**INTRODUCTION**

Adverse environmental damage can occur when too much phosphorus (P) accumulates in soil and the metabolic problems that arise in dairy cattle, especially during the transition phase, when potassium (K) levels are too high. In 1951, Hignett and Hignett observed that P improved conception rate in dairy cattle. However, this improvement in conception rate was relative to cows consuming P deficient diets (less than 0.25%). Therefore, over the last 50 years the importance of the concentration of dietary P on reproductive performance has been overemphasized. In a field survey, Sink et al. (2000) reported that Virginia dairy producers were feeding 0.49% P. Similarly, Wu et al. (2000) reported that the average U.S. dairy producer fed 0.45 to 0.50% P. Recently, dietary P requirements have been reduced to 0.38% (NRC, 2001) compared to 0.41% P (NRC, 1989) for a cow producing 53 kg milk/d.

The reduction in dietary P was initiated because of the negative impact P can have on the environment. Of all of the essential dietary minerals for dairy cattle, P represents the greatest potential risk for environmental damage via pollution of surface water (NRC, 2001). Over enrichment of surface water with P accelerates the development of algal blooms. The rapid growth of algae leads to eutrophication which depletes dissolved oxygen levels and creates toxins within the water resulting in fish kills. The concentration of P in the feces is positively correlated to the concentration of P in the diet (Morse et al., 1992). Therefore, feeding P in excess of requirements will result in greater amounts of P being excreted. Recycling of P to crops, at rates greater than crop needs, allows P to accumulate in soil; increasing the amount of P available to potentially enter surface water. Thus, managing dietary P levels to reduce P excretion should minimize environmental contamination.

When applied in excess, some nutrients accumulate within the plant instead of the soil. Forages have the ability to consume K in luxury amounts (Brady and Weil, 1999). When excess K is applied to soil, this excess K is mirrored within the forage. Since forages are the primary feed ingredients of the prepartum cow’s diet, the use of high K forages increases the incidence of parturient paresis (milk fever) (Goff and Horst, 1997; Horst et al., 1997), which can lead to other metabolic diseases (Curtis et al., 1983). In 1998, Crill reported that Oregon dairy producers were overfeeding K in prepartum diets.

The objectives of this study were 1) to determine if Oregon dairy producers have adapted new P feeding recommendations, 2) to follow the progress of K feeding levels in dry cow rations, 3) use real Oregon data as the basis for ongoing extension programming for the dairy industry and nutritionists providing technical services to the dairy farmers.
MATERIALS AND METHODS

A field study consisting of 37 Oregon dairy farms was conducted from July 2002 to July 2003. Participating farms were located in the western region of Oregon and were divided in two regions based upon geographic location of farms: valley (V) and coast (C). Valley comprised 17 farms residing in the Willamette Valley and located in the following counties: Benton, Clackamas, Marion, Lane, Linn, Polk, Washington and Yamhill. The remaining 20 farms were located on the coast of Oregon in Coos and Tillamook counties. In addition to geographic location, farms were classified as either small (S) or large (L). Farms with herd size smaller then the herd size median, for each region, were classified as S. Likewise, farms with herd size larger than herd size median, for each region, were classified as L.

Each farm was visited on three separate occasions to collect data. Data collection included: ration information, for both lactating and dry cows, feed components included in the rations, as well as fecal and urine sample from the lactating and dry cow group. Individual feeds, fecal matter and urine were then analyzed for P and K.

A five-page survey covering topics of ‘soil testing and commercial fertilizer use’, ‘P information’, ‘K information’, ‘manure management’, and ‘your views and your farm’ was issued to participating farmers on the initial visit. The majority of the questions were multiple choices; however, a few fill in the blank questions also appeared. The survey was conducted in a manner that was compliant to the regulations of the Oregon State University Institutional Review Board therefore completion of the survey was voluntary and all results will remain anonymous.

RESULTS AND DISCUSSION

Description of Farms

Overall, average herd size was 339 cows and ranged from 50 to 1650, with an average of 277.1 acres receiving manure ranging from 65 to 1000. Producers were divided into groups based on geographic region (V or C) and herd size (S or L) and characteristics of these groups are summarized in Table 1.

Survey

Out of the 37 surveys issued, a total of 34 surveys were completed for a 92 percent response rate. Since the surveys were voluntary, two producers chose not to participant in the survey portion of this study. Total P and K knowledge within region, were averaged separately, however, responses were numerically similar between regions, thus responses were combined and reported as a whole. The original survey by Russelle et al. (2000) was issued to farmers in southeastern Minnesota and west central Wisconsin. Similarities in questions between the original and present survey, allows for comparisons between soil testing and commercial fertilizer use, P information, manure management, and farm characteristics between the Midwest and Oregon.
Table 1. Characteristics of participant farms.

<table>
<thead>
<tr>
<th></th>
<th>Coast</th>
<th>Valley</th>
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<tbody>
<tr>
<td></td>
<td>Small</td>
<td>Large</td>
</tr>
<tr>
<td>Number of farms</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Herd size, cows</td>
<td>101</td>
<td>278</td>
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<tr>
<td>Milk Yield, lbs/d</td>
<td>56.5</td>
<td>64.9</td>
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<td>Grazing (months)</td>
<td>7.8</td>
<td>6.7</td>
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<tr>
<td>Total acres receiving manure</td>
<td>171</td>
<td>292</td>
</tr>
<tr>
<td>Owned</td>
<td>117</td>
<td>181</td>
</tr>
<tr>
<td>Rented</td>
<td>55</td>
<td>111</td>
</tr>
<tr>
<td>Acres/Cow</td>
<td>1.69</td>
<td>1.05</td>
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</table>

Based upon the responses received by the participating Oregon dairy producers, it appears that respondents were more knowledgeable about P information when compared to the Midwest producers. When asked about the P levels in manure and grass crops, 60% of the Oregon respondents answered correctly, compared to a 40% correct response rate from the participating Midwest producers. Oregon respondents also had more knowledge of the rate at which P moves through the soil. However, when asked about the effect of excessive soil P on the environment, only 12% of Oregon respondents answered correctly-affects surface water. However, 61% indicated that both surface and ground water would be adversely affected by excessive soil P. By selecting the response of both surface and ground water, producers practiced more caution when considering effects of excess P in the soil, thus researchers considered this answer as a correct response. When combining the two responses, a total of 71% of Oregonian respondents are aware of the effects of excessive soil P.

Survey responses received regarding K information were as follows. When asked “what does excessive soil K affect” only 41.9% of the respondents correctly answered animal nutrition. Water quality, was also another popular answer (42%) indicated on the survey. Although K is easily leached from the soil (Brady and Weil, 1999), potential pollution caused by leaching has not been reported. Fifty-six percent of the producers surveyed were also aware that excessive K in rations could cause problems with dry cows. Finally, when asked to compare the amount of nitrogen, to the amount of K in manure and in pasture, 72.7 and 57.9%, respectively, correctly responded less than.

**Diet, Fecal, and Urine**

The superior knowledge of P is reflected in feeding practices implemented by the farms (Table 2). Participating Oregon dairy producers were feeding 0.40% P (DM basis) to lactating dairy cattle. Based upon milk production records, a typical farm should feed 0.33 to 0.35% P DM (NRC, 2001). Phosphorus levels in diets studied were higher than currently recommended. In comparison to a Virginia field study, Oregon producers are feeding less P. Sink et al. (2000) reported dietary P content of lactating cow rations was 0.49%.

Table 2. Levels of P and K for diet, feces, and urine for lactating and dry cows.
Dietary P levels of lactating diets between region \((P = 0.12)\) or herd size \((P = 0.76)\) did not differ. A difference between feeding levels of dietary P within herd size was expected since L herds are more apt to use professional services, such as nutritionist, compared to S herds. In addition, V herds were expected to have lower dietary P due to more consistent rations since C herds graze more often.

Dietary P content of the dry cow diet was 0.31%. No difference in feeding levels of P to dry cow was detected between region \((P = 0.42)\) or herd size \((P = 0.46)\). On day 240 of gestation, dietary P requirement is 0.22% and increases to 0.26% near parturition (NRC, 2001). Therefore, Oregon dairy producers are overfeeding P to dry cows by 19 to 41%. Dry cows constitute only 12 to 17% of the dairy herd; nevertheless, feeding as close to recommendations is ideal for all dairy cattle despite stage of lactation.

Average fecal P from all lactating cow samples was 0.92% (DM basis). The overall mean for urinary P was 2.58 mg/dl. Wu et al. (2001) reported that the concentration of fecal and urinary P excreted by lactating cows consuming 0.39% P (87.6g/d) was 0.85% (DM basis) and 2.8 mg/dl, respectively. Fecal and urinary P values were similar to that of Wu et al (2001). Interestingly, although P intake is similar for region and herd size, the fecal P output was greater \((P = 0.08)\) for V herds, resulting in a lower apparent digestibility.

Oregon producers are overfeeding K to both the lactating and dry cows. Herds in the coast were feeding higher levels of K in lactating diet than V farms \((P = 0.01)\) (Table 2). Lactating K content of diet for C and V herds was 1.84 and 1.58%, respectively. No difference \((P = 0.10)\) in dietary K for lactating cows was reported between herdsize. Dietary K for dry cows averaged 1.99% (DM basis) with no difference between detected between region \((P = 0.40)\) or herdsize \((P = 0.72)\) (Table 2). Potassium feeding recommendations for lactating diets ranges between 1.00 to 1.07% whereas dietary K should be limited to 0.51% in the dry cow diet (NRC, 2001). Oregon producers were overfeeding K by 58% in lactating diets and 300% in dry cow diets. Because of
the implications of K and metabolic disease in dry cow diets, we expected to see lower levels than that fed to lactating cows. In 1998, average K in prepartum diets fed in Oregon was 1.67% (Crill, 1998). In the present study, dietary K in the prepartum diet was 1.99%.

CONCLUSION

Based on survey results, Oregon dairy producers are knowledgeable about P and its potentially negative affect on the environment. However, P is being slightly overfed in lactating cow rations, but not to the extent reported in other states. A potential problem may exist with the limited land base that receives manure. The inability to apply manure at agronomic rates leads to accumulation of soil P and the potential for surface water damage. This should be of concern since the majority of Oregon producers reported surface water borders farm property.

Potassium in lactating and dry cow rations is in excess of feeding recommendations. The use of high K forages significantly contributes to the elevated levels of K within the diet, primarily in dry cow diets. Because of this, the amount of K excreted in manure is in excess of typical K excretions. The high level of K excreted in combination with the small land base which receives the manure, contributes to the K available for forage uptake and compounds the problem of high K forages.

REFERENCES