Phosphorus Mass Balance on Livestock and Poultry Operations

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Disclaimer
This fact sheet reflects the best available information on the topic as of the publication date.
Date 5-25-2007

This Feed Management Education Project was funded by the USDA NRCS CIG program. Additional information can be found at http://www.puyallup.wsu.edu/dairy/joeharrison/publications.asp
This project is affiliated with the LPELC http://lpe.unl.edu

USDA United States Department of Agriculture

NRCS Natural Resources Conservation Service

Introduction

This fact sheet has been developed to support the implementation of the Natural Resources Conservation Service Feed Management 592 Practice Standard. The Feed Management 592 Practice Standard was adopted by NRCS in 2003 as another tool to assist with addressing resource concerns on livestock and poultry operations. Feed management can assist with reducing the import of nutrients to the farm and reduce the excretion of nutrients in manure.

The Natural Resources Conservation Service has adopted a practice standard called Feed Management (592) and is defined as “managing the quantity of available nutrients fed to livestock and poultry for their intended purpose”. The national version of the practice standard can be found in a companion fact sheet entitled “An Introduction to Natural Resources Feed Management Practice Standard 592”. Please check in your own state for a state-specific version of the standard.

Mass balance is calculated as the difference between imported and exported mass across the farm boundary. Estimating mass balance can provide critical information for (comprehensive) nutrient management planning and to manage the movement of nutrients and manure. Estimation of whole-farm P mass balance is used to determine the acres of land needed for crop production to use manure P. Environmental risk to surface and ground waters is increased if the amount of P imported into the farm (e.g., from fertilizers, feeds, and animals) exceeds the amount of P exported from the farm (e.g., crops, animals, manure, milk, meat, eggs, and fibers).

In Table 1 are estimates of P excretion derived by mass balance calculations using standard diets, animal performance, and the acres needed for land application at a crop removal rate of 50 pounds P_2O_5/acre per year. Mass balance estimates vary among farms, depending upon specific inputs and outputs, and should be calculated specifically for each farm when doing nutrient management planning.

Table 1. Examples of annual phosphate (P_2O_5) excretion and acreage needed for various livestock enterprises per 1,000 head of production to maintain zero P mass balance (imported P = exported P) annually.

Livestock Enterprise	Pounds P_2O_5 Excreted	Acres needed
Growing-finishing beef	17,500	350
Horses	22,000	440
Lactating dairy cows	86,000	1,720
Dairy heifers	27,000	540
Laying hens	1,200	24
Cow-calf beef	48,000	960
Sheep	13,500	270
Swine breeding herd with phytase	37,000	740
Swine growing-finishing with phytase	3,600	72
Turkeys with phytase	1,300	26

Ways to affect P mass balance

Farms may consider moving manure off site to reduce P mass balance if not enough acreage is available. Additionally, potential feeding strategies to reduce P balance (and excretion), feed costs, and necessary land base include the following.

1. Routinely complete laboratory analyses of feeds and re-balance rations as needed to meet animals' P requirements.

2. Formulate rations to meet the animal's P requirements for maintenance, lactation, growth, and pregnancy. In general for a lactating Holstein cow, 1 gram of P for each pound of milk produced is sufficient to meet these combined requirements. Based on this, ration P should equal 0.32 to 0.38% in DM depending on feed intake and milk yield (NRC, 2001). Greater concentrations are not necessary unless feed intake is depressed.

3. Beef and dairy cattle rations may not need P supplementation at all to meet the animals' requirements if basal ration ingredients have high P concentrations. Discontinuing P supplementation may reduce land

base required by 25 to 50% (depending on the amount of over-supplementation in the original feeding program).

4. If typical rations (e.g., corn silage, soybean meal, alfalfa, and corn grain) contain more P than needed to meet requirements, and if land base is limiting, alternative feedstuffs should be considered. The cost of using alternative feedstuffs may be less than the cost of using common "least-cost" feeds and managing excess manure P.

5. Swine and poultry are able to absorb only part of the P in diets, so formulate based on "available P." Grains for swine and poultry can vary from 14 to 50% in available P. In contrast, over 90% of ration P is available to cattle and sheep due to rumen microbial phytase.

6. Supplemental phytase in corn-soybean meal based-diets for swine and poultry increases the P availability so that 25 to 35% less total ration P is needed.

7. Pelleting and reducing the particle size of rations can increase the efficiency of P use by swine and poultry by 5 to 10%.

8. Formulating rations for specific production phases, genotypes and genders. "Phase- feeding" programs for growing swine, poultry and lactating dairy cows can reduce P imports and excretion at least by 5 to 10%.

References

National Research Council. 2001. Nutrient Requirements of Dairy Cattle. 7th rev. ed. Natl. Acad. Sci., Washington, DC.

Project Information

Detailed information about training and certification in Feed Management can be obtained from Joe Harrison, Project Leader, jhharrison@wsu.edu, or Becca White, Project Manager, rawhite@wsu.edu.

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