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Abstract
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Keywords
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MANURE AND LAGOON NUTRIENTS FROM DAIRIES USING FLUSH SYSTEMS

T. D. Strahm¹, J. P. Harner¹, D. V. Key², and J. P. Murphy¹

Summary

Nine primary 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 surface. 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.

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

The authors thank the dairy producers who cooperated with this study and allowed them access to their dairies.

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 (P₂O₅)    | mg/L  | 1345    | 643  |
| Potassium (K₂O)      | 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 (P₂O₅)      | mg/L  | 337     | 173  |
| Potassium (K₂O)        | 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

| Nutrient                  | Units | Handling System |        |        |
|--------------------------|-------|----------------|-------|-------|
|                          |       | Scrape         | Flush |       |
| **Concrete Basins**      |       |                |       |       |
| 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 (P₂O₅)        | mg/L  | 2539           | 1345  |       |
| Potassium (K₂O)          | mg/L  | 4157           | 1420  |       |
| **Lagoons**              |       |                |       |       |
| 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 (P₂O₅)        | mg/L  | 74             | 337   |       |
| Potassium (K₂O)          | mg/L  | 512            | 1134  |       |

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

| Nutrient                  | Units | Solid          | Liquid        |
|--------------------------|-------|----------------|---------------|
|                          |       | Sand           | Manure        |
|                          |       | Sand           | Manure        |
| **Total nitrogen**       | mg/L  | 3100           | 3920          |
| Phosphorus (P₂O₅)        | mg/L  | 1300           | 1410          |
| Potassium (K₂O)          | mg/L  | 1260           | 1630          |
| 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           |