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# Calf, heifer phosphorus levels often in excess of requirement

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While there has been considerable concern with nitrogen losses into groundwater and contaminating runoff, phosphorus contamination is different as it does not leach but accumulates in soils. However, it may also run off with soil erosion or soil saturation (Powers and Knowlton, 2002). Thus, the dietary levels of phosphorus that are adequate for animal performance without contributing to phosphorus accumulation have been increasingly scrutinized.

In Table 1 are dietary phosphorus values for calves and heifers from the 1989 and 2001 National Research Council (NRC) dairy requirements.

In the 1989 NRC, grams of phosphorus per day increased with increasing bodyweight up to 21 g per day at 880 lb. Above that bodyweight, phosphorus required in grams per day remained static. As a percent of dry matter intake (DMI), values decreased progressively with increasing bodyweight, indicating that the numerical grams per day are not increasing as fast as DMI is increasing.

However, there is another confounding factor. At and above 880 lb. bodyweight, the DMI predicted in 1989 is an overestimate as it was driven by assuming increasingly lower dietary energy concentrations that would have required increasingly higher DMI (see footnote "A" under Appendix Table 2 on page 142 in the 1989 NRC that, in part, reads, "They are not intended to be estimates of voluntary intake but are consistent with the specified dietary energy concentrations …"). In fact, at those low-energy concentrations, DMI would have decreased because of low digestibility.

For the 2001 NRC data in Table 1, the same average daily gain of 1.76 lb. was used as for the 1989 data. The phosphorus values, as a percent of DMI, for 110 and 165 lb. of bodyweight are actually a bit higher than the 1989 values as specified in the footnoted assumptions. Keep in mind that in the 2001 NRC, absorbed phosphorus needs were calculated above 220 lb. bodyweight and then converted to total dietary phosphorus using an aver-

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TABLES

**1. Dietary phosphorus values for calves and heifers**

| Bodyweight, lb. | 1989 NRC g per day | 1989 NRC DMI, lb. | 1989 NRC % of DMI | 2001 NRC g per day | 2001 NRC DMI, lb. | 2001 NRC % of DMI |
|---|---|---|---|---|---|---|
| 110 | 6 | 2.9 | 0.46 | — | 2.2 | 0.60[a] |
| 165 | 8 | 4.4 | 0.40 | — | 4.5 | 0.45[b] |
| 220 | 10 | 6.7 | 0.33 | 8.3 | 6.0 | 0.31 |
| 330 | 12 | 8.8 | 0.30 | 15 | 9.3 | 0.29 |
| 440 | 15 | 10.9 | 0.30 | 15 | 11.4 | 0.29 |
| 550 | 17 | 13.2 | 0.28 | 16 | 13.7 | 0.26 |
| 660 | 19 | 15.6 | 0.27 | 17 | 15.6 | 0.24 |
| 770 | 20 | 18.1 | 0.24 | 18 | 17.4 | 0.23 |
| 880 | 21 | 20.8 | 0.22 | 19 | 19.4 | 0.22 |
| 990 | 21 | 23.8 | 0.19 | 27 | 23.1 | 0.26 |
| 1,101 | 21 | 27.2 | 0.17 | 28 | 24.9 | 0.25 |
| 1,211 | 21 | 30.9 | 0.15 | 29 | 26.9 | 0.24 |
| 1,320 | 21 | 35.2 | 0.13 | 30 | 28.6 | 0.23 |
| 1,431 | — | — | — | 31 | 30.4 | 0.22 |

[a]Calculated assuming 60% of DMI from milk replacer and 40% from calf starter as specified in Table 10-2 and using phosphorus content for these feeds as specified in Table 10-6 of the 2001 Dairy NRC. No grams per day phosphorus are indicated at this bodyweight.
[b]Calculated assuming calves are weaned and are being fed only calf starter with the phosphorus content as specified in Table 10-6 of the 2001 Dairy NRC.

**2. Percent of dairy operations exceeding 2001 NRC by 25%**

| Mineral | Bodyweight 440 lb. | Bodyweight 661 lb. | Bodyweight 991 lb. |
|---|---|---|---|
| Calcium | 97 | 93 | 90 |
| Phosphorus | 83 | 86 | 90 |
| Magnesium | 100 | 93 | 100 |
| Chloride | 100 | 100 | 97 |
| Potassium | 100 | 100 | 100 |
| Sodium | 80 | 63 | 60 |
| Sulfur | 53 | 16 | 20 |
| Copper | 83 | 73 | 83 |
| Iron | 100 | 100 | 100 |
| Manganese | 100 | 100 | 100 |
| Zinc | 93 | 80 | 93 |

**3. Percent of dairy operations meeting or exceeding 2001 NRC from forages fed only**

| Mineral | Bodyweight 440 lb. | Bodyweight 661 lb. | Bodyweight 991 lb. |
|---|---|---|---|
| Calcium | 75 | 75 | 75 |
| Phosphorus | 15 | 46 | 80 |
| Magnesium | 90 | 90 | 98 |
| Chloride | 93 | 93 | 93 |
| Potassium | 97 | 97 | 94 |
| Sodium | 3 | 3 | 5 |
| Sulfur | 19 | 19 | 19 |
| Copper | 5 | 5 | 17 |
| Iron | 95 | 97 | 98 |
| Manganese | 83 | 84 | 95 |
| Zinc | 5 | 10 | 61 |

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age absorption coefficient of 0.68.

The phosphorus requirements in grams per day increased more slowly in 2001 than in 1989 from 440 to 990 lb. bodyweight. In the 2001 versus the 1989 NRC, increased phosphorus requirements due to pregnancy are factored in, which account for the large increase from 880 to 990 lb. bodyweight. Thus, the phosphorus requirements during pregnancy continue to slowly increase with increasing bodyweight while in the 1989 NRC, they actually leveled off.

The rationale and basis in the 2001 NRC are more appropriate than the values in the 1989 NRC. The phosphorus requirements, as a percent of DMI, actually decrease faster in 2001 NRC data above 330 lb. bodyweight than in the 1989 NRC until 770-880 lb. bodyweight, where they are similar between the two data sets. Above 880 lb. bodyweight, phosphorus as a percent of DMI is higher in the 2001 NRC due to inclusion of the additional requirement of pregnancy and due to a lower, more realistic estimate of DMI.

How are we doing feeding diets relative to phosphorus requirements for growing dairy heifers? At the 2002 Midwest American Dairy Science Assn./ American Society of Animal Science meetings, Zygarlicke and Hoffman presented a poster in which they summarized survey data from mineral feeding practices on Wisconsin dairy operations. An on-site evaluation, including samples of all feedstuffs and their fed amounts, was done along with subsequent mineral analyses of feedstuffs. Three groups of heifers were identified on each farm, namely 440, 661 and 991 lb. bodyweight groups. Inductive coupled plasma emission spectroscopy analyses were done for calcium, phosphorus, magnesium, potassium, sodium, sulfur, iron, copper, manganese and zinc. Dietary levels of minerals were compared to 2001 NRC requirements.

Only sulfur requirements were not met well among the various minerals surveyed. This is especially true considering that values in Table 2 reflect overages beyond 25% above the 2001 NRC requirements.

However, this does not answer the question of how much total dietary mineral intake may have been from mineral/supplement and not from forages fed. Table 3 addresses that question using the same format as Table 2.

Forages alone met most of mineral requirements except for sodium, sulfur, copper and zinc. At the highest bodyweight of 991 lb., there was some improvement in meeting these mineral requirements compared to 661 and 440 lb. bodyweight. At the lowest bodyweight of 440 lb., forages provided only 15% of the phosphorus requirement; but then phosphorus requirements were increasingly met at 46% of the operations for 661 lb. bodyweight and 80% for 991 lb. bodyweight. This reflects that DMI is increasing faster than the absolute grams of phosphorus required as noted in Table 1.

So, what happens as other feedstuffs may be fed to supplement forages?

A perusal of phosphorus content of some feedstuffs commonly fed to dairy cattle (NRC, 2001; Table 15-3) indicates that all forages had in excess of 0.20% phosphorus on a dry matter basis, most often exceeding 0.30% phosphorus. Only fibrous byproducts such as citrus and beet pulp, corn cobs, hulls (such as almond, cottonseed and soy) and apple pomace had less than 0.20% phosphorus on a dry matter basis, with wheat straw being the lowest at 0.10% phosphorus. On the other hand, grain byproducts from which starch has been removed or reduced ranged generally between 0.50 and 0.80% phosphorus, with cottonseed meal, sunflower meal and wheat middlings being even higher at or more than 1% phosphorus. Rice bran had the highest phosphorus content of any ingredient listed at 1.78%. This makes it challenging to avoid overfeeding phosphorus to growing dairy heifers without using some poor-quality fibrous feedstuffs.

At the annual Professional Dairy Heifer Growers Assn. program in March in Baltimore, Md., Powers and Knowlton (2002) presented a picture of land in the U.S. based on what percentage animal agriculture contributes to phosphorus export onto the land. In the Midwest and Plains states, from 30 to 50% of phosphorus export is from animal agriculture (see www.dasc.vt.edu/knowlton/knolton.html under "Invited Talks"). As the Environmental Protection Agency's re-definition and final action of concentrated animal feeding operations takes place by Dec. 15, this issue will take on an even greater dimension.

## The Bottom Line

As phosphorus accumulation in soils becomes a greater environmental concern, feeding practices will undergo increasing scrutiny. It appears that phosphorus levels fed to calves and heifers are often in excess of requirements. This is an area where adjustments can be made and still ensure that requirements are being met.

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