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Feed Program Impact on Land Requirements for Managing Manure Nutrients from a Feedlot

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Decisions relative to protein and phosphorus ration content of diets for a 1,000 head feedlot can alter the land requirement for managing manure nutrients from 500 to 1,250 acres.

Summary

Using data from UNL feeding trials (1998 Nebraska Beef Report, pp. 86-88) designed to compare the impact of protein and phosphorus intake on nutrient excretion, an estimate is made of the land requirement for manure application. A balanced diet formulated using the 1996 NRC was compared to other typical feed rations. The standard industry ration required an additional 100 and 400 acres of land to manage the additional manure nitrogen and phosphorus excreted, respectively, by a 1,000 head feedlot. A spreadsheet tool is introduced for estimating land requirements for manure produced by alternative feeding programs.

Introduction

Is sufficient land available for managing the nutrients in manure? This question is fundamental to sound environmental management of manure. It is being asked by the Nebraska Department of Environmental Quality (NDEQ) as permit applications are reviewed, and it should be addressed by any cattle producer housing livestock in confined facilities.

Current NDEQ permit procedures for livestock facilities require producers to document adequate land base available for manure application based upon manure nitrogen (N). Phosphorus (P) based management of manure typically requires significantly greater land area than N-based management. Currently, land requirements are not regulated based upon P. However, growing pressure exists for greater regulation of P buildup in soil. NDEQ requires that a producer submit soil tests for soil P levels, minimum of one composite per 40 acres. However, no upper limits for soil P level have been established at this time in Nebraska.

Many factors affect manure nutrient excretion and eventual land requirements for agronomic nutrient application. Decisions at the feed bunk will play a critical role. To examine the impact of diet on land requirements, UNL feed trial and manure excretion data were used.

Procedure

In the 1998 Nebraska study (1998 Nebraska Beef Report, pp. 86-88), the "balanced" diet formulated using the 1996 NRC was reported to not impact gains, slightly improve feed efficiency and reduce manure nutrient excretion compared to a more standard industry feed ration (control diet). Using these rations, manure nutrient-excretion was estimated by performing a "nutrient balance" on the animal. The nutrient balance approach estimates nutrient excretion by subtracting animal retention of nutrients in weight gain from nutrient consumption in the diet. For beef cattle, National Research Council procedures are used for estimating N and P retention by beef cattle.

To account for nutrient losses, 55% of the N and 95% of the P was assumed retained in the manure after volatilization and feedlot runoff losses based upon standard Natural Resource Conservation Service estimates for feedlots. After losses were considered, land requirements were estimated, assuming continuous corn averaging 160 bushels per acre. All crop nutrient needs were assumed to be met from manure only.

Results

Protein not used for animal maintenance/growth needs will be excreted as urea or organic N in the manure. Typically, 85 to 90% of the N fed to animals as protein will be excreted by beef cattle in feedlots. Feeding protein in excess of animal requirements adds to the N in the manure.

An estimate of nutrient excretion and land requirements is presented for the control and balance rations, assuming a N based application rate (Table 1). Twenty percent more land is needed for manure N management for the higher protein control diet. For a 1,000 head feedlot, an additional 100 acres is needed for managing the N in manure.

Commonly observed ranges for P levels in feedlot rations can have an even

Table 1. Changes in land application area needs for a 1,000 head feedlot as a result of difference in diet protein content.

Crude protein dietary options	Manure nitrogen		Land requirement for managing N (ac)[a]
	Excretion (lb. N/yr.)	After losses (lb. N/yr.)	
Balanced (11.5%)	134,000	72,000	510
Control (13.5%)	161,000	87,000	610

[a]Assumptions:
- Nutrient use in crop production assumes continuous corn (160 bushels/acre) and all crop nutrient requirements are met from manure.
- Assumes that 55% of the N and 95% of the P are retained in the manure collected for land application.

Table 2. Changes in land application area needs as a result of differences in diet P content.[a]

Phosphorus dietary options	Manure phosphorus Excretion (lb. P/yr.)[b]	Manure phosphorus After losses (lb. P/yr.)[b]	Land requirement for managing P (ac)
Balanced (0.22% P)	13,200	12,600	510
Control (0.35% P)	24,000	23,000	930
Diet using corn processing by-products (0.45% P)	33,000	31,000	1,250

[a]See Assumptions used for Table 1.
[b]To obtain phosphorus fertilizer equivalent, multiply P value by 2.29 to obtain P_2O_5 equivalent.

Table 3. Manure nutrient excretion based upon two alternative procedures for estimating manure nutrient excretion.

Estimating procedure	N excretion estimate lb. N/year	P excretion estimate lb. P/year.
Book value		
ASAE[a]	105,000	29,800
NRCS[b]	97,000	30,400
Nutrient balance[c]		
Control diet	160,800	24,000
Balanced diet	133,700	13,200

[a]American Society of Agricultural Engineers. 1999. ASAE Standards 1999. Published by American Society of Agricultural Engineers. St. Joseph, MI.
[b]Soil Conservation Service. 1992. Agricultural Waste Management Field Handbook. United States Department of Agriculture. Publication No. 651.
[c]Nutrient accretion is estimated from National Research Council. 1996. Nutrient Requirements for Beef Cattle. National Academy Press, Washington, D.C.

greater impact on land requirements (Tables 1 and 2). A diet containing .35% P will result in 50% more land needed for managing manure P than is needed for managing the N. For the control diet, an additional 290 acres of corn production was required for a 1,000 head feedlot.

A ration containing a 0.22% P results in almost half the manure P excretion as compared to a diet with 0.34% P (Table 2). In addition, 420 acres less land was required for a 1,000 head feedlot. The land requirements based upon P application rate are reasonably close to those required for an N-based application rate at this lower dietary P level. This should substantially reduce the buildup of P in soils and the resulting high soil P tests commonly observed around many feedlots.

It is also important to recognize the impact of alternative feeds such as the by-products of corn processing (Table 2). Use of these feed sources can result in dietary P levels of 0.45%. The resulting excretion of excess P will require almost 2.5 times more land for managing the P in manure as compared to the 0.22% P diet.

Typically, a book value estimate is used for manure nutrient production based upon accepted references relative to manure excretion. The weakness of a book value approach is that it assumes all beef cattle are fed the same ration and perform the same. A comparison of the two procedures for estimating manure nutrient production is illustrated in Table 3. Two common references for a book value estimate of nutrient excretion result in a lower estimate of N excretion as compared to the nutrient balance procedure. Conversely, the book value procedure estimates a greater nutrient excretion than the nutrient balance procedure for P excretion. The book value procedures estimate more P excretion than the animals are consuming for both the control diet (29,000 lb. of P) or balanced diets (18,600 lb. of P). A nutrient balance procedure should provide a more realistic estimate of manure nutrient excretion.

The implication of the nutrient balance procedure is that it will recommend the need for greater land requirements for managing N than current book value estimating procedures used by Nebraska Department of Environmental Quality. It also suggests the need for a smaller land base for managing P, although this is not a regulated issue at this time. If regulatory procedures base land requirements upon P, it will be to the producers' advantage to use the nutrient balance procedure.

The previous estimates of land application area needs may vary for individual farms for a variety of reasons. To develop a better understanding of land needs for an individual situation, a "Manure Nutrient Inventory" spreadsheet has been developed to assist Nebraska livestock producers and advisors. The spreadsheet can be accessed via the Internet from a home computer and used with Microsoft Excel (version 5.0 or later). The spreadsheet and a set of instructions are available at:

http://www.ianr.unl.edu/manure

Many Cooperative Extension and NRCS offices also have access to this same tool and would likely be able to assist one in reviewing an individual situation.

The purpose of the Manure Nutrient Inventory Spreadsheet is to estimate the excretion of nutrients by livestock and poultry, the quantity of nutrients remaining after losses and the land needs for using those nutrients at agronomic rates. A producer can evaluate the impact of 1) herd size, 2) feeding program, 3) method of storage and/or treatment of manure, 4) method of land application, and 5) crop selection, rotation and yield on estimated land requirements.

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