

Precision Feeding to Reduce Nutrient Losses from Virginia Dairy Farms

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Project Director

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Project Objectives

The goal of this proposal is to reduce N and P pollution of the Chesapeake Bay through implementation of incentives for precision feeding, and demonstration of intensive dietary nutrient management strategies on Virginia dairy farms.

Results

At peak, there were 215 participating herds (29% of all Virginia dairy farms) with 35,064 cows (35% of all the dairy cows in Virginia). A total of 152 herds were active throughout the study with 27,019 cows; we retained 71% of herds and 77% of cows originally signed up.

Herds were signed up in groups, with staggered start dates for logistical reasons. Seventy one herds completed the full three years of the study, 113 herds completed two years and 163 completed one year¹. Farmers made significant improvements in dietary nutrient management as a result of the project. The initial period indicated that farms averaged ~30% overfeeding. The range in observed feeding rates was from 70% to 215% of the requirement. In year 1, 6% of herds were within 5% and 55% of herds received some incentive payment (Figure 1).

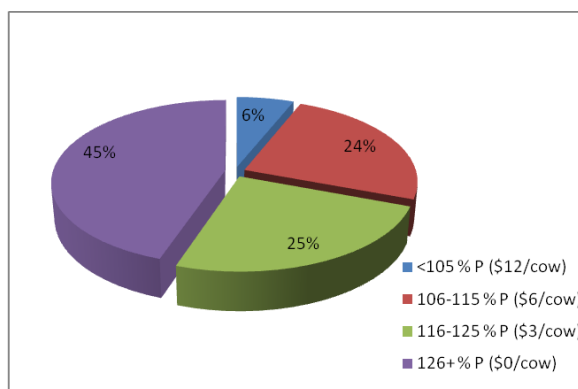


Figure 1. Herds meeting P feeding targets in year 1 (163 herds total).

¹These numbers don't necessarily mean farmers dropped out after one or two years. Farms were deemed to have completed one year when they completed a minimum number of samplings (five). Many farms were slow in sampling, some were on the project for the full three years but only completed enough samplings to be counted as completing one or two years.

As the project progressed a greater and greater portion of herds achieved targeted feeding rates for dietary P. In years 2 and 3, the proportion of herds achieving the lowest overfeeding increased to 13% (Figures 2 and 3), and a total of 70 % of herds (year 2) and 74% of herds (year 3) were feeding within 25% of requirements.

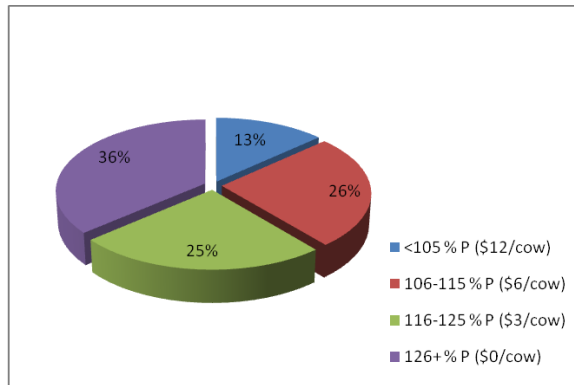
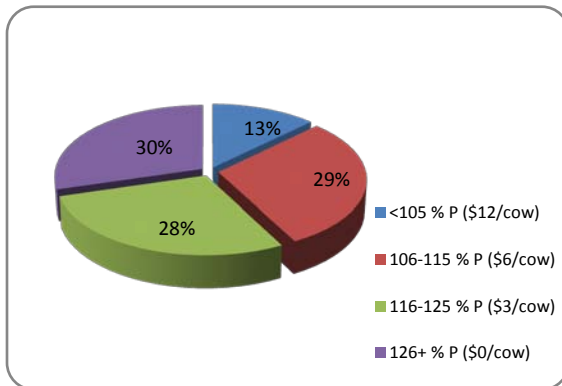


Figure 2. Herds meeting target feeding levels in year 2 (113 herds total)

Figure 3. Herds meeting target feeding rates in year 3 (71 herds)



Closer evaluation of these herds indicates that the degree of overfeeding is declining over time. Removal of supplemental P sources is the largest contributor to the initial reductions in TMR P content. Additional reductions will require more significant ration modifications, such as ingredient substitution or limited inclusion rates for some ingredients.

Intensive feed management study

Feeding nutrients more closely to a cow's nutrient requirements will reduce excretion of nitrogen and phosphorus by dairy cattle. We have evaluated the impact of improved feeding accuracy on whole farm nutrient balance through the use of feed management software (Figure 4) on 18 dairy herds located in Virginia. Use of this software enables producers to monitor forage and supplemental feed inventory; facilitate communication between nutritionist, manager and feeder through electronic means; and evaluate the feeder. This software can be used on the office computer and a handheld or truck mounted computer. Comparisons can be made between the amounts of ingredients

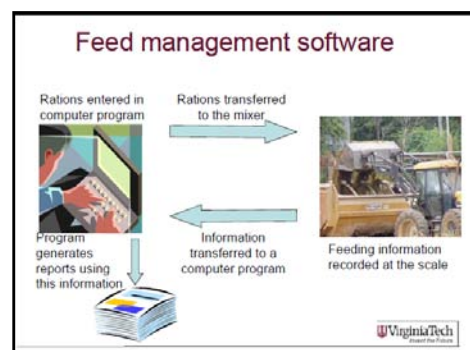


Figure 4. Feed management software use on farms

specified by the nutritionist and that the observed amount of each ingredient actually loaded by the feeder. This software addresses the problem of inaccurate feed delivery, a significant source of variation on farms. Inaccurate feed delivery occurs because scales on mixer wagons are rarely checked for accuracy, mixing consistency is assumed to be constant, and feeders are inadequately trained and monitored. Unfortunately producers overcome many of these obstacles in their feeding program by instituting a substantial safety margin. That is, they overfeed to ensure that the

cows' N and P requirements are met. Our hypothesis was that by improving farmers' ability to monitor and control feed delivery, producers would feel confident reducing those margins of safety, reducing overfeeding and improving whole farm nutrient balance.

Nine herds began using the TMR Tracker feed management software in 2006 and were compared to nine control herds not using feed management software. Over the course of the project, project personnel worked intensively with each intensive farm to address identified opportunities for improvement and to measure impact. Each of the treatment herds was visited on a monthly basis. Annual inputs of nitrogen and phosphorus from purchased feed, fertilizer and animals were recorded from 2005 through 2008. Nitrogen and phosphorus exported from the farm as milk, animals, sold manure and feed were recorded. Whole farm nutrient balance was calculated using University of Nebraska software.

Eight treatment herds and four control herds completed the three year project. Herd sizes averaged 290 and 325 for treatment and control farms. Daily milk production averaged 29.4 and 26.1 kg/d per cow respectively. Crop hectares averaged 326 and 284 respectively. Data were analyzed using proc mixed of SAS with repeated years, using 2005 data as a covariate.

Measures of surplus (input-output) and ratio (input/output) were analyzed per farm and per cow. Herds using feed management software for three years had significantly lower whole farm N balance on a per cow basis (Figure 5).

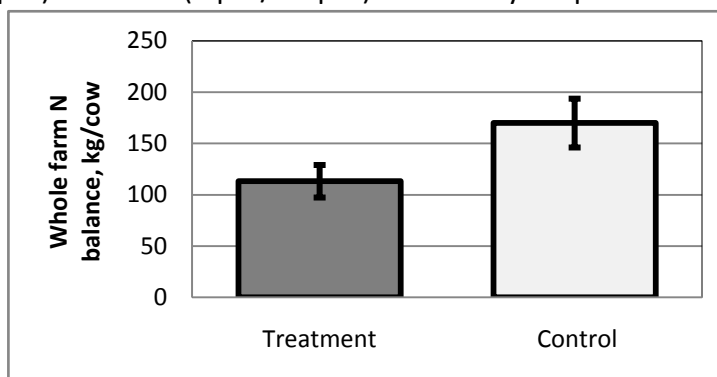


Figure 5. Whole farm N balance on farms using or not using feed management software

Annual P input/output ratios averaged 1.9 ± 0.9 (SD) and annual P surplus averaged 16.1 ± 2.6 kg/cow/yr. There was no effect of use of feed management software on these measures. The lack of consistent effect of feed

management software on whole farm P balance was due to a number of factors. Primary among these is the fact that many economical byproduct feeds are high in P (Table 1).

Table 1. P content of commonly used byproduct feeds

Feedstuff	Typical P content, % of DM
Distillers grains from ethanol industry	0.78
Corn gluten feed	1.0
Brewers grains	1.0
Hominy feed	0.50
Wheat middlings	0.80

Due largely to the educational programming conducted prior to and during this project it has become uncommon for dairy rations to be supplemented with inorganic P, leaving these byproduct feeds as the primary remaining cause of

overfeeding. This challenge of inexpensive high P byproduct feeds will only become more serious in the future with the expansion in ethanol production from various feedstocks and increased use of corn-based sweeteners. From a societal perspective, use of these high P byproducts as livestock feed is positive; the byproducts must be disposed of in some way and

recycling them as livestock feed is a better option than land filling them. With time, perhaps technology will be developed to extract P from feeds. Until then, this challenge remains.

Impacts

By the end of the project 163 herds had submitted at least the 5 feed samplings required to receive an annual report and have been considered for incentive payment. 116 of these herds qualified for incentive payments totaling \$126,773.58 (some farms refused payment so total payout was \$ 112,671.78). Herds enrolled in the project have received free feed testing valued at \$\$166,804.46. ***Cows enrolled on the project are being fed an average of 2.89 lbs of P less per cow per year, resulting in an estimated reduction in P₂O₅ excretion of 179,143 lbs per year.***

To quantify the extended impact beyond project herds we conducted a survey of nutritionists advising at least one herd in the project. The survey asks about their current P feeding practices, how many cows they formulate diets for ***not*** on the project, and most important, whether they are consistent in their P feeding recommendations in project and non-project herds. Fifteen nutritionists responsible for feeding an additional 56,280 cows replied, and all indicated that diets for non-project herds are fed similar dietary P to project herds. This implies ***additional reductions of 187 tons of manure P₂O₅ per year for a total reduction of 552,295 lbs of phosphate per year.***

Field observations by project staff

Two field staff hired as part of this combined DCR-NRCS project became assets to the project because they developed strong positive relationships with participating farmers. These staff members were a subtle but effective route to continually educate the farmers. We asked for their overall impressions of farmer's attitudes and practices related to precision feeding, and for any changes in those attitudes and practices. Their report (Craun and Winfield, personal communication) is pasted below.

"We noticed several significant changes in farmer's attitudes during the course of our visits during the 'P' project. In our estimation, the most significant (changes) were in farms located east of the Blue Ridge Mountains. We found many farmers at the beginning of the project were feeding a 'standard' dairy supplement which contained high levels of phosphorus. Most were not aware that they were incurring additional feed costs for something they did not need. We felt like many of these farmers mentioned this to their feed suppliers and several months later we noticed that 'standard' dairy formulations changed to reduce or eliminate supplemental inorganic phosphorus. We also noticed a general softening of attitudes towards phosphorus management in feed supplementation."

How might this incentive payment program be converted to a less labor intensive cost-share program?

Project personnel have given a great deal of thought to alternative approaches to converting this grant-funded project to a sustainable cost-share program. We believe that subsidy of feed analysis is an important component. For many farmers, feed analysis is a hidden cost because their feed company provides the analysis at no charge, but for those paying their own analytical bills, subsidy of these costs was perceived as being of great value while adding relatively little to program costs. Subsidy of these analytical costs allows the agency involved to monitor implementation of the practice. It also assures that the necessary "wet chemistry"

analytical method is used rather than the less expensive but inaccurate (for minerals) NIR measurement. The improvements in N whole farm nutrient balance are an added benefit of subsidizing feed analysis. If the type of extensive sampling and analysis conducted in this study isn't feasible, even a focus on just sampling commodity feeds (especially byproduct feeds) would yield great return because variability in nutrient content in these feeds is significant.

The carrot of the incentive payment appears to be very important to producers, at least initially. While we saw good persistence of revised feeding practices one year beyond the availability of the incentive payment it is unclear how long this effect would persist. As feed prices fluctuate, the incentive payment provides one way to keep dietary P content among the factors considered in ration formulation.

The major question is the degree of "hand holding" necessary for successful precision feeding implementation. Personnel costs were by far the most expensive component of the project. There is evidence within our work suggesting that more intensive intervention yields greater progress in precision feeding. The eight herds that implemented feed management software and were trained on its use and interpretation of results adopted precision feeding practices more quickly and 7 of 8 earned incentive payments during the study.

However, for dietary P management to become a sustainable long term cost-share program the opposite must occur – labor efficiencies must be realized. We see two ways to streamline the project. For the first we again asked our field staff how they felt we could achieve some of the same results with less personnel time. They concluded that a minimum level of human contact was necessary but that it could be limited to an initial visit and then one visit per year to provide feedback on the farmer's results, collect a "check sample" to confirm that the samples farmers submitted through the year were representative of rations actually being fed. Best results might be achieved if the initial visit was by a known and trusted farm advisor (for instance, the area dairy extension agent) along with local staff who might conduct the annual check samples. It is possible that the annual check test could be conducted by local FSA staff (similar to the annual checks associated with BMPs like cover crops) or by local SWCD or NRCS staff. This would reduce the field labor requirement significantly while retaining the direct contact we believe is necessary for success of feed management BMPs.

One related factor influencing adoption of this practice is continued and even improved communication with local, state and federal agency staff on this subject. Possibly because of significant turnover among field staff, many remain unaware of the fundamentals of nutrition and the scope of the problem.

Implementation of the project could also be streamlined on the data management end. In the current project farmers submitted samples to be analyzed every two months. We feel that frequency is needed to provide farmers good information on their practices and feedback as they make changes. Our approach to summarizing the data and calculating eligibility for incentive payment was quite accurate biologically, but overly labor intensive. We collected herd information with every feed sample, including data on current body weight, milk yield, feed intake. This allowed us to express dietary P as a percent of the requirements for that specific herd. This approach accounts for the biological reality that herds' requirement for P varies. Our approach is, therefore, more biologically accurate. The labor involved, however, in collecting and collating this data is probably not justifiable in the context of a long term cost-share program. A simpler and still useful approach would be to simply define targets in terms of the phosphorus content of the ration making simplifying assumptions about milk yield, body weight

and feed intake. For instance, cutoffs of 0.38%, 0.40, and 0.42% P for a three-tier incentive payment system might be appropriate.

Role of feed management software

Feed management software is a useful tool to improve feed feeding management. With these, farmers can monitor the performance (loading accuracy, consistency) of their staff in charge of feed mixing and delivery. This provides opportunity to reduce overfeeding and reduce ration cost. There is clear opportunity to reduce N surpluses through use of this software. Some herds experienced significant improvements in P balance but these were not consistently observed. This software encourages farmers and their staff to establish standard feeding protocols regarding load order and mix time, and to monitor equipment including maintenance reminders. This software supports better communication with nutritionist via electronic reports. A key component of the success of the software is its use in monitoring the accuracy and precision in loading feed ingredients. In addition to reducing overfeeding from a biological perspective, the farm can realize improvements in reducing feed costs which is a more positive motivating force.

Publications and reports during current project period

Significant educational programming has been completed as part of this project. A total of 3 national webcasts (webinars), 8 conference presentations, 4 peer-reviewed extension publications, 5 newsletters, and 2 abstracts were presented to farmers and their advisors. All publications, presentations and online multimedia presentations associated with this project are listed below in reverse chronological order.

- R. E. James. Nutrition Management, Making Money, and Protecting the Environment. Presented at Southeast Dairy Management Conference. November 3 & 4, 2010. Macon, GA. Proceedings will be posted to <http://www.ads.uga.edu/extension/dairycattle/>
- J. H. Harrison, Stallings, C. S., James, R. E., M. H. Hanigan. Precision Phosphorus Feeding for Dairy Cattle. March 19, 2010 national webcast posted at http://www.extension.org/pages/Precision_Phosphorus_Feeding_for_Dairy_Cattle
- C. S. Stallings, K. F. Knowlton, R. E. James and M. D. Hanigan. Using Incentive Payments to Reduce Overfeeding of Phosphorus. Land Grant and Sea Grant National Water Conference, SC. February 21-25, 2010. Retrieved August 12, 2010 from <http://www.usawaterquality.org/conferences/2010/PosterPDF/Stallings.pdf>
- B. Stewart, B. Cox, R. E. James, C. Stallings, K. F. Knowlton, and M. Hanigan. Impact of feed management software on feeding management and whole farm nutrient balance of Virginia dairy farms. Land Grant and Sea Grant National Water Conference, SC. February 21-25, 2010. Retrieved August 12, 2010 from http://www.usawaterquality.org/conferences/2010/WednesdayPDF%27s/Concurrent_Sessions/SessionQ_120pm-5pm_AnimalAgriculture/James.pdf
- C. S. Stallings. Development of feed management plans. Virginia State Feed Association and Nutritional Management Cow College. February 19, 2010. Available online at http://www.vtdairy.dasc.vt.edu/pdf/cow_college/2010/18%20stallings%20Feed%20Management%20future.pdf

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- Stallings, C. C., K. F. Knowlton, R. E. James, and M. D. Hanigan. 2009. The Virginia Feed Phosphorus Monitoring Project. J. Dairy Sci. 92: (E-Suppl. 1) 350.
- In February 2009 Virginia Tech co-sponsored the Virginia State Feed Association Conference & Nutritional Management "Cow College". Multiple speakers presented information on feed management practices to improve nutrient utilization by lactating dairy cattle. Articles can be retrieved at <http://www.vtdairy.dasc.vt.edu/2009%20Cow%20College.htm>
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