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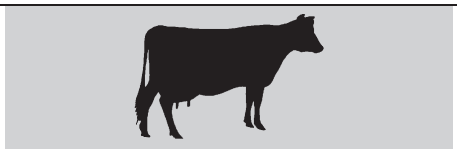

Case Study: Farm-level evaluation of implementing nitrogen and phosphorus feeding best management practices on Pennsylvania dairy farms

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ABSTRACT

Feeding best management practices (BMP) can have a significant effect on the environmental footprint of dairy farms. This case study was conducted to evaluate the environmental and productive effects of implementing several feeding BMP on commercial dairy farms in Pennsylvania. Fifteen farms (124.8 ± 20.5 ha, 169 ± 39 cows, and 31.4 ± 0.2 kg/d milk yield) participated in the study. Four baseline TMR, forage, milk, feces, and urine samples, as well as feed intake and production data, were collected from each farm every 2 wk between January and March of 2013 (PreBMP period). Feeding BMP were offered, and participating producers chose a set of BMP to implement on their farms, including reduction of dietary CP (n = 7) and P (n = 3) concentrations, adjusting rations for changes in forage DM (n = 10), group feeding of the lactating herd (n = 2), and no use of BMP (n = 3). Following BMP implementation, another 4 sampling and data-collection events took place between June and August of 2013 (PostBMP period). Seven farms reduced dietary CP (from 17.2 to 15.8%; P < 0.001), which resulted in decreased concentrations of total urinary N (0.75 vs. 0.57%; P < 0.001), urinary urea-N (544 vs. 461 mg/dL; P = 0.007), and milk urea-N (16.8 vs. 13.7 mg/dL; P < 0.001) from PreBMP to PostBMP, respectively. Three farms lowered dietary P (from 0.42 to 0.40%; P = 0.06), which resulted in decreased fecal P (0.83 vs. 0.69%; P = 0.001). Dry matter intake (23.3 vs. 22.7 ± 0.46 kg/d; P = 0.05), milk yield (32.7 vs. 31.9 ± 0.76 kg/d; P < 0.001), bulk-tank milk fat (3.91 vs. 3.56%; P < 0.001), and milk protein (3.13 vs. 2.98%; P < 0.001) decreased on all farms from PreBMP to PostBMP period, due to seasonal effects. In conclusion, reduced dietary CP decreased N concentrations in urine, feces, and milk, and reduced dietary P decreased fecal P concentration on commercial dairy farms.

Key words: best management practice, crude protein, phosphorus, dairy farm

INTRODUCTION

Implementing feeding best management practices (**BMP**), such as reducing dietary CP, reducing dietary P, grouping and feeding cattle according to their nutrient requirements, and reducing variability in TMR composition, can reduce N and P excretions in manure without negatively affecting animal productivity. For example, 16.5 to 16.7% dietary CP (DM basis) is adequate for high-producing dairy cows (NRC, 2001; Broderick, 2003; Colmenero and Broderick, 2006), but commercial herds are often fed higher levels of CP (Hristov et al., 2006), which is likely to increase N excretion in urine and, consequently, increase ammonia volatilization losses from manure (Hristov et al., 2011).

Formulating dietary P in agreement with NRC (2001) recommendations is the most effective method to mitigate

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excess P output in manure (Kebreab et al., 2008). In 2003, a survey of 612 mid-Atlantic dairy producers reported lactating diets ranged from 0.36 to 0.70% P (DM basis) with a mean of 0.44% P (Dou et al., 2003). According to the NRC (2001), P requirements of a Holstein cow with 680 kg of BW, 90 DIM, and milk production of 35 kg/d, consuming 24 kg of DM/d, would be met with dietary P concentration of 0.35%, which is considerably lower than the average TMR P concentrations reported for commercial dairy herds by Dou et al. (2003; 0.44%) and Hristov et al. (2006; 0.49%). Typically, diets without added P contain 0.33 to 0.40% P (Wu et al., 2000).

Grouping dairy cattle by milk production or parity can better meet nutrient requirements and decrease DMI variation within the group (Grant and Albright, 2001). Feeding a single lactating diet can limit high-producing cows because their requirements may not be met, but low-producing cows on the same diet may not efficiently use dietary nutrients and will store them in adipose tissue or excrete them in manure (St-Pierre and Thraen, 1999).

Another management practice that may more accurately match animal requirements with dietary nutrient supply is regularly monitoring forages for changes in DM and accordingly adjusting TMR ingredient composition. Accuracy and consistency of TMR composition over time are important factors when feeding dairy cattle (Weiss et al., 2012; McBeth et al., 2013; Sova et al., 2014). Although nutrients in dairy rations may be balanced well, variation in forage DM, when not properly adjusted for, can cause inconsistencies in the TMR delivered to the feed bunk (Barmore, 2002).

Therefore, the objective of the present case study was to evaluate the environmental and productive effects of implementing one or more feeding BMP on commercial dairy farms in Pennsylvania. We hypothesized that implementation of BMP, such as decreased dietary CP and P, would decrease concentrations of N and P in manure, without negatively affecting milk production and composition.

MATERIALS AND METHODS

All procedures involving animals in this study were reviewed and approved by The Pennsylvania State University's Animal Care and Use Committee. All documents initially submitted to cooperator farms were reviewed and approved by The Pennsylvania State University's Institutional Review Board.

Cooperator Farms Selection and Study Design

Farms selected for the study were located in 2 Pennsylvania watersheds identified as N and P priority watersheds by the Chesapeake Bay Watershed Program (Chesapeake Bay Program, 2015). The watersheds were the Upper Kishacoquillas Creek and the West Branch Little Conestoga Creek. The Upper Kishacoquillas Creek watershed is a subwatershed of the Kishacoquillas Creek watershed and is located in the northern portion of Mifflin County, Pennsylvania. The West Branch Little Conestoga Creek watershed is 1 of 6 subwatersheds within the Little Conestoga Creek (and Susquehanna River) watershed located on the western side of Lancaster County.

Initially, dairy farms located in the Upper Kishacoquillas Creek and West Branch Little Conestoga Creek watersheds were identified based on inputs from the Conservation Districts and Natural Resources Conservation Service offices in Mifflin and Lancaster Counties. The farms were visited, the objectives of the study explained to the farm owners and their consulting nutritionists, and 15 collaborator farms were selected primarily based on their size, concentration of CP and P in their lactating-cow diets, and willingness of the owners to participate in the study and consider implementing feeding BMP. Initial surveys were conducted on the selected farms to gather baseline information on land area (124.8 ± 20.5 ha), herd size (169 ± 39 cows), current management practices, and lactating-cow diets provided by their consulting nutritionist. All dairies were Holstein herds. The facilities were free-stall (12 dairies) or tie-stall (3 dairies) barns. Seven dairies fed 2 lactating-cow TMR, separated by production parameters; 6 dairies fed a single lactating-cow TMR; and 2 dairies implemented group feeding during the study.

During an initial visit with the owners of the 15 cooperator farms, university resources devoted to the project and expected inputs by the producers were discussed. Following these initial visits, 4 baseline sampling and data-collection events took place every 2 wk between January and March 2013 (**PreBMP** period). After the baseline sampling was completed, follow-up interviews were conducted with each producer and their consulting nutritionist to review a list of 42 feeding-related BMP, including maximizing forage quality, regularly monitoring rations for nutrient composition and particle size, precision diet formulation, use of feed additives, and others. Producers reviewed which feeding BMP and herd-management strategies were already in place on their farm and which BMP they would like to implement. Seven farms implemented reduced CP concentration in the lactating-cow diets (**NBMP**) and did so according to their consulting nutritionist's recommendations, either by decreasing concentrate inclusion, decreasing CP concentration in the grain mix, or by partially replacing alfalfa haylage with corn silage in the diet. Three farms lowered dietary P in their lactating-cow diets (**PBMP**) by reducing or eliminating mineral P supplements. Two farms split their lactating herd into 2 groups based on production parameters (**GFBMP**); there were no changes to the facilities used at these farms. In attempt to improve TMR formulation accuracy, 10 farms monitored forages and