Liquid Swine Manure Nutrients

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Summary and Implications

Swine manure pits in Iowa were sampled as part of an extension program to encourage producer sampling. Solids concentrations, and nutrient data were collected for finishing and non-finishing operations, for indoor concrete, outdoor concrete, and earthen pits, and for wet/dry finishing systems with deep pits. Nutrient summaries are presented.

Introduction

For effective manure nutrient management, the nutrient concentration in the manure to be land applied must be known. If samples are not available, estimates must be used. Iowa has developed manure nutrient estimates from pit and lagoon samples (Lorimor et al., 1996). NRCS, Iowa Department of Natural Resources, and Extension all use these same estimates in Iowa. Although the estimates are thought to be fairly accurate they do require ongoing research to maintain a current database of manure nutrient values as management techniques and rations change.

Rations, genetics, and housing systems have changed significantly in the last 5 years. Feeding and manure handling systems also have changed. For instance wet/dry feeders, total slats versus partial slats, and swinging waterers can all potentially cause differences in the moisture (solids) content and nutrient concentrations of pit manure. The use of phytase is becoming more popular, and will reduce manure phosphorus concentrations in the future. And nitrogen (protein) in rations is being reevaluated. As production systems evolve, manure nutrients will change.

This paper reports on a field sampling project that both encouraged producers to have their manure tested, and provided current nutrient values to update our estimates.

Materials and Methods

Extension agricultural engineering field specialists in northwest, southeast, and east central Iowa carried out the project. Each specialist, working with a certified commercial analytical laboratory, offered sampling assistance to producers in their multicounty region. The assistance consisted of cost sharing and either actual sampling by the specialist, or providing a sampler and sample containers. The majority of samples were taken by the field specialists using 12 foot probes. The Extension ag engineers in each area organized and carried out the sampling in their respective areas.

A vertical profile of the manure in storage was sampled if possible. Twelve-foot coli-wasa samplers were used for sampling. In concrete pits, either under-building or outside, sampling using the 12-foot plastic probes worked well. Each sampler has a manually operated valve at the bottom of a plastic tube that could be opened prior to inserting the tube into the manure. Once inserted to the bottom of the pit, the valve was closed, resulting in a vertically integrated sample. Thick solids made sampling difficult occasionally, but generally the sampler worked well. Deep pit buildings were sampled from outside the buildings through pump access ports. Equipment was disinfected after each visit. Samples were sent to the appropriate labs for analysis as soon as possible after collection, typically on the same day.

Results in this paper also include sample results from a large number swine finish contractors that used earthen pits. Sampling at their facilities was always done during land application, when pit agitation had been ongoing for at least several hours.

Results and Discussion

A total of 183 pits was sampled as the result Extensions efforts for this project. Extension ag engineers sampled a total of 126 of the pits; producers sampled the rest. Of these, 12 were earthen swine pits and 93 were concrete swine pits. The other 57 samples were from lagoons, open lot basins, or non-swine facilities. The cooperating swine finisher contractor provided 479 sample results from 78 sites

Concrete finishing pits. Nutrient concentrations in swine deep pits are increasing slowly with time. Management changes such as using wet-dry feeders, better control of sprinklers, and watching more closely for leaking waterers, minimize water waste, resulting in lowered manure volume and increased nutrient concentrations. Brumm (1997) reported a 30% reduction in manure volume by switching to wet-dry feeders in a Nebraska study. Deep pits are typically expected to be more concentrated than outdoor pits because they're isolated from natural precipitation, although Iowa has a precipitation deficit (annual evaporation exceeds precipitation). Iowa's standard nutrient concentration estimate for swine finishing pits is 50 35-25 lb/1000 gal for N-P_2O_5-K_2O, respectively. As shown in Table 1, average concentrations for concrete finishing pits (both indoor and outdoor) in this study were higher in every category. Typical estimates for solids concentrations are 5% for finishing pits; these results showed a 6.8% average.

Table 1. Manure nutrient concentrations in concrete finishing swine pits.

	N lb/kgal	P_2O_5 lb/kgal	K_2O lb/kgal	Solids percent
Average	58.1	48.4	29.4	6.8
Max	104.3	124.7	62.3	18.1
Min	20.7	14	9.6	1.7
Std dev	19.1	21.8	9.3	3.1
No. obs	83	83	83	70

The nutrients varied significantly among pits. As shown in Table 1, nitrogen varied fivefold from 20 to 104 lbs/1000 gal; phosphate varied 14 to 124 lbs/1000 gal; and potash varied from 10 to 60 lbs/1000 gal, a factor of 6 times. Standard deviations were about one-third of the means.

Deep pits are typically expected to be more concentrated than outdoor pits. A separate analysis of 33 finishing deep pits showed this to be the case. The average manure in the deep pits had 7.6% solids, and nutrients were from 10 to 21% more concentrated than the analysis for all concrete pits. The average deep pit analysis was 66-58-32 lb/1,000 gal.

Finishing deep pits with wet/dry feeders were separated out to see what effect the feed/water system had on the manure. Deep pit manure below wet/dry feeders averaged 75-54-40 lb/1,000 gal.

Earthen finishing pits. In general earthen swine pits contain lower nutrient concentrations than concrete pits. One reason may be that the greater surface area to volume ratio (due to sloping sidewalls) allows more ammonia volatilization. Additional dilution from precipitation is possible compared with concrete pits with vertical sidewalls. Another reason that may affect these results is that earthen pits are very difficult to sample due to the sloping sidewalls. Earthen pits are best sampled during agitation. Table 2 shows nutrient concentrations in earthen swine pits.

Table 2. Manure nutrient concentrations in earthen finishing swine pits.

	N lb/kgal	P_2O_5 lb/kgal	K_2O lb/kgal	Solids percent
Average	32.1	22.2	19.5	5.0
Max	97.9	121.1	38.3	11.9
Min	15.0	1.6	7.5	2.5
Std dev	11.4	15.7	5.3	2.5
No. obs	89	89	89	12

Although the averages were less, the variation was even greater than in the concrete pits. The greatest variation was in the phosphate concentration, which varied by 120 lb/1,000 gal. The solids shown in Table 2 are based on only the extension sampled pits.

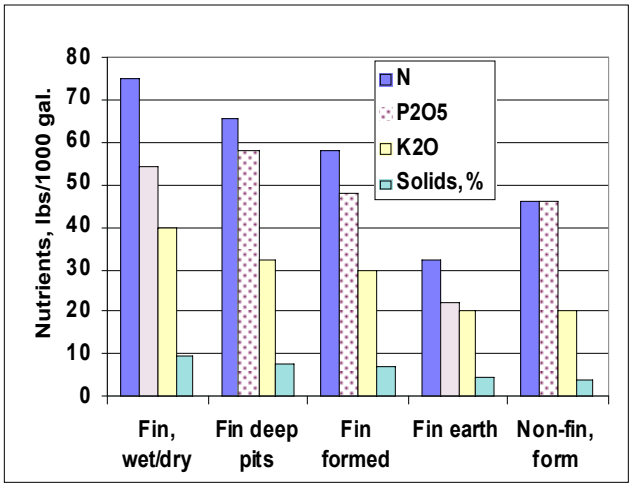
Concrete non-finishing swine pits. Nutrient concentrations for concrete non-finishing swine pits lie between concrete and earthen finishing pit concentrations for several reasons. Gestation sows are limit fed, so solids will necessarily be a lower percentage of the manure (assuming they still drink the same). Farrowing and nursery water consumption may be greater than finishing, and washing occurs more frequently in these facilities. Although the number of samples was not great, test results from this study are in line with what is normally expected relative to finishing pits. Results are summarized in Table 3.

Table 3. Manure nutrient concentrations in concrete non-finishing swine pits.

	N lb/kgal	P_2O_5 lb/kgal	K_2O lb/kgal	Solids percent
Average	46.6	46.2	20.4	4.2
Max	80.3	71.9	36.0	7.1
Min	31.2	26.4	9.6	3.1
Std dev	16.7	15.4	10.5	1.2
No. obs	8.0	8.0	8.0	8.0

Even though these pits involved different types of operations such as gestation, farrowing, and nursery, nutrient variation was less than in the finishing pits. Part of the reason for the lack of extreme variation may be simply that fewer pits were sampled. Figure 1 shows a summary of nutrient values for the various types of operations and pits.

Figure 1. Nutrient values in liquid swine manure.



Results from a field study of 183 swine pits in Iowa show that concrete manure deep pits for finishing swine using wet/dry feeders have the highest concentrations of N, P_2O_5, and K_2O of the various swine pits sampled. Other types were less concentrated. Concrete pits (inside and outside, combined) for non-finishing swine were less concentrated than for finishing. Earthen pits contained

significantly lower concentrations of all three crop nutrients than the concrete pits. Large variation in the concentrations of all three nutrients exists between pits.

While the use of tabular values, and state or agency estimates provides a starting place for manure nutrient planning, the large variation in this study clearly shows that to manage manure nutrients properly, individual tests are needed.

References

1. Brumm, Michael. 1997. Personal communication

2. Lorimor, J.C., R. Zhang, S.W. Melvin, and R. Killorn. 1996. Land application for effective manure nutrient management. Iowa State University Extension publication Pm-1599. Iowa State University, Ames, Iowa.