NC STATE UNIVERSITY DEPARTMENT of SOIL SCIENCE

North Carolina Trends in Animal Waste Nutrient Concentrations

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INTRODUCTION

Nutrient plans aim to manage amount, source, placement, form, and timing of nutrient applications with the expressed purpose of optimizing production and complying with governmental regulations for environmental stewardship (NRCS-NC, 2004). Animal wastes are budgeted based on volume generated and nutrient concentrations via laboratory analysis, historical records, or default values. North Carolina (NC) animal waste default values are primarily based on a survey of livestock operations from 1980 to 1991 (Barker & Zublena, 1995). Improved animal production practices (e.g. dietary nutrient targets and sources, and enzyme supplements) have occurred in the past 20 years resulting in altered waste nutrient concentrations. The Plant/Waste/Solution (PWS) section of the NC Department of Agriculture–Agronomic Division analyzes over 15,000 waste samples annually where the majority are from swine, poultry, and dairy. We reviewed animal waste nutrient concentrations analyzed over the past eight years to update the default values and improve nutrient planning and recommendations.

OBJECTIVES

1. Evaluate trends in average, annual nutrient concentration of swine, poultry, and dairy manures over the past eight years in NC
2. Compare average nutrient concentrations of swine, poultry, and dairy manures with established default values

MATERIALS & METHODS

- Animal waste nutrient analyses were queried from the 1999-2006 NCDA-PWS database (unpublished). Individual waste types were averaged for each year, and standard deviation, standard error, and coefficient of variance was calculated using JMP 7.0 (SAS Institute, 2007).
- Swine, poultry, and dairy waste averages were compared to the established default values from Barker & Zublena (1995), and nutrient differences were reported relative to default values on a percentage basis.
- Solid wastes were analyzed on dry basis, and converted to "as is" or wet nutrient concentrations using the dry matter content.

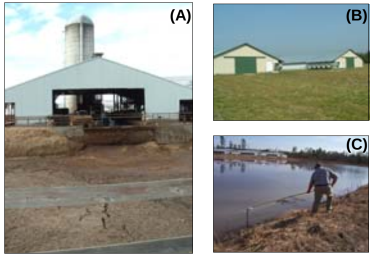

Figure 1. (A) Dairy free stall barn and waste storage pond, **(B)** Poultry houses, **(C)** Swine anaerobic lagoon.

RESULTS & DISCUSSION

SWINE

Nitrogen (N) in anaerobic swine effluent was highest in 2001 (Figure 2). Very dry growing conditions yielded greater spray-field applications and evaporation; thereby concentrating N in the effluent. Nitrogen steadily decreased to 400 mg L^{-1} in 2006, while phosphorus (P) levels changed very little in the eight years (Figure 2). Potassium (K) increased approximately 200 mg L^{-1} from 2000-2002, and maintained concentration around 700 mg L^{-1} over the past four years (Figure 2).

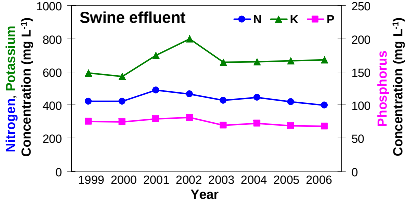

Figure 2. Anaerobic swine effluent concentrations of N, P, and K from NCDA-PWS 1999-2006 waste analysis database.

DAIRY

Dairy cow manures have shown the greatest change over the past eight years. In 2003, concentrations of N, P, and K in dairy slurry samples decreased by 37, 29, and 30%, respectively, and have remained at the lower levels (Figure 3). These decreases are most likely due to diet modifications where enzymes (e.g., cellulase, phytase) are supplemented to increase animal efficiency in processing forages, protein N and organic P (phytate in grain) (NRC, 2001). Zinc (Zn) and copper (Cu) concentrations increased in 2002, but levels have dropped to approximately 10 and 13 mg L^{-1}, respectively (data not shown).

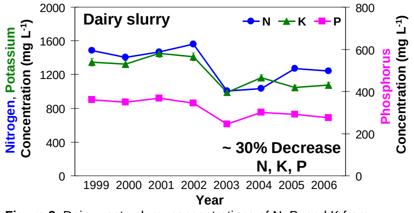

Figure 3. Dairy waste slurry concentrations of N, P, and K from NCDA-PWS 1999-2006 waste analysis database.

POULTRY

Poultry nutrient concentrations have not changed dramatically in the past eight years where P was very similar among manures of broiler breeder, broiler, and turkey (Figure 4). Broiler manure was highest in N followed by turkey and broiler breeder manures (Table 1).

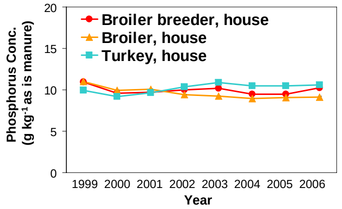

Figure 4. Broiler breeder, broiler, and turkey house manure P concentrations from NCDA-PWS 1999-2006 waste analysis database.

NUTRIENT CONCENTRATION COMPARISON

NCDA-PWS swine effluent N was 20% lower than Barker & Zublena values (Figure 5, Table 1). Dairy waste concentrations were substantially lower from 2003-2006 (Figure 3) and thus averaged for these comparisons. Dairy slurry N were 53% and 59% lower for 1999-2006 and 2003-2006 averages, respectively (Figure 5). Broiler breeder manure N increased nearly 50%; whereas, broiler and turkey manures changed very little (Figure 5).

Phosphorus and sulfur were generally lower across poultry manures, swine effluent, and dairy slurries (Figure 5, Table 1). Phosphorus reduced by 15, 44, and 27% for broiler breeders, broilers, and turkeys, respectively (Figure 5). Strategies to reduce P in poultry manures include reducing diet P ration (i.e. feed closer to actual P requirement rather than supplying excess) and supplementing feed with phytase to assist in hydrolyzing phytate (i.e. greater utilization of organic P). Swine effluent and dairy slurry P also decreased.

Interestingly, poultry manures increased in Mn, Zn, and Cu with the greatest percentage increases in Cu (Figure 5). Conversely, swine effluent and dairy slurry Mn and Zn decreased. All dairy slurry nutrients reduced substantially except Cu (Figure 5). Dairy slurry Cu increased from 5.5 (Barker & Zublena, 1995) to 15.5 (NCDA-PWS, 1999-2006) or 13.8 (NCDA-PWS, 2003-2006) mg L^{-1} (Table 1). This increase in Cu was most likely due to increased use of $CuSO_4$ foot baths to prevent hoof diseases. Thus, even with substantial decreases in most nutrients (especially N, P, and Zn), dairy slurry applications need to account for high levels of Cu to maintain soil and crop productivity.

NUTRIENT CONCENTRATION COMPARISON

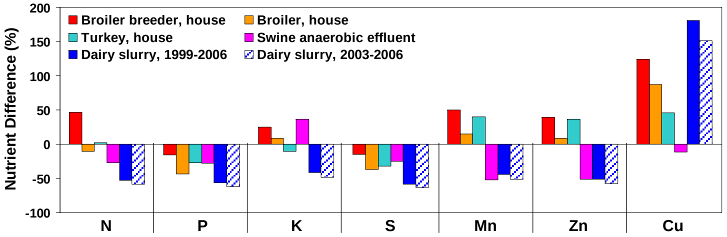

Figure 5. Nutrient differences in the NCDA-PWS animal waste concentrations relative to Barker & Zublena (1995) values.

Table 1. Comparison of animal waste nutrient concentrations of Barker & Zublena (1995) vs. NCDA-PWS 1999-2006.

SOLID Waste	Samples	Dry Matter	N	P	K	S	Mn	Zn	Cu
Barker & Zublena, 1995		%	g kg^{-1} as is manure						
Broiler breeder, house	26	64 ± 13	15.5 ± 6.0	11.8 ± 4.6	12.9 ± 4.6	4.3 ± 1.6	0.29 ± 0.12	0.26 ± 0.10	0.11 ± 0.09
Broiler, house	517	78 ± 6	36.0 ± 11.5	17.0 ± 4.8	19.1 ± 4.2	7.5 ± 2.3	0.34 ± 0.11	0.32 ± 0.11	0.23 ± 0.10
Turkey, house	219	74 ± 10	26.0 ± 8.0	14.0 ± 4.8	15.4 ± 5.0	4.5 ± 1.6	0.30 ± 0.12	0.28 ± 0.09	0.22 ± 0.12
NCDA-PWS 1999-2006									
Broiler breeder, house	2943	69 ± 13	22.7 ± 9.8	10.0 ± 2.8	16.1 ± 4.5	3.6 ± 1.3	0.43 ± 0.14	0.36 ± 0.12	0.24 ± 0.16
Broiler, house	11336	74 ± 7	32.2 ± 8.6	9.6 ± 2.4	20.8 ± 4.6	4.7 ± 1.8	0.38 ± 0.12	0.34 ± 0.10	0.42 ± 0.20
Turkey, house	4487	73 ± 9	26.5 ± 10.5	10.2 ± 3.3	13.7 ± 5.0	3.0 ± 1.0	0.41 ± 0.14	0.38 ± 0.12	0.32 ± 0.18
LIQUID Waste									
Barker & Zublena, 1995			mg L^{-1}						
Swine anerobic effluent	469		601 ± 309	102 ± 67	488 ± 290	44 ± 30	1.5 ± 1.4	6.6 ± 7.1	1.3 ± 1.6
Dairy slurry	296		2759 ± 1044	732 ± 329	2091 ± 866	372 ± 168	21.6 ± 9.6	25.2 ± 20.4	5.5 ± 4.1
NCDA-PWS 1999-2006									
Swine anerobic effluent	93959		436 ± 258	73 ± 121	665 ± 319	33 ± 45	0.7 ± 3.5	3.2 ± 14.5	1.2 ± 8.1
Dairy slurry, 1999-2006	3425		1309 ± 1033	317 ± 263	1226 ± 761	154 ± 132	12.0 ± 11.3	12.2 ± 15.0	15.5 ± 33.6
Dairy slurry, 2003-2006	1890		1138 ± 885	279 ± 244	1069 ± 659	134 ± 119	10.5 ± 10.6	10.5 ± 12.0	13.9 ± 29.6

CONCLUSIONS

- NC nutrient values for swine and poultry manures will be updated using the 1999-2006 NCDA-PWS database.
- Dairy slurry N, K, and P decreased by nearly 30% in 2003, and NC values will be updated using 2003-2006 analyses.
- Increased animal nutrient use efficiencies were evident based on past eight years of NCDA-PWS waste analyses and in comparison to 15-year old default values.
- The more accurate representation of animal waste nutrient contributions will assist in managing nutrients better, optimizing crop production, and improving profit margins in a world of increasing fertilizer costs.

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