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Summary

Feed Nutrient Management Plan Economics software (FNMP$; Koelsch et al., 2007; available at http://cnmp.unl.edu *under software resources) was used to evaluate the effect of distillers grains inclusion and manure application rate on feedlot nutrient management plans. Inclusion of distillers grains in diets resulted in greater nutrient excretion, land requirements, and manure hauling distances. However, the increased cost of manure management from feeding byproducts has the potential to be offset by increased manure fertilizer value. Changing from N-based to a P-based application rate increased the amount of land required and costs to apply manure. However, when manure was applied at a 4-year P-based rate instead of a 1-year P-based rate, single year land requirement remained similar and application time was reduced by 41% from the 1-year P-based rate.*

Introduction

Both dietary N and P levels in feedlot diets impact the fertilizer value of feedlot manure. A specific feedlot may adjust ration ingredient inclusions to minimize feed costs which may change the N and P in the diet and the nutrient profile of the feedlot manure.

Traditional manure management programs have been based on crop N needs. Due to an imbalanced ratio of N to P in feedlot manure compared to crop needs, applying manure on a N basis results in applying P in excess of crop requirements. Long-term net addition of P to agricultural soils has the potential for degrading surface water quality. Therefore, environmentally preferred manure management programs should be based on practices that apply manure to meet crop P needs.

Ration changes and transitioning from a N-based to a P-based manure application system affect manure management cost and manure fertilizer value. However, accurately calculating these costs/values has been difficult due to the many steps and intricate details involved. The objective of this analysis was to use the feed nutrient management plan economics (FNMP$) software tool to evaluate the effect of distillers grains inclusion and manure application rate on feedlot nutrient management plans.

Procedure

The FNMP$ software tool (Koelsch et al., 2007; available at *http://cnmp.unl.edu* under software resources) is designed to estimate 1) nutrient excretion, 2) manure amounts and nutrient content, 3) land requirements for agronomic utilization of the manure, 4) time requirements (labor and equipment) for land application, 5) costs associated with land application, and 6) potential nutrient value (N and P only) of manure (Table 1).

Research has shown that feedlots may increase profitability by including distillers grains plus solubles (DGS) in feedlot finishing diets (*2006 Nebraska Beef Report*, pp. 54-56; *2008 Nebraska Beef Report*, pp. 50-51). The inclusion of DGS in feedlot diets changes subsequent manure nutrient composition. Three distillers grains plus solubles (DGS) scenarios were evaluated for a 10,000-head feedlot. The feedlot was assumed to have access to 40% of the land around it for manure application and crop land was in a corn (175 bu/ac) and soybean rotation (60 bu/ac). Dietary inclusion rates of 0%, 20%, and 40% (DM basis) DGS replacing corn in feedlot rations were compared.

In addition, federal and state regulations require feedlots to apply manure at rates that do not exceed crop nutrient needs. This has required feedlots to apply manure on P-based rates instead of N-based rates. P-based

Table 1. Summary of key user inputs and outputs of individual modules within FNMP$ software.

Module	Inputs	Outputs
Excretion	Ration nutrient concentration Feed intake Animal performance (e.g. weight gain, days on feed) Facility housing animals	Excreted nitrogen mass Excreted phosphorus mass Excreted solids mass and concentration
Nutrient Availability	Manure housing/storage type Nutrient retention in storage (optional) Crop availability (optional) Land application characteristics Manure moisture and ash concentrations	Crop available nitrogen Crop available phosphorus Harvested manure mass and volume (liquid systems only)
Land and Distance	Crop rotation, yield, and crops receiving manure Crop nutrient requirements (optional) and credits from non-manure sources Basis for application rate Average field size Land Availability Value of nutrients	Manure nutrient concentration Application rate Land requirements for agronomic use Average and maximum travel distance
Economics	Application and nurse tank/truck equipment Application equipment operating characteristics Operating costs (optional)	Application time for spreading equipment and nurse tank/truck Total annual costs for manure application Nutrient value of manure Net costs of manure application

Table 2. Impact of inclusion of distillers grains with soluble (DGS) in cattle ration for 10,000-head capacity feedlot. Assumes 40% of land is accessible for manure application and cropland is in a corn (175 bu/ac) and soybean rotation (60 bu/ac).

Options:		0% inclusion of DGS in diet [a]	20% inclusion of DGS in diet[a]	40% inclusion of DGS in diet[a]
Manure Nutrients Available				
Nitrogen				
Excreted (lb/year)		1,096,000	1,320,000	1,653,000
Crop Available (lb/year)		218,000	265,000	331,000
Phosphorus (P_2O_5)				
Excreted (lb/year)		134,000	192,000	256,000
Crop Available (lb/year)		128,000	185,000	245,000
Manure Application				
Land Required (acres)		5,780	8,430	11,070
Land Required (acres/year)		1,580	2,100	2,770
Average Haul Distance (miles)		2.0	2.5	2.9
Maximum Haul Distance (miles)		3.0	3.7	4.3
Application Rate (as-is ton/acre)		8.0 [b]	5.8	4.5
Land Available for Manure		40%	40%	40%
Manure Application Equipment				
Application Equipment Selected		Truck mounted 20-ton spreader	Truck mounted 20-ton spreader	Truck mounted 20-ton spreader
Total Time (hours/year)		820	990	1,200
Field Time (hours/year)		460	570	720
Road Travel Time (hours/year)		210	260	300
Loading/Unloading (hours/year)		160	160	160
Manure Management Economics				
Nutrient Value	Total ($/year)	$ 109,000	$ 148,000	$ 192,000
	Total ($/ton)	$ 3.50	$ 4.70	$ 6.20
Application Cost	Total ($/year)	$ 48,000	$ 59,000	$ 72,000
	Total ($/ton)	$ 1.50	$ 1.90	$ 2.30
Net Value	Total($/year)	$ 61,000	$ 89,000	$ 120,000
	Total ($/ton)	$ 2.00	$ 2.80	$ 3.90

[a]Ration crude protein and P concentrations are 13% and 0.29% (0% inclusion), 15.3% and 0.39% (20% inclusion), and 18.7% and 0.49% (40% inclusion), respectively.
[b]Limited to N-based rate. P-based rate exceeded crop N requirement.

Table 3. Impact on costs of manure application when manure application rate was determined on an N or P based rate. Assumes 40% of land is accessible for manure application and cropland is in a corn (175 bu/ac) and soybean rotation (60 bu/ac).

Manure Application Rate Options:		N-Based Rate[a]	1-year P-Based Rate[a,b]	4-year P-Based Rate[a]
Manure Nutrients Available				
Nitrogen - Crop Available (lb/year)		331,000	331,000	331,000
Phosphorus - Crop Available (lb/year)		243,000	243,000	243,000
Manure Application				
Land Required (acres)		2,400	11,900	11,100
Land Required (acres/year)		2,400	11,100	2,800
Average Haul Distance (miles)		1.2	3.0	2.9
Maximum Haul Distance (miles)		1.9	4.4	4.3
Application Rate (as-is ton/acre)		5.4	1.1	4.5
Portion of Land Available for Manure		40%	40%	40%
Manure Application Equipment				
Application Equipment Selected		Truck mounted 20-ton spreader	Truck mounted 20-ton spreader	Truck mounted 20-ton spreader
Truck mounted 20-ton spreader				
Total Time (hours/year)		920	2,100	1,200
Field Time (hours/year)		640	1,600	720
Road Travel Time (hours/year)		130	320	300
Loading/Unloading (hours/year)		160	160	160
Manure Management Economics				
Nutrient Value	Total ($/year)	$ 197,000	$ 195,000	$ 192,000
	Total ($/ton as-is)	$ 6.40	$ 6.40	$ 6.20
Application Cost	Total ($/year)	$ 52,000	$ 144,000	$ 72,000
	Total ($/ton as-is)	$ 1.70	$ 4.70	$ 2.30
Net Value	Total($/year)	$ 145,000	$ 51,000	$ 51,000
	Total ($/ton as-is)	$ 4.70	$ 1.70	$ 3.90

[a]Ration crude protein and P concentrations are 18.7% and 0.49% (40% inclusion of DGS), respectively for a 10,000 head feedlot.
[b]Field speed of manure applicator was assumed to be 5.0 miles/hour for the N-based rate and 4-year P-based rates. It was assumed to increase to 8.0 miles/ h for a 1-year P-based rate.

rates are typically lower than N-based rates, requiring additional land access and time for manure applications. The FNMP$ tool was used to compare manure application at a N-based rate versus a 1-year P-based rate. The results from the 1-year P-based rate were compared to a 4-year P-based rate. A 1-year P-based rate applies sufficient manure P to meet crop removal for 1 cropping year. A 4-year P-based rate applies sufficient manure P to meet P removal for 4 cropping years with no additional manure application during the 4-year period.

Results

Impact of Feeding DGS

The impact of the dietary change was quantified in terms of manure nutrient excretion, land area, labor and equipment operating time, and land application costs. Increased inclusion of DGS from 0% to 40% (DM basis) increased diet CP from 13% to 18.7% and P in the diets from 0.29% to 0.49%. Greater diet N and P resulted in greater N and P excretion for 40% DGS compared to 0% DGS (51% and 90% N and P increase, respectively; Table 2). Land area increased from 5,780 to 11,070 acres and average haul distance increased from 2.0 to 2.9 miles at 40% DGS to manage the extra P. Equipment operating time and labor increased with greater land requirements. Most of the increase in time requirement was a result of greater field time for manure application. Finally, the total costs associated with land application of manure increased from $48,000 to $72,000, or by about $24,000.

For this situation, the negative impacts on land, time, and costs were offset by the increased nutrient value of the manure being land applied assuming the end-user of manure pays fertilizer prices for manure nutrients. The $24,000 increase in land application costs were more than offset by an $83,000 increase in manure value. The actual increase in manure value may be less than this value

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based on neighboring land owners willingness to pay fertilizer value for manure nutrients. If manure was valued for N, P, and K fertilizer nutrient values, OM content for improvement of soil structure and water holding capacity, Ca liming effect, and micronutrient composition, dietary changes that increase nutrient excretion increase manure value. To achieve this value, manure would need to be applied to fields where excess nutrients have not accumulated and crop producers need to recognize this value and substitute manure for commercial fertilizer.

Another consideration is the impact of a feed management change on animal production and profitability. For example, the average profitability of the animal is increased by $15 to $30 per finished animal using 20% to 40% DGS in the diet depending on inclusion level, distance from the plant, and price relative to corn grain (*2006 Nebraska Beef Report,* pp. 54-56). Therefore, the annual economic return for 20,000 finished steers (two turns in a 10,000 head feedlot) from least cost formulation in this example would be $300,000 to $600,000 due to including DGS in the diet. The income from feeding DGS is quite large compared to the increased cost ($24,000) to spread manure further.

Impact of N vs. P-Based Application Rate

Nitrogen and P-based rates were evaluated for the feedlot introduced previously with 40% DGS inclusion in the diet and those results were summarized in Table 3. For this example, moving from a N-based rate to a P-based rate (applied to meet a single crop year P needs) increased total land requirements from 2,400 to 11,900 acres. In addition, labor and equipment operation time increased from 920 to 2,100 hour/year, which is a 230% increase. Most of these hours were for field application of the manure. The maximum haul distance of available fields increased from 1.9 to 4.3 miles. A $94,000 increase in land application costs was also identified. Therefore, the net value of the manure was decreased.

Impact of 1-year vs. 4-year P-Based Application Rates

The total land requirement for 4-year P-based manure application remained similar to a 1- year P-based rate. However, for a 1-year P-based rate, all land must receive manure each year as opposed to every fourth year, and application rates must be reduced (1.1 vs. 4.5 tons/acre). If the model feedlot applied manure on a 4-year P-based rate instead of a 1-year P-based rate, it would decrease annual labor and equipment operating time by approximately 900 hours. In addition, the feedlot would reduce application cost by more than $70,000 annually. The nutrient value of manure exceeded the costs of manure application for all situations evaluated, assuming that neighboring farmers are willing to pay fertilizer value for manure nutrients. Transitioning to a 4-year P-based rate had significantly less costs than a 1-year P-based rate. A 1-year P-based rate has no environmental benefit over a 4-year rate (Agricultural Phosphorus Management and Water Quality Protection in the Midwest, 2005).

A history of manure application to fields close to the feedlot with N-based application rates may have provided a more than adequate supply of P for future crop production. Therefore, farmers further from the feedlot may be willing to pay more for the full nutrient value of the manure to replace commercial P fertilizer. The access to new land may offer feedlots new opportunities to market manure, especially higher P manure produced by cattle fed DGS.

The transition from a N-based rate to a single year P-based application will have substantial impact on all costs evaluated. Feedlot managers will experience far less financial and time burdens if a 4-year P-based application system is used instead of a 1-year P-based rate while achieving the same environmental benefits.

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