Nutrient Balance on Nebraska Feedlots

Richard K. Koelsch
University of Nebraska-Lincoln, rkoelsch1@unl.edu

Gary Lesoing
University of Nebraska-Lincoln, glesoing2@unl.edu

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Nitrogen and phosphorus inputs in excess of managed outputs on many Nebraska feedlots is a driving force behind the environmental challenges faced by the industry.

Summary

A balance between the nutrient inputs and the managed nutrient outputs balance was constructed for 16 Nebraska feedlots to provide insight to potential environmental risks. Substantial nitrogen and phosphorus imbalances were observed for many participating feedlots. Size of the livestock operation and the degree of integration of livestock with a cropping operations provided only limited explanation concerning nutrient balance variations observed among the feedlots. Substantially improved nutrient balances were achieved by those feedlots marketing manure nutrients to off-farm customers. A "sustainable" nutrient balance appears possible for larger feedlots actively marketing manure nutrients.

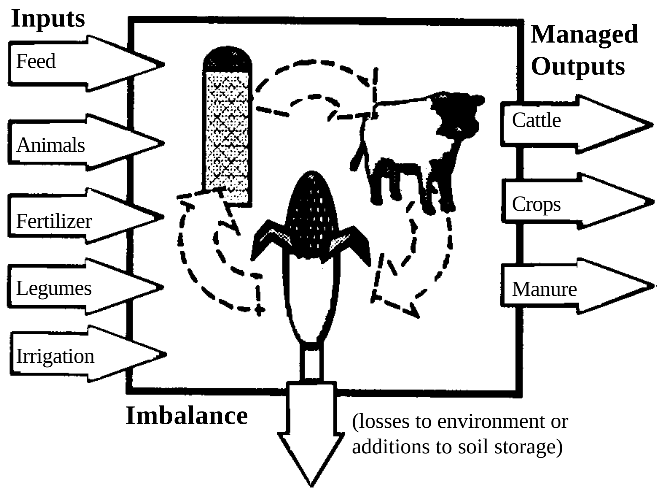

Figure 1. Balance Between Nutrient Inputs and Managed Outputs for a Feedlot.

Introduction

Nitrogen and phosphorus losses to surface and groundwater are critical water quality issues associated with livestock manure. In Nebraska, livestock and poultry excrete approximately 320,000,000 pounds of nitrogen and 230,000,000 pounds of phosphorus annually. A 1995 GAO report to the United States Senate suggested manure was the source of 37% of all nitrogen and 65% of all phosphorus into watersheds in the central states, including Nebraska.

An underlying cause to the environmental problems associated with livestock production is the accumulation of nutrients on livestock farms. A large fraction of nutrients consumed by animals does not leave the farm as meat. Klopfenstein has previously reported yearling cattle retain only 10.4% and 18.5% of the nitrogen and phosphorus fed, respectively. Most nutrients fed to animals remain on the farm in manure.

The intent of this study is to define the nutrient balance on Nebraska livestock operations. The study also attempts to identify characteristics or management practices minimizing the accumulation of nutrients on 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 16 cattle feedlot operations (Figure 1). Changes in farm inventory were included in the analysis. The accounting period was for one year (1995 for four feedlots and 1996 for 12 feedlots). The degree of imbalance was estimated based upon differences in inputs, managed outputs and inventory changes. The calculated imbalance in nutrients can either be lost to the environment (nitrate leaching to groundwater, nitrogen in surface water runoff or ammonia volatilization) or added to soil storage mechanisms (increasing potential for phosphorus losses in surface runoff).

When available, measured nutrient concentrations values for individual feedlot nutrient inputs and outputs were used. Generally, a nutrient analysis was available for purchased feeds and marketed manure and sometimes for crops sold. Literature values were used for other nutrient inputs and outputs. Feed values from the 1996 NRC Nutrient Requirements of Beef Cattle were used for crops and feeds with no individual farm nutrient analysis.

Results

The nutrient balance is defined (Table 1) for two integrated crop and livestock operations (Farms 1 and 2) and two predominantly cattle feedlot operations (Farms 3 and 4). The magnitude of the nitrogen (41 tons to 2,180 tons per year) and phosphorus (-4 to +280 tons per year) accumulation on these four farms was significant. Farms 1 and 2 exhibited a smaller relative nitrogen imbalance (approximately 50% of inputs) and a negative or neutral phosphorus balance. Both have a substantial land base relative to the animal numbers. Farms 3 and 4 relative nutrient imbalances were larger (approximately 75% of nitrogen inputs and 60% of phosphorus inputs). The relative reliance on home-grown feeds (Farms 1

Table 1. Nitrogen and phosphorus balance for four Nebraska feedlots.[a]

	Farm 1	Farm 2	Farm 3	Farm 4
		Farm Characteristics		
Animal Units (1000 lb.)[b]:	540	3770	4330	20,650
Crop Acres Per Animal Unit:	1.7	0.4	0.0	0.1
		Nitrogen (tons/year)		
Inputs	94	130	516	2852
Managed Outputs	-46	-68	-135	-639
Inventory Change	-8	0	0	-30
N Balance ...tons	41	62	381	2,183
%	47%	48%	74%	77%
		Phosphorus (tons/year)		
Inputs	6	18	94	459
Managed Outputs	-8	-19	-37	-168
Inventory Change	-2	0	0	-9
P Balance ...tons	-4	-1	57	280
%	-98%	-7%	61%	62%

[a]This nutrient balance assumes no export of manure nutrients to off-farm customers. Any corrections to this assumption will be made in Table 3.

[b]Animal units represents the average animal capacity of a feedlot times the average animal weight divided by 1,000. A 2,000 head feedlot average capacity with an average animal weight of 950 pounds represents 1,900 animal units (2,000 X 950 / 1,000 = 1,900).

Table 2. Nutrient balance for a 4,500 head feedlot with no land base and 20,000 head feedlot with limited land base with and without off-farm marketing of manure nutrients.

	Is Marketing of Manure Nutrients To Off-Farm Customers Credited?			
	Farm 3		Farm 4	
	NO	YES	NO	YES
Nitrogen Imbalance[a]	381 t/yr. (74%)	316 t/yr. (61%)	2,183 t/yr. (77%)	1,465 t/yr. (52%)
Phosphorus Imbalance[a]	57 t/yr. (76%)	-1 t/yr. (-1%)	280 t/yr. (62%)	156 t/yr. 35%

[a]Tons of nutrient per year (percent of total nutrient inputs).

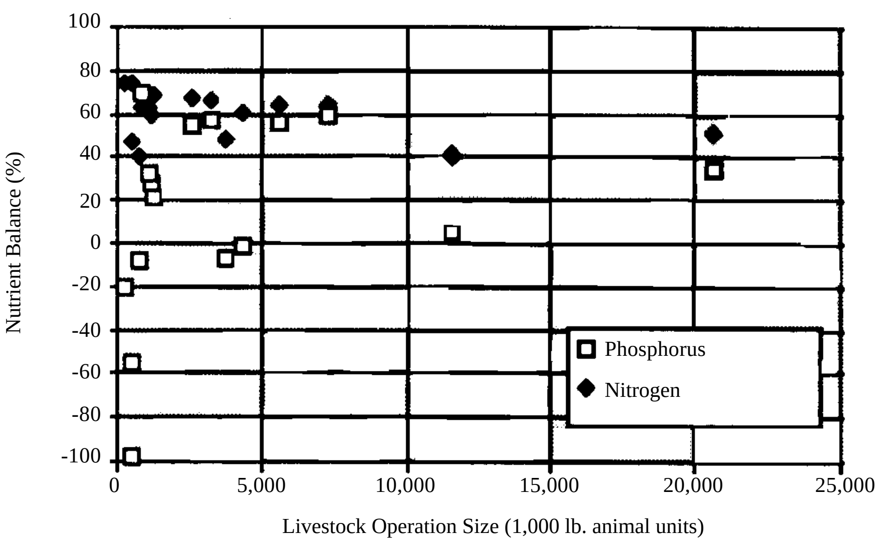

Figure 2. Nutrient balance versus size of livestock facility for 16 Nebraska feedlots.

and 2) versus purchased feeds (Farms 3 and 4) is a primary difference between these four operations.

From a water quality perspective, phosphorus balance (phosphorus is generally conserved by the manure management systems) provides a better indication as to when a sustainable nutrient balance has been achieved. Substantial losses of ammonia nitrogen by volatilization often mask when a balance is achieved. In addition, differences in volatilization losses between farms make nitrogen balance comparisons difficult.

The value of exporting manure nutrients to off-farm customers is illustrated in Table 2. As illustrated in Table 1 the nutrient balance for farms 3 and 4 assumes no export of manure nutrients from these farms. In fact, both farms actively market manure nutrients, substantially improving the nutrient balance of both. Nitrogen imbalance has been reduced, but not eliminated. The remaining nitrogen imbalance is probably due to ammonia volatilization losses to the atmosphere from the feedlot surface, manure storage (farm 4 only) and composting (farm 3 only). The phosphorus imbalance has been eliminated for farm 3 and substantially reduced for farm 4. Marketing of manure nutrients to off-farm customers appears to have achieved a sustainable nutrient balance for farm 3 and substantially improved the sustainability of farm 4.

A nutrient balance, including any transfer of manure to off-farm customers, was completed for a total of 16 cattle feedlots. The relative imbalance measured as a percentage of inputs of nitrogen and phosphorus, is summarized in Figure 2. The increasing imbalance with feedlot size observed in Table 1 is less evident in Figure 2. The largest imbalances of nitrogen were observed for several smaller feedlots. The phosphorus imbalance shows some advantage for several of the smaller feedlots. A negative phosphorus imbalance was observed for several of the smaller feedlots.

The degree of integration of crop and livestock enterprises is often

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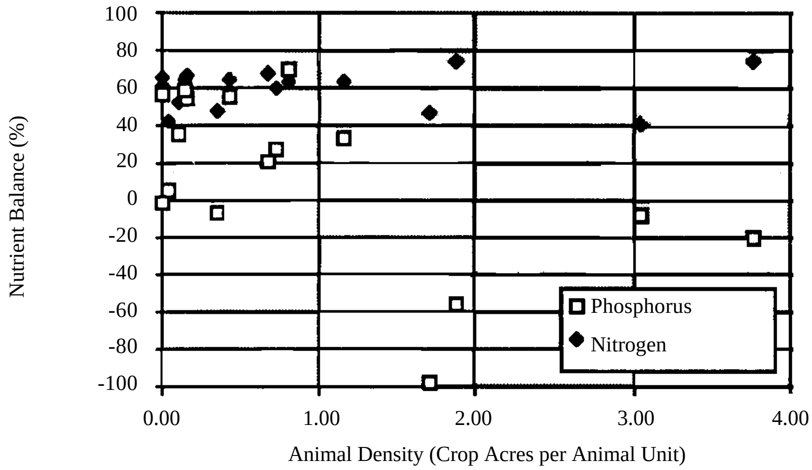

Figure 3. Nutrient balance versus crop land to animal density for 16 Nebraska feedlots.

considered an indicator of the relative potential for environmental problems. For the 16 participating farms, the nitrogen imbalance showed little change for greater animal densities (lower crop acres to animal units, Figure 3). However, the phosphorus imbalance tended to be smaller or negative for lower animal density. Farms with a significant land base have greater potential for exporting of phosphorus as crops marketed off farm.

Substantial variation in nutrient balance exists between farms. Size of livestock operation (Figure 2) and degree of integration of the livestock operation with a crop operation (Figure 3) provide only limited explanation of this variation. The role other farm characteristics or management practices play in determining the variation in nutrient balance requires additional evaluation.

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[1]Rick Koelsch, Assistant Professor, Biological Systems Engineering and Animal Science, Lincoln; Gary Lesoing, Research Assistant Professor, Center for Sustainable Agricultural Systems, Lincoln.