

## Phosphorus in dairy cattle diets

Phosphorous (P) is the second most abundant mineral element found in the dairy cow's body and it is involved in almost all metabolic reactions. For this reason greater attention is paid to providing proper supplementation. There has been a tendency for dairy nutritionists to formulate rations with P levels higher than what the National Research Council (NRC) has recommended. It is not unusual to see ration P levels in excess of requirements 130 to 160%. However, environmental concerns with P have forced a re-evaluation of the necessary levels needed in the dairy cow's diet.

Nutritionists do have their reasons for balancing rations with higher P levels. They include: 1) added safety margins to account for variations in animal status, P content of feeds, feed delivery accuracy, and feed bunk management, 2) uncertainty about P availability, and 3) added P to the ration improves reproduction. However, none of these can substantiate an increase in dietary P because the NRC recommendation already contains a safety margin and the P requirements are adequate for maximum performance.

Formulating rations accurately for P has its challenges. There is considerable variation in P content of concentrates and forages. To fine-tune the level of P going into the cow, frequent testing of forages, concentrate ingredients and total mixed rations for this mineral are recommended. Book values should not be counted on as an accurate source of information. Generally, cereal grains are uniformly higher in P than forages with byproduct ingredients (i.e. wheat midds) and oilseed meals (i.e. soybean meal) being especially high.

Adjusting rations for P content can significantly affect excretion in the manure. The consequences of feeding excess P equates to more manure P. If manure has to be managed according to soil P levels and potential for P transport from the field, then less manure is applied per acre and two to four times as much land is required to use up the manure. The most effective way to reduce manure P is to feed less of the mineral. Formulating rations to meet the animal's requirement for P and not exceed it should be the primary objective of the producer and nutritionist.

The 2001 NRC adopted research results developed over the last decade to estimate the P requirements of lactating cattle. Most of the popular press articles written to date on P have listed requirements as percents and they have not mentioned the pounds required or the difference dry matter intakes make on the percent. The more precise way of balancing P in the ration is to examine the pounds (or grams) being consumed.

Using equations from the 2001 NRC to estimate dry matter intake and phosphorus requirements, Excel spreadsheets have been developed to evaluate P requirements for lactating cows, dry cows and heifers. Tables 1 and 2 are examples of the output generated from the spreadsheets. Table 1 illustrates the variability in percent P depending on the animal's production, dry matter intake, and week of lactation. Table 2 lists the phosphorus requirement for mid lactation animals. The spreadsheet requires minimal inputs and can be used as a tool in determining guidelines for P levels in rations.

Table 1. Estimated phosphorus levels for early lactation cows based on the 2001 NRC.

Milk lbs.	Week of lactation	Dry matter intake lbs.	Phosphorus lbs.	Phosphorus %
80	4	41.8	0.17	0.42
80	8	48.5	0.18	0.38
80	12	51.6	0.19	0.37
85	4	43.1	0.18	0.42
85	8	50.0	0.19	0.39
85	12	53.2	0.20	0.37
90	4	44.5	0.19	0.43
90	8	51.6	0.20	0.39
90	12	54.9	0.21	0.38
95	4	45.8	0.20	0.44
95	8	53.1	0.21	0.40
95	12	56.5	0.22	0.38
100	4	47.2	0.21	0.44
100	8	54.7	0.22	0.40
100	12	58.2	0.23	0.39

Note: Assumes an average body weight of 1350 pounds, 3.6% milkfat and 67% phosphorus availability.

Table 2. Estimated phosphorus levels for mid lactation cows based on the 2001 NRC.

Milk lbs.	Dry matter intake lbs.	Phosphorus lbs.	Phosphorus %
60	47.2	0.16	0.33
61	47.6	0.16	0.33
62	47.9	0.16	0.33
63	48.3	0.16	0.33
64	48.6	0.16	0.33
65	49.0	0.16	0.34
66	49.3	0.17	0.34
67	49.7	0.17	0.34
68	50.0	0.17	0.34
69	50.4	0.17	0.34
70	50.7	0.17	0.34
71	51.1	0.18	0.34
72	51.4	0.18	0.35
73	51.8	0.18	0.35
74	52.1	0.18	0.35
75	52.5	0.18	0.35
76	52.8	0.19	0.35
77	53.2	0.19	0.35
78	53.5	0.19	0.35
79	53.9	0.19	0.35

Note: Assumes an average body weight of 1350 pounds, 3.6% milkfat and 67% phosphorus availability.

It is unrealistic to formulate P levels for individual animals, however, rations can be formulated that most closely meet a group's or herd's requirements. For example, in a one group total mixed ration scenario, a possible tactic is to aim for a P level that most closely meets the majority of the herd in dry matter intake, production level and days in milk. If cows are grouped according to production, then formulating for different P levels would be recommended. Depending on the herd dynamics (changes in production and days in milk), different P levels may need to be formulated at different times of the year. For nutritionists, the old way of formulating rations with the same value for every herd or for the same herd throughout the year may not be acceptable.

Some of the feeding management principles that are currently recommended for dairy operations can also help monitor and control P intake. An example would be testing dry matters on high moisture ingredients and adjusting rations accordingly to ensure animals are receiving nutrients in the proper amounts. Recording dry matter intakes for the herd can help track P intake. As mentioned earlier, testing feeds and the ration for P will be necessary to correctly determine P intake. Collecting and maintaining this information can help producers account for nutrient usage on the farm.

More information on nutrient management is located at <http://nutrient.psu.edu> You may also contact Virginia Ishler at 814-863-3912 for additional information. The Excel spreadsheets on determining phosphorus requirements are located on the nutrient management web site under dairy cattle, nutrition.