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Abstract

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Keywords

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MANURE AND LAGOON NUTRIENTS FROM DAIRIES USING FLUSH SYSTEMS

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Summary

Nine primar,y lagoons and solids storage basins were sampled on Kansas dairies using flush systems. These samples were analyzed for nutrient content of wastewater and sand manure. The manure moisture content in the storage basins averaged 81%. The average totals of nitrogen, phosphate, and potash were 3450, 1345, and 1420 mg/L, respectively, for flushing systems. The average totals of nitrogen, phosphate, and potash in the lagoon samples were 816, 337, and 1134 mg/L, respectively, for dairies using recycled water for flushing alleys. These data and previously reported data indicate that lagoon effluent and manure removed from basins must be managed differently between dairies using flush versus scrape systems.

(Key Words: Manure, Nutrients, Dairy, Sand, Lagoons.)

Introduction

Consulting engineers and extension educators can use the MidWest Plan Service (MWPS) MWPS-18 Handbook, Natural Resource Conservation Service (NRCS) National Engineering Handbook 651, or ASAE Standard D384.1 Manure Production and Characteristics for information on the expected daily nutrient production per given animal unit. Most of these data are based on excreted manure rather than manure that actually is being applied to the land. Assumptions as to the expected losses and location, i.e., lagoon or solids storage basin, of the nutrients must be made based on the engineer's experience.

Many dairies are using total mixed rations and sand- or manure-bedded freestalls. However, limited information is available on the nutrient content of waste streams from these freestalls. The purpose of this study was to characterize the manure and effluent nutrients from dairies using recycled water for flushing their facilities.

Procedures

Samples were collected from manure storage basins at nine Kansas dairies. The dairies used sand bedding or composted manure in the stalls. The dairies used flush systems to clean freestall housing and holding pen areas. The sampling was completed during spring 2000.

Manure samples were retrieved using a capped PVC cylinder attached to a metal electrical conduit handle on five of the dairies. A cord was connected to open a spring-closed lid, while the cylinder was under the surface. Depending on the amount of manure in the basin, samples were taken at depths of 2 to 3 ft. The sampler was used to open the crust and then was pushed to the desired depth before the lid was pulled open to collect the sample. Four to six individual samples were taken from around the perimeter (3 to 4 ft from the edge) of each basin and then mixed in a bucket to make one composite sample. On two dairies, solid manure

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samples were taken from mechanical solid separators.

Some of the lagoon samples were collected with the same sampling device. Other samples were collected with a PVC sampler that was thrown 40 to 50 ft from the edge into the water. The sampler was weighted and filled as it sank below the sur-face. The individual samples were combined and analyzed as one composite sample. The samples were refrigerated in 1 liter plastic bottles until sent for laboratory analysis. Servi-Tech Laboratories completed total nutrient analysis on each sample. Samples also were collected at several dairies using 30 pans placed in a field prior to land application of lagoon effluent using reel irrigation systems. These samples were taken to evaluate the variability in sprayed effluent.

Results and Discussion

Data in Table 1 show the average nutrient analysis of the manure samples taken from the solids basins. Manure samples from the two dairies that used mechanical solid separators had an ash content of about 2%. Samples from the other dairies had ash contents ranging from 4 to 13%. The electrical conductivity and pH averaged 7.5 mmho/cm and 6.4, respectively. The average total nitrogen was 3,420 mg/L of which 94% was in the organic form. The phosphate and potassium averaged 1345 and 1420 mg/L, respectively.

Table 2 shows the nutrients available from the lagoons on dairies using a flush system. The average total nitrogen (TN) was 816 mg/L, about five times higher than average values for the scrape systems. Approximately 50% of the N was in the ammonia form, and the remainder as organic N. Phosphate averaged 337 mg/L, which is 4.5 times more than the average for the scrape systems, and potash was more than double at 1134 mg/L.

The data in Table 3 for TN indicate that different management strategies are needed when pumping effluent from lagoons located on dairies using scrape and flush systems. The nutrient values for dairies using a scraping system were reported in 1999 Dairy Days. If effluent is pumped annually onto fields adjacent to a lagoon and TN rates are limited to 114 kg (250 lb) per acre, then only 2 inches of water from the lagoon storing the recycled flush water could be applied per acre. About 7 inches of water could be applied to land receiving lagoon effluent from a dairy using a scrape system. With these application rates, excessive phosphates should not be applied to cropland.

Table 4 shows nutrient concentrations and properties of samples taken from flush systems with composted manure or sand bedding. Nutrient concentrations were greater in the solid and liquid samples from facilities using composted manure, especially phosphorus. The liquid samples from composted manure bedding had greater concentrations of total dissolved solids, 5830 mg/L as compared to 3940 mg/L from sand bedding. Similarly, the solid manure samples from sand-bedded facilities contained less organic matter and more ash.

The following are initial conclusions derived from this field study:

1. The ratio of total nitrogen to phosphorus was approximately 3 in manure from dairy cows fed total mixed rations using a corn silage-based ration.

2. The moisture content of manure was 81% for dairies using flush systems with concrete basins, earthen basins, or mechanical separators.

3. Nutrient content in lagoons from dairies using recycled flush water was much higher than that found in lagoons on dairies that are scraping.

4. A comparison of flush systems showed greater nutrient concentrations when composted manure was used as bedding than when sand was used.

5. Additional data are needed from more dairies using recycled flush water to quantify the nutrients available from lagoons and storage basins.

Acknowledgment

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Table 1. Nutrient Analysis of Manure Samples Taken from Storage Basins on Dairies Using a Recycled Flush System

Nutrient	Units	Average	S.D.
Organic nitrogen	mg/L	3251	768
Urea	mg/L	182	193
Nitrate - nitrogen	mg/L	17.1	28.3
Total nitrogen	mg/L	3450	805
Phosphorus (P_2O_5)	mg/L	1345	643
Potassium (K_2O)	mg/L	1420	680
Other Properties:			
Moisture	%	80.7	4.2
Solids	%	19.3	4.2
Organic matter	%	12.6	4.9
Ash	%	6.7	4.1
Carbon/nitrogen ratio		23.0	10.9
Electrical conductivity	mmho/cm	7.5	4.5
pH		6.4	0.8
Total salts	mg/l	11786	5969

Table 2. Nutrient Analysis of Manure Samples Taken from Primary Lagoons on Dairies Using a Recycled Flush System

Nutrient	Units	Average	S.D.
Organic nitrogen	mg/L	418	150
Ammonia	mg/L	398	176
Nitrate-nitrogen*	mg/L	1.1	0.2
Total Kjeldahl nitrogen	mg/L	816	266
Phosphorus (P_2O_5)	mg/L	337	173
Potassium (K_2O)	mg/L	1134	367
Other Properties:			
Chloride	mg/L	377	245
Total dissolved solids	mg/L	4753	1299
Water pH		7.7	0.2
Electrical conductivity	mmho/cm	7.9	1.6
Sodium adsorp. ratio	(SAR)	3.0	1.3

*1.0 mg/l = 1 or less.

Table 3. Comparison of Average Nutrient Values for Samples Taken from Storage Basins and Lagoons on Dairies Using Scrape and Flush Systems for Handling Manure

Concrete Basins			
		Handling System	
Nutrient	Units	Scrape	Flush
Organic nitrogen	mg/L	3489	3251
Urea	mg/L	1700	182
Nitrate-nitrogen	mg/L	3.2	17.1
Total nitrogen	mg/L	5191	3450
Phosphorus (P_2O_5)	mg/L	2539	1345
Potassium (K_2O)	mg/L	4157	1420
Lagoons			
		Handling System	
Nutrient	Units	Scrape	Flush
Organic nitrogen	mg/L	80	418
Ammonia	mg/L	77	398
Nitrate-nitrogen	mg/L	0.3	1.0
Total Kjeldahl nitrogen	mg/L	156	816
Phosphorus (P_2O_5)	mg/L	74	337
Potassium (K_2O)	mg/L	512	1134

Table 4. Comparison of Average Sample Characteristics with Composted Manure and Sand Bedding in Flush Systems

		Solid		Liquid	
Nutrient	Units	Sand	Manure	Sand	Manure
Total nitrogen	mg/L	3100	3920	760	900
Phosphorus (P_2O_5)	mg/L	1300	1410	300	380
Potassium (K_2O)	mg/L	1260	1630	930	1410
Other Properties:					
Total dissolved solids	mg/L			3940	5830
Moisture content	%	81.4	79.8		
Organic matter	%	11.3	14.3		
Ash	%	9.0	6.0		