Maximizing Poultry Manure Utilization Through Nutrient Management Planning

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The value of manure as an organic fertilizer and a source of plant nutrients has been recognized for centuries. Poultry manure fertilizer contains the essential nutrients required for crop production. Even with its beneficial effects on plant growth, manure constitutes only a small percentage of nutrients applied to cropland when compared to commercial fertilizer.

There are several reasons why poultry fertilizer is not used to its maximum potential. Among these are: (a) lack of information on the value of manure as a source of plant nutrients (b) failure to recognize how and where to utilize it; (c) lack of recognition of its economic value, and (d) transportation costs.

This publication provides information presently available for the appropriate application and the most effective use of poultry fertilizer and to assist poultry producers in developing a nutrient management plan.

Quantity of Poultry Fertilizer Generated

Georgia's poultry industry produces large quantities of poultry manure. In 2002, Georgia's poultry population was estimated at 1.3 billion broilers; 12 million commercial laying hens; 11.8 million broiler breeder hens; and12 million replacement pullets (both light and heavy). The manure produced by these birds is a valuable by-product, with a potential gross value of over $60 million dollars.

For each pound of feed consumed, a chicken will produce approximately 1 pound of fresh manure having a moisture content of about 75 percent. Once voided from the bird, the manure rapidly loses water due to evaporation. The final product typically has a moisture content of 20 to 40 percent, although the final moisture content will also vary depending on type and quantity of bedding, bird concentration, watering equipment and ventilation systems in use.

Good estimates of annual manure production are: 2.5 pounds of manure for a 5.0 lb. broiler, 20-30 pounds per commercial layer, 44 pounds per broiler breeder, and 8 pounds per replacement pullet. Manure production can vary substantially with management programs, thus on-farm records are the most accurate means of determining manure production for individual operators.

Composition of Poultry Fertilizer

Poultry litter from floor-raised birds (broilers, turkeys, broiler breeder pullets) consists primarily of droppings and bedding (usually wood shavings or sawdust) with varying moisture content. Feathers and waste feed make up the remainder except in dirt floor houses where soil may be mixed in. Poultry manure consisting of only fecal droppings is associated with caged layers and broiler breeders. Liquid manures from some laying hen operations is typically stored in lagoons.

Lagoons are biological digesters in which bacteria decompose organic matter into gases, liquids and sludge. A lagoon is not considered a convenient method of waste disposal but rather one treatment process in the overall waste management plan.

Average plant nutrient content of poultry fertilizer is listed in Tables 1 and 2. Poultry litter and manure vary in both physical and chemical composition. Factors affecting composition include: type of birds raised, number of birds per unit area, nutrient density of the feed, type and amount of bedding material, time in use and other management factors. Environmental factors during production, storage, and methods of handling after production also influence poultry manure composition. Frequently it is necessary to stockpile poultry litter when producers clean out their facilities. The litter should be placed in a structure that will prevent surface or groundwater contamination. Generally, stockpiled litter will go through some degree of composting. As a result, the level of certain plant nutrients, especially nitrogen, will change.

Based on the average plant nutrient levels, a ton of poultry litter has an estimated value of $31.00 (Table 3). A 20,000 bird broiler house will produce approximately 150 tons of litter per year (6 flocks) with a potential gross value of $4,650. A flock of 14,000 breeder hens will produce approximately 150 tons of manure (50% dry weight basis) in one year with a potential gross value of $3,000.

The cost of transporting poultry litter can vary. Litter removed from a broiler house is usually very bulky (67 cubic feet per ton), increasing its transportation cost per pound of nutrient. The cost of transporting a ton of broiler litter ranges from $8 to $14 per ton. The average delivered cost per ton of broiler litter by commercial operators is $20. Thus, poultry litter can provide an economic benefit for many growers if effectively utilized.

Nutrient Quality

The nutrient quality of broiler litter has been improved by the move toward built-up litter, the housing of multiple flocks prior to clean-out. It is now customary to produce four to six flocks per year with an annual clean-out of the house.

To obtain maximum nutritive value, incorporate poultry litter into the soil immediately after spreading. Research shows that 40 to70 percent of the total nitrogen is available during the first six weeks, depending upon the nitrogen content of the fertilizer and the form in which it is present. The remaining nitrogen will be released very slowly during the process of decomposition of the organic residues. This release may require more than one growing season. The nutrient availability of poultry manures during the first year of application is listed in Table 4. For optimum utilization, poultry litter should be used to meet as much of the phosphorus and nitrogen needs of the crops as possible. Use commercial fertilizer to furnish other nutrients to the levels needed as indicated by soil tests.

Phosphorus is predominantly in organic form in chicken manure. This element becomes available much more slowly than nitrogen, being directly related to the rate at which the manure decomposes and it's binding qualities within the soil.

Potassium in chicken manure is present as an inorganic salt in the excretions from the kidneys and in the living and dead cellular material in the feces. All forms of potassium in manure are quite readily available to plants in most cases, but may be rapidly lost by leaching.

Many other elements are present in chicken manure in very small quantities (Table 2). Little is known concerning the rate of release of these elements, but essentially all become available in the course of decomposition. Currently, these elements are not thought to have significant effects on either plant fertility or environmental factors.

In addition to being an excellent source of plant nutrients, poultry fertilizer can increase the water infiltration rates of soils by improving the soil structure. On a short term basis, poultry fertilizer can also increase the soil organic matter content.

Application of Poultry Fertilizer

Poultry fertilizer can be successfully used on many crops. General rates and timing of applications are listed in Table 5. A successful utilization program includes the following: 1) obtaining soil tests for application fields, 2) calculating crop nutrient requirements, 3) obtaining manure nutrient analysis, and 4) ensuring proper storage and application rates. To prevent excessive application of poultry fertilizer and the potential contamination of surface and ground water, prepare a nutrient budget worksheet for each field or crop (see Appendix for sample budget worksheet). You can contact your county extension agent for assistance in generating site-specific field budgets.

The figures given in Tables 1 and 2 are average values for nutrient content of manures. As indicated previously, the actual nutrient profile of a particular manure sample may vary greatly from the averages. Therefore, having your manure analyzed for its true plant nutrient content is recommended. Armed with this information and coupled with appropriate soil tests, you and your county agent can decide on the best plan of action to utilize poultry fertilizer for your individual cropping needs.

Record Keeping

Keeping accurate records of all your poultry and commercial fertilizer uses and off-site transfers is an essential component of a working nutrient management plan. On-farm field applications and off-site transfers of manure should be recorded when these activities occur. Such records can help to validate your use of appropriate BMPs and environmental stewardship practices on the farm should the environmental impact of your farm ever be called into question.

Table 1. Average nutrient composition of poultry manure on an as-received basis.

Manure Type	Total N	Ammonium NH_4	Phosphorus P_2O_5	Potassium K_2O
	lb/ton			
Broiler litter	64	10	54	48
Stockpiled litter	36	8	55	35
Breeder manure	31	7	40	35
Layer manure				
Highrise cleanout [1]	40	18	94	58
Lagoon sludge[2]	26	8	92	13
Lagoon effluent[3]	62	42	59	37

[1]Annual manure accumulation in lbs/ton.
[2]lbs/1,000 gallons.
[3]lbs/acre-inch. Acre-inch is equivalent to 3630 cubic feet or 27,154 gallons.
Sources: North Carolina State University Department of Biological and Agricultural Engineering; The University of Georgia Agricultural and Environmental Services Laboratory.

Table 2. Mineral analysis of poultry litter on an as-received basis.

Manure type	Ca	Mg	S	Fe	Mn	Zn	Cu	B	Al	Na
	lb/ton			ppm						
Litter										
Broiler cake	36	81	91	1459	340	272	366	35	2403	5764
Broiler cleanout	43	9	15	1610	334	265	319	33	2632	5498
Broiler stockpiled	54	10	12	1437	362	286	313	33	2236	5739
Breeder manure	120	11	8	1979	321	286	121	22	2897	4097
Pullet cleanout	37	67	59	2158	294	246	142	19	3393	3908
Layer manure										
Highrise cleanout [1]	86	6	9	5	2	0.5	0.4	Trace	- -	- -
Lagoon sludge[2]	71	7	12	4	2	2	0.8	0.1	- -	- -
Lagoon effluent[3]	35	7	8	5	3	0.4	0.4	Trace	- -	- -

[1]Annual manure accumulation in lbs/ton.
[2]lbs/1,000 gallons.
[3]lbs/acre-inch. Acre-inch is equivalent to 3630 cubic feet or 27,154 gallons.
Source: The University of Georgia Agricultural and Environmental Services Laboratory.

Table 3. Example of relative value of fertilizer elements in one ton of broiler litter and breeder hen manure.

Nutrient	$ per pound	Broiler ($/ton)[1]	Breeder Hen ($/ton)[1]
Nitrogen	0.30	13.44	6.51
Phosphate	0.28	12.10	8.96
Potash	0.12	5.76	4.20
Total		**$31.30**	**$19.67**

[1]Assumes the following efficiency factors relative to commercial fertilizers: Nitrogen-70%, Phosphate-80%, Potash-100%

Table 4. Typical first-year nitrogen availability coefficients for different poultry manures.

Manure Type	Soil			
	Injection[1]	Soil Incorporation [2]	Broadcast[3]	Irrigation[4]
	N availability coefficient			
All poultry litters[5]	--	0.7	0.5	--
Layer Highrise cleanout	--	0.6	0.4	--
lagoon sludge	0.6	0.6	0.4	0.4
liquid effluent	0.8	0.7	0.4	0.3

[1]Manure injected directly into soil and covered immediately.
[2]Surface-spread manure plowed or disced into soil within two days.
[3]Surface-spread manure uncovered for one month or longer.
[4]Sprinkler-irrigated liquid uncovered for one month or longer.
[5] Includes in-house and stockpiled litters.

Table 5. Maximum yearly application rates for broiler litter bases on nitrogen application.

Crop	Maximum Application Rates		Time of Applications
	Single Application	Yearly Total	
	tons/acre		
Forages			
Bahia, Bermuda & dallis grass pasture	4	6	Spring-Summer
Fescue & orchardgrass pasture	4	5	Fall & Spring
Bermuda & Bahia hay	4/cutting	cutting dependent	Spring-Summer
Cool season annual grass	4	6	Fall & Spring
Cool season annual grass with legume	3[2]	3	Fall
Warm season annual grass	4[2]	5	Spring-Summer
Row Crops[3]			
Corn, grain	4[2]	6.5	Fall-Spring
Corn, silage	4[2]	8	Fall-Spring
Cotton	3[2]	3	Fall-Spring
Grain sorghum & sweet sorghum	4[2]	4	Fall-Spring
Sorghum silage	4[2]	8	Fall-Spring

[1]Buffer zone is band of vegetation (grass, trees or wetland) between spreading area and intermittent or permanent surface water.
[2]Decrease the total application rate by 25 percent if incorporated immediately after application.
[3]Maximum application rates should not be applied on crop land with greater than 8 percent slope. For recommendations, contact your local Natural Resource Conservation Service or Cooperative Extension Office.

References

Soil Facts: Poultry Manure as a Fertilizer Source, North Carolina Cooperative Extension Service.

Poultry Waste Management and Environmental Protection Manual, Alabama Cooperative Extension Service.

Vest, L., M. Merka, and W. Segars, 1998. Poultry Waste: Georgia's 50 Million Dollar Forgotten Crop. University of Georgia Cooperative Extension Service, Leaflet #206.

Links

CAES AWARE www.engr.uga.edu/service/aware
- CNMP maps
- AFO LAS permit
- CAFO NPDES permit
- P-index spreadsheet
- Field budget spreadsheet

Litter/Manure Removal Record

Farm Location_____

Farm Owner_____

Litter/Manure Type Produced_____

Dated Removed	Tons Removed	Name of Recipient	Phone Number

Field Record - Litter Application

Farm Owner	
Spreader Operator	

Field #	Date (mm.dd.yr)	Crop Type	Field Size (acres)	Application Method[1]	Volume Applied[2] (tons)

[1] SI = soil incorporated (plowed, disced); BR = broadcast (surface applied)
[2] Found in operator's manual for the spreader.

Field Record - Liquid Manure Application

Farm Owner	
Spreader Operator	

Field #	Date (mm.dd.yr)	Crop Type	Field Size (acres)	Application Method[1]	Volume Applied[2] (acre/in)

[1] SI = soil incorporated (plowed, disced); BR = broadcast (surface applied); IR=irrigated
[2] Found in operator's manual for the spreader.

Field #_____

Crop Nitrogen Requirement Worksheet

	Example	Your Farm
1. Crop to be grown	Fescue Hay	
2. Crop yield expectations from field records or NRCS standards	2.5 tons	
3. Nitrogen guidelines per unit of yield (Table-----)	50 lb/ton	
4. Crop nitrogen requirement (2 x 3)	125 lb/acre	
5. Starter fertilizer nitrogen or previous legume nitrogen	0 lb/acre	
6. Commercial fertilizer nitrogen added	0 lb/acre	
7. Crop nitrogen need from poultry manure (4 minus 5 and 6)	125 lb/acre	
8. Poultry manure plant available nitrogen		
a. Nitrogen composition of poultry manure from farm average or state average (Table 1)	64 lb/ton	
b. Nitrogen availability coefficient (Table 4)	0.7	
c. Plant-available nitrogen (a x b)	44.8 lb/ton	
9. Poultry manure application rate (7 ÷ 8 c)	2.8 ton/acre	
10. Acres of crop to be grown	100 acres	
11. Total poultry manure required (9 x 10)	280 tons	

Poultry Litter Utilization Record

Date of Clean Out	Total Removed (tons)	Spread on Farm (tons)	Other use (tons)	Removed From Farm (tons)	Temporary Storage (tons)

Field #_____

Crop Phosphorus Requirement Worksheet

	Example	Your Farm
1. Crop to be grown	Fescue Hay	
2. Crop yield expectations from field records or NRCS standards	2.5 tons	
3. Phosphorus guidelines per unit of yield (Table-----)		
4. Crop phosphorus requirement (2 x 3)		
5. Commercial fertilizer phosphorus added	0 lb/acre	
6. Crop phosphorus need from poultry manure (4 - [5 + 6])	0 lb/acre	
7. Poultry manure plant available phosphorus		
a. Phosphorus composition of poultry manure from farm average or state average (Table 1)	54 lb/ton	
b. Phosphorus availability coefficient (80%)	0.8	
c. Plant-available phosphorus (a x b)		
8. Poultry manure application rate (7 ÷ 8 c)		
9. Acres of crop to be grown	100 acres	
10. Total poultry manure required (9 x 10)		

Estimating Annual Farm Manure Production

Broilers

a. Number of broilers produced (total annual) _____

b. Pounds of manure per broiler 2.5

c. Total pounds of manure (a x b = c) _____

d. Tons of manure (c ÷ 2000) _____

Breeders

a. Number of breeders _____

b. Pounds of manure per breeder 44

c. Total pounds of manure (a x b = c) _____

d. Tons of manure (c ÷ 2000) _____

Pullets

a. Number of pullets (total annual) _____

b. Pounds of manure per pullet 8.0

c. Total pounds of manure (a x b = c) _____

d. Tons of manure (c ÷ 2000) _____

Commercial Layers

a. Number of layers _____

b. Pounds of manure per layer 30

c. Total pounds of manure (a x b = c) _____

d. Tons of manure (c ÷ 2000) _____

Crop Fertilization Guidelines

Crop	lb N / RYE[1]	lb P / RYE[1]
Corn (grain)	1.0 - 1.25 lb N/bu	lb P/bu
Corn (silage)	10 - 20 lb N/ton	lb P/bu
Cotton	0.06 - 0.12 lb N/lb lint	lb P/lb lint
Sorgham (grain)	2.0 - 2.5 lb N/cwt	lb P/cwt
Wheat (grain)	1.7 - 2.4 lb N/bu	lb P/bu
Rye (grain)	1.7 - 2.4 lb N/bu	lb P/bu
Barley (grain)	1.4 - 1.6 lb N/bu	lb P/bu
Triticale (grain)	1.4 - 1.6 lb N/bu	lb P/bu
Oats	1.0 - 1.3 lb N/bu	lb P/bu
Bermudagrass (hay[2,3])	40 - 50 lb N/dry ton	lb P/dry ton
Tall fescue (hay[2,3])	40 - 50 lb N/dry ton	lb P/dry ton
Orchardgrass (hay[2,3])	40 - 50 lb N/dry ton	lb P/dry ton
Small grain (hay[2,3])	50 - 60 lb N/dry ton	lb P/dry ton
Sorgham-sudangrass (hay[2,3])	45 - 55 lb N/dry ton	lb P/dry ton
Millet (hay[2,3])	45 - 55 lb N/dry ton	lb P/dry ton
Pine and hardwood trees[4]	40 - 60 lb N/dry ton	lb P/dry ton
Peanuts and soybeans[5]	0	0

[1]RYE = Realistic Yield Expectation
[2]Annual maintenance guidelines
[3]Reduce N rate by 25 percent when grazing
[4]On trees less than 5 feet tall, N will stimulate undergrowth competition
[5]Not recommended for peanuts and soybeans