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Nutrient Balance on Nebraska Livestock Confinement Systems

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Summary

Managing the environmental risk associated with livestock production is a significant challenge. The degree of imbalance between the amount of nutrient input and nutrient output for a livestock operation provides insight into the underlying causes of nutrient-related environmental challenges. A nitrogen and phosphorus balance was constructed for 33 Nebraska livestock operations (including 17 swine operations). On most farms, substantially more nitrogen entered the farm (through purchased feed, fertilizer, etc) than left it in the form of animals, crops and manure sold. Most farms also had an accumulation of phosphorus. Size of the operation and the degree of integration between livestock and a cropping operation provided only limited explanation of the variation in nutrient balance observed among the individual operations.

Introduction

Nitrogen (N) and phosphorus (P) losses to surface and groundwater are critical water-quality issues associated with livestock manure. In Nebraska, approximately 320,000,000 pounds of N and 230,000,000 pounds of P are excreted annually by livestock and poultry. A 1995 General Accounting

Table 1. Average characteristics and nutrient balance for 33 Nebraska livestock farms

	<250 animal units[1]	250-2500 animal units[1]	>2500 animal units[1]
	Farm Characteristics		
Number of livestock units	12	13	8
Animal units (1000 lb.):	154	668	7597
Cropped acres	578	932	1819
Crop acres per animal unit:	3.7	1.4	0.2
	Nitrogen Balance (tons/year)		
Inputs	38	102	922
Managed outputs	-26	-42	-405
Inventory change[2]	-3	-9	-2
N Imbalance ...tons/year	9	51	514
% of inputs	26%	55%	56%
	Phosphorus Balance (tons/year)		
Inputs	5.1	13.2	180
Managed outputs	-4.1	-8.7	-113
Inventory change[2]	-0.4	-1.4	-1
P Imbalance ...tons/years	0.6	3.1	66
% of inputs	14%	26%	37%

[1]One animal unit represents 1,000 lb of live bodyweight.
[2]Negative inventory change indicates an increase in inventory and a reduction in nutrient balance.

Office report to the United States Senate suggested manure was the source of 37 percent of all N and 65 percent of all P going into watersheds in the central states, including Nebraska.

An underlying cause of the environmental problems associated with livestock production is the accumulation of nutrients on livestock farms. A large fraction of the nutrients consumed by livestock does not leave the farm as meat, but remains on there in manure. An accumulation of nutrients on livestock operations would represent contributing factor to the industry's nutrient-related water-quality challenges.

The intent of this study was to define a whole farm nutrient balance on Nebraska livestock operations. The study also attempted to identify characteristics or management practices minimizing the accumulation of nutrients on farm.

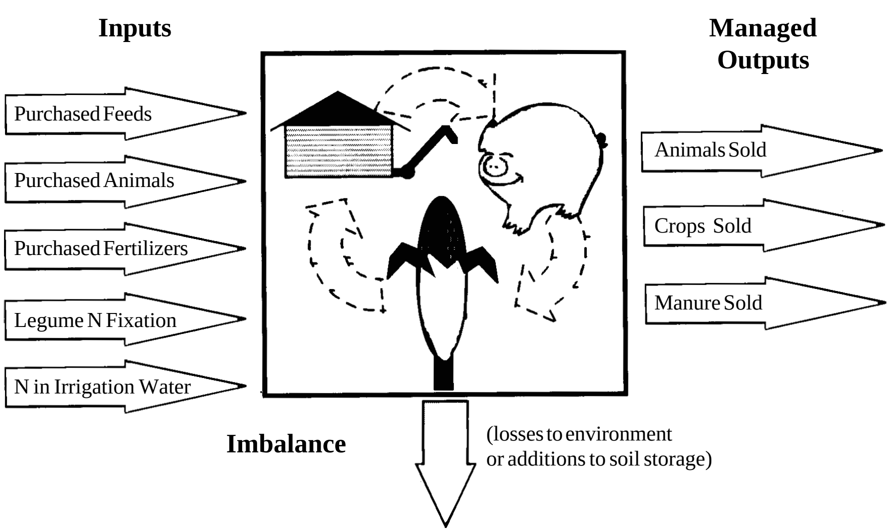

Figure 1. A whole farm nutrient balance considers multiple nutrient inputs and managed outputs for a livestock farm.

Procedure

An accounting of nutrient inputs (purchased feed, fertilizer, animals, biologically fixed nitrogen and nitrates in irrigation water) and managed nutrient outputs (animals, crops and other products moved off farm) was completed for 33 livestock operations (Figure 1). Changes in farm inventory of nutrient inputs and outputs were included in the analysis. The accounting period was for one year (1995 for six operations; 1996 for 27 operations). The degree of imbalance was estimated based upon the differences in inputs managed outputs, and inventory changes. The calculated imbalance in nutrients can either be lost to the environment (i.e., nitrate leaching to groundwater, or ammonia volatilization) or added to soil storage mechanisms (i.e., increasing soil phosphorus levels, which increase the risk of phosphorus in surface runoff).

Results and Discussion

The average nutrient balance for all 33 farms is summarized in three distinct size groupings in Table 1. The magnitude of nutrient inputs, managed outputs and imbalance increased with livestock operation size. The relative nutrient imbalance (percent of inputs) also increased with size of the operation and was more than two-fold greater for farms with more than 2,500 animal units as compared to farms with less than 250 animal units (see "percent of inputs" in Table 1).

Phosphorus balance provides a better indication as to when a sustainable nutrient balance has been achieved from a water quality perspective. The only environmental impact of a high P imbalance is on water quality. Nitrogen can be lost through volatilization (a relatively benign environmental loss) or to surface and groundwater (a more damaging environmental loss). Substantial losses of ammonia N by volatilization is often masked when a reasonable N balance is achieved. For this

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reason, the following comparisons will focus primarily on P balance.

The observed nutrient imbalance cannot be explained strictly by the size of the livestock operation (see Figure 2). Substantial variation in both N and P balance existed among individual farms. Although larger livestock units tend to have greater nutrient imbalances, farm size provides only a limited explanation for the observed variation. Some of the largest nutrient imbalances were observed for farms with 100 to 1,000 animal units.

A neutral or negative P balance was observed for several of the smaller livestock operations, indicating equal or greater managed outputs than inputs of P (Figure 2). These farms tended to have fewer livestock numbers and larger land bases. Farms with negative P balances were commonly removing more P from the soils as crops than was added as commercial fertilizer or manure. These farms were drawing upon soil phosphorus reserves during the year the nutrient balance was estimated.

Several larger livestock operations also had a relatively small P imbalance (see Figure 2). A closer review of data from three of those farms (cattle feedlots) indicates an active effort to move manure to neighboring crop producers. Marketing of manure nutrients increased the managed outputs of nutrients, contributing to an improved nutrient balance.

The degree of integration of crop and livestock enterprises is often considered an indicator of the relative potential for environmental problems (Figure 3). For the 33 participating farms, nutrient balance shows substantial variation when plotted against the density of livestock-to-land-base ratio. Lower P imbalances were more common for livestock operations with larger relative land bases. However, the three previously mentioned cattle feedlots, all with very limited land resources, were capable of achieving a reasonable balance in P inputs and managed outputs. The degree of integration of crop and livestock production provided only limited explanation

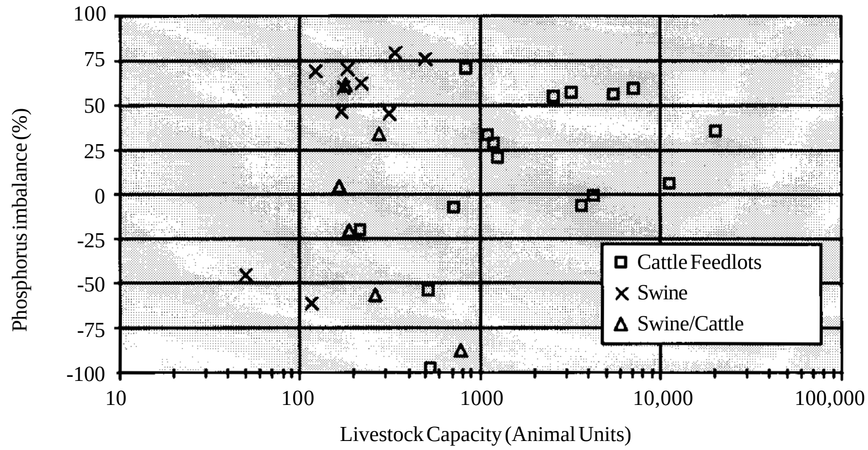

Figure 2. Phosphorus balance versus size for 33 Nebraska livestock operations.

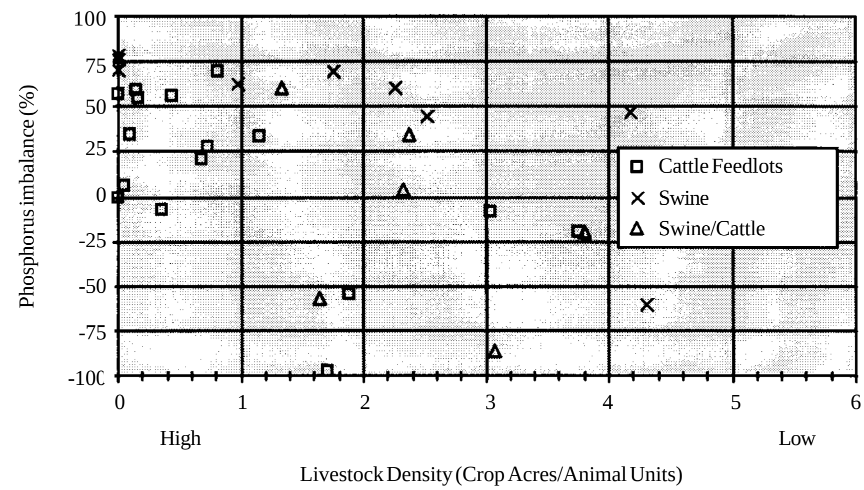

Figure 3. Phosphorus balance versus crop land to animal density for 33 Nebraska livestock farms.

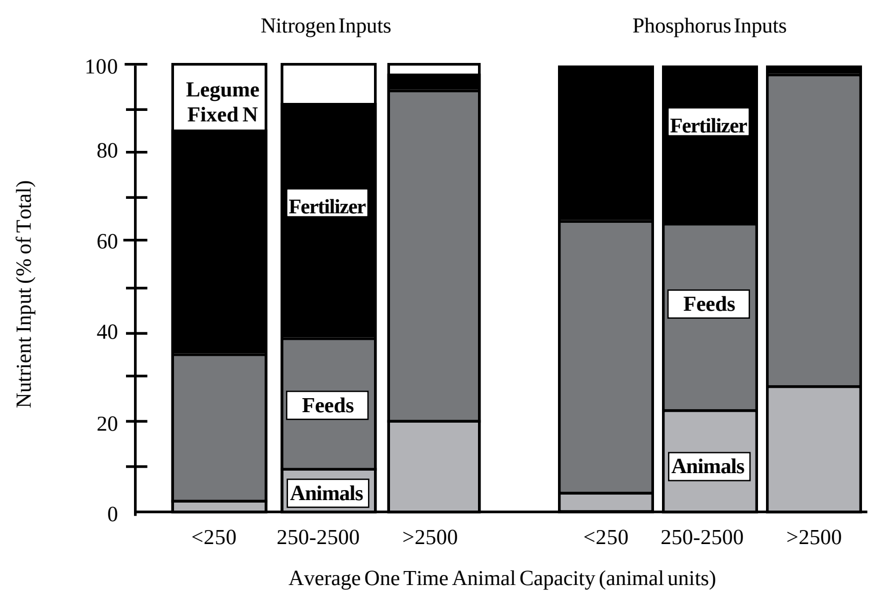

Figure 4. Relative sources of nitrogen and phosphorus inputs of different sized units.

for the variation observed.

The source of nutrient inputs to livestock operations is illustrated in Figure 4. Purchased animal feeds were a significant source of the N and P inputs. Nitrogen inputs as feed varied from 33 to 77 percent of total N inputs for farms with less than 250 animal units and more than 2,500 animal units, respectively. Phosphorus inputs as feed showed less variation, ranging from 62 to 71 percent of total inputs for the same livestock groupings. Livestock units < 250 animal units were predominantly swine operations. The addition of inorganic P to swine diets contributed to purchased animal feed being a primary source of P inputs.

Commercial fertilizer was the most significant N input for livestock operations with < 2,500 animal units. Fertilizer was also an important source of P input for these same farms. Commercial fertilizer was an insignificant nutrient input for the livestock operations with > 2,500 animal units (2 percent of nitrogen inputs and 1 percent of phosphorus inputs).

Industry Implications

This study highlights several critical implications relative to managing livestock operations in harmony with the environment.

1. Evaluating livestock systems nutrient balance from a whole-farm perspective provides a more complete picture of the driving forces behind nutrient-related environmental challenges. Accumulation of nutrients resulting from an imbalance of nutrient inputs and outputs is a problem for many, but not all, Nebraska livestock operations.

2. An assessment of environmental risk based strictly on factors such as livestock herd size or livestock to crop land density oversimplifies a complex issue. Both factors provided a very limited explanation of the variation in observed nutrient balance. Neither smaller-sized livestock operations or operations better integrated with crop production insured a "sustainable" nutrient balance resulted.

3. New strategies are needed for addressing the risk associated with nutrient accumulations on livestock operations. Management practices which stop nutrient leaks (i.e., feedlot runoff control) will not resolve nutrient related problems associated with livestock production. Nutrient management planning that focuses on improved utilization of manure nutrients to replace commercial fertilizers address only part of the nutrient inputs to most livestock operation. Future nutrient planning efforts should focus on improving whole-farm nutrient balances by:

- Reducing purchased feed nutrient inputs,
- Expanding managed outputs of nutrients by marketing manure nutrients to off-farm customers.

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