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Dairy manure quantification and characterization in grazing systems

Abstract: *Information is needed on the amount and nutrient concentrations of manure generated by lactating dairy cows that are managed in an intensive grazing system. Currently the most frequently cited data sources for these are 20-year old ASAE tables. These data are important because manure nutrient figures are used to determine the maximum animal stocking density that will safeguard against nutrient runoff or degradation of water quality by concentrated nutrients.*

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$35,666 for year one
$33,726 for year two

Background

Only minimal data are available on manure production and manure characteristics from dairy cows in grazing systems. Most available data of this nature, based on cows fed in confinement systems, come from older American Society of Agricultural Engineers (ASAE) tables or from reasonably accurate nutrition-based models that are available to predict fecal excretions from cows fed mixed diets (forage plus concentrate). These models predict quantity and composition of excretion based on feed intake and the indigestibility of the consumed feed, but need to be verified for grass-based operations, where intake is difficult to quantify and pasture composition changes continuously.

In climates such as Iowa's, livestock producers need to have information that documents manure quantity and composition during grazing times as well as periods when pasturing is not possible and animals must be housed in buildings with collected and stored manure. This kind of information will allow graziers to make environmentally sound decisions regarding stocking rates and storage capacity of milking area wash water and collected manure. Therefore, current dairy herd data for grazing cows that assess the impact of diet and level of production are greatly needed to facilitate better management.

Project objectives were to:

1. Characterize the concentrations of nutrients related to water quality found in the collected manures,
2. Quantify seasonal fecal excretions from lactating Holsteins managed in an intensively grazed system,
3. Quantify the proportion of daily excretion that is voided on pasture versus voided in the milking area or other area where manure would be collected and stored,
4. Identify other important factors that influence manure quantity and nutrient concentrations,
5. Develop nutrient excretion prediction equations based on the important factors that were identified in objectives 3 and 4, such as body weight, level of production, and dietary intake which are specific to season in a grazing system, and
6. Provide published results that can be used by dairy producers as well as policy makers to develop animal density guidelines and storage needs.

Approach and methods

Observations from two dairy operations were used in this study. The Holstein herd used is owned and operated by Jed Becker in Cresco, Iowa, while Jersey data came from a herd on the Iowa State University dairy farm. Lactat-

ing cows, ten of each breed, representing a range of production levels and stages of production, were used for the project.

Fecal and urine samples were collected twice monthly from each of the 20 selected animals. The samples were used to determine nitrogen, phosphorus, and chemical oxygen demand (COD) composition of the excreta. Additionally, four cows at each location were fitted with fecal collection bags to allow for 24-hour collection, thereby providing measures of fecal quantity. At the same time, samples of diets, concentrates, and forages, as well as pasture clippings were collected. All samples were then frozen and stored for future analyses. Feed samples were evaluated for total nitrogen, total phosphorus, total potassium, moisture, and chemical oxygen demand. All feed analyses were conducted at a commercial laboratory.

Body weight measurements and milk yields were recorded monthly. Also, milk samples were collected monthly and analyzed for nitrogen content by a commercial laboratory.

Results and discussion

Breed effects reflected specific herd management practices as well as the differences between breeds. Although herd was a significant factor, the season (grazing or winter) did not significantly impact fecal production. Fecal extraction per kg live weight was not significantly different between breeds or herds.

Comparison of measured values to estimates of excretion illustrates that digestible intake values provide reasonable estimates of fecal production. Pasture forage from the Holstein herd ranged from 52 to 60 percent digestibility throughout the grazing season, while samples from the Jersey herd were slightly higher (58 to 62 percent). Fecal production was similar to estimated values, if typical high forage diets are assumed and measured digestibilities are considered. Winter rations and totally mixed rations (TMR) would be expected to have higher (and more desirable) digestibilities (65 to 72 percent) due to feed processing and the inclusion of more concentrates in the diet.

Conclusions

Based on comparisons to modeled manure production estimates, this work confirms that input-output models to predict fecal excretions work well for grazing herds. In this study, pasture analyses from the grazing herd indicated a typical diet digestibility of 58 to 59 percent. For the Holstein herd, diet digestibility was slightly higher (61 to 67 percent), reflecting the mixed pasture used in this system. Measured excretions reflect the values calculated from the models. Nutrient concentrations were different between breeds and between seasons. Variations in management practices between the two herds rather than genetics were likely to be responsible for the observed herd differences. Management as well as nutrient intake account for seasonal variations in nutrient concentrations of fecal and urine excretions.

Impact of results

As nutritionists continue to promote a nutrition-based approach to manure production predictions, the work conducted for this project will serve as a validation for the input-output approach in grazing systems. With the implementation of Comprehensive Nutrient Management Plans (CNMP), there will be increased interest in this approach.

Education and outreach

Updates and findings from this project have been and will continue to be shared with those involved in CNMP development, particularly at the NRCS (Natural Resources Conservation Service). The project investigators have used this work as part of a spreadsheet-based model that considers nutritional impacts on manure production. This spreadsheet is used in both undergraduate and graduate classes at ISU, and may be combined with programs currently available from ISU Extension. Information about the project has been presented at several field days as well as at nationalresearch meetings.

Stories about the project have appeared in *Resource* magazine of the American Society of Agricultural Engineers, *Jersey Journal*, and the *Iowa State University Dairy Research Report.*

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