435	0.405

[1] Based on a 64% absorption coefficient for P supplied from forages.

[2] Based on a 70% absorption coefficient for P supplied from concentrates.

[3] Based on a 75% absorption coefficient for P supplied from inorganic sources.

To what levels can dairy producers reduce dietary P and not compromise the health and productivity of their cows? Southern dairy rations typically contain a variety of by-product ingredients. The use of these ingredients supports recommended ranges presented in the second column (using the 70% coefficient of concentrates) as realistically representing field conditions. We are proposing that DMI for high producing cows on southern rations containing by-product ingredients is usually sufficient to permit lowering of dietary P percentage of DM to 0.36% to 0.44% (considering P supplied

through the concentrate portion of the ration). The lower end of this range would be accurate if some depletion of body stores of P is accepted in early lactation.

REFERENCES

Jordan, E. and S. Stokes, 1998. Extension Update. *Mid-South Ruminant Nutrition Conference*, Irving, TX.

National Research Council, Nutrient Requirements of Dairy Cattle. 2000. NRC, 7th rev. ed. Natl. Acad. Sci., Washington, D.C.

Sansinena, M., L.D. Bunting, S.R. Stokes, and E.R. Jordan. 1999. A Survey of Trends and Rationales for Dietary Phosphorus Recommendations Among Mid-South Dairy Nutritionists. *Mid-South Ruminant Nutrition Conference*, Irvin