



THE UNIVERSITY OF GEORGIA
COOPERATIVE EXTENSION
Colleges of Agricultural and Environmental Sciences & Family and Consumer Sciences

Maximizing Poultry Manure Use Through Nutrient Management Planning

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

Poultry manure fertilizer is not used to its maximum potential for several reasons, including:

- a) lack of information on its value as a source of plant nutrients,
- b) failure to recognize how and where to use it, and
- c) lack of recognition of its economic value.

This publication provides current information about the appropriate application and most effective use of poultry fertilizer. It will also help poultry producers develop a simple nutrient management plan that meets permitting authority standards.

Quantity of Poultry Fertilizer Generated

Georgia's poultry industry produces large quantities of poultry manure. Georgia's yearly poultry production is estimated at 1.3 billion broilers, 12 million commercial laying hens, 11.8 million broiler breeder hens and 12 million replacement pullets. The manure these birds

produce is a valuable by-product with a potential gross value of more than \$60 million.

For each pound of feed consumed, a chicken will produce approximately 0.5 pound of fresh manure with a moisture content of about 75 percent. The manure rapidly loses water due to evaporation, and the final product typically has a moisture content of 20-40 percent, depending on bedding type and quantity, bird concentration, watering equipment and ventilation systems.

Manure production can vary substantially with management programs, so on-farm records are the most accurate means of determining manure production for each operation. Manure production estimates are as follows: 2.5 pounds per broiler, 20-30 pounds per commercial layer, 44 pounds per broiler breeder, and 8 pounds per replacement pullet.

Poultry Fertilizer Composition

Poultry litter from floor-raised birds (broilers, turkeys, broiler breeder pullets) consists primarily of droppings and bedding (usually wood shavings or sawdust). Feathers and waste feed make up the remaining litter components. Poultry manure consisting of only fecal droppings is associated with caged layers and broiler breeders. Liquid manure from some laying hen operations is typically stored in lagoons —

biological digesters in which bacteria decompose organic matter into gases, liquids and sludge.



Covered storage enhances litter value and nutrient retention.

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, feed nutrient density, bedding material type and amount, time in use and other management factors. Environmental factors during production and storage and post-production handling methods also influence poultry manure composition. Average poultry fertilizer plant nutrient content is listed in Tables 1 and 2.

It is often 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. Broiler litter nutrient quality has been improved by housing multiple flocks prior to cleaning out the poultry house. It is now customary to produce four to six flocks per year followed by an annual clean-out.

Based on average nutrients, a ton of poultry litter has an estimated value of \$41 (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 \$6,150. A flock of 14,000 breeder hens will produce approximately 150 tons of manure (50 percent dry weight basis) per year with a potential gross value of \$4,300.

The cost of transporting poultry litter varies. Litter removed from a broiler house is usually very bulky (67 cubic feet per ton), increasing its transportation cost per pound of nutrient. The average delivered cost for commercial operators is \$20 per ton of broiler litter; thus, litter can provide an economic benefit for many growers if it is effectively marketed.

Application of Poultry Fertilizer

To maximize poultry litter's nutrient value, incorporate it into the soil immediately after spreading. Forty to 70 percent of the total nitrogen is available during the first six weeks. The remaining nitrogen will be slowly released as organic residues decompose and may require more than one growing season. Poultry manure's nutrient availability during the first year of application is listed in Table 4. For optimum utilization, use poultry fertilizer to meet as much of the crops' phosphorus and nitrogen needs as possible, then use commercial fertilizer to furnish other nutrients to the levels needed as indicated by a soil test.

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

Potassium is present in chicken manure as both 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 readily available in most cases but may be rapidly lost by leaching if not incorporated.

Many other elements are present in chicken manure in small quantities (Table 2). Little is

known about the rate of release of these elements, but essentially all become available through decomposition. These elements are not thought to significantly affect either plant fertility or environmental factors.

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



Buffer development prevents nutrient runoff.

Poultry fertilizer can be successfully used on many crops. General rates and application timings are listed in Table 5. A successful utilization program includes the following:

- 1) Obtaining a soil test for application fields.
- 2) Calculating crop nutrient requirements.
- 3) Obtaining manure nutrient analysis.
- 4) Ensuring proper application rates.

To prevent excessively applying poultry fertilizer and potentially contaminating surface and ground water, prepare a nutrient budget worksheet for each field or crop (see Appendix for sample budget worksheet). Contact your county Extension agent for assistance generating site-specific field budgets.

The figures given in Tables 1 and 2 are average values for manure nutrient content. As indicated previously, the actual nutrient profile of a particular manure sample may vary. Having

your manure analyzed for its true plant nutrient content is recommended. Armed with this and appropriate soil test information, you and your county agent can decide on the best plan of action to use 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 manure transfers should be recorded. Such records can help to validate your use of appropriate BMPs (best management practices) and environmental stewardship practices on the farm should the environmental impact of your farm ever be called into question.

References

- Soil Facts: Poultry Manure as a Fertilizer Source*. North Carolina Cooperative Extension.
- Poultry Waste Management and Environmental Protection Manual*. Alabama Cooperative Extension.
- Vest, L., M. Merka, and W. Segars, 1998. *Poultry Waste: Georgia's \$50 Million Forgotten Crop*. University of Georgia Cooperative Extension, Leaflet #206.

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

Manure Type	Total N	Ammonium NH ₄	Phosphorus P ₂ O ₅	Potassium K ₂ O
		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

¹Annual manure accumulation in lbs/ton.²lbs/1,000 gallons.³lbs/acre-inch. Acre-inch is equivalent to 3,630 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	--	--

¹Annual manure accumulation in lbs/ton.²lbs/1,000 gallons.³lbs/acre-inch. Acre-inch is equivalent to 3,630 cubic feet or 27,154 gallons.

Source: The University of Georgia Agricultural and Environmental Services Laboratory.

Table 3. Example of the relative value of fertilizer elements in 1 ton of broiler litter and breeder hen manure.

Nutrient	\$ per pound	Broiler (\$/ton) ¹	Breeder Hen (\$/ton) ¹
Nitrogen	0.30	19.20	9.30
Phosphate	0.40	21.60	16.00
Potash	0.30	14.40	10.50
Calcium	0.03	1.29	3.60
Total		\$56.50	\$39.50

¹Assumes 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 ¹	--	0.6	0.4	--
Lagoon sludge ²	0.6	0.6	0.4	0.4
Lagoon effluent ³	0.8	0.7	0.4	0.3

¹Manure injected directly into soil and covered immediately.

²Surface-spread manure plowed or disked into soil within two days.

³Surface-spread manure uncovered for one month or longer.

⁴Sprinkler-irrigated liquid uncovered for one month or longer.

⁵Includes in-house and stockpiled litters.

Table 5. Yearly application rates for broiler litter based 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 ¹	3	Fall
Warm season annual grass	4 ¹	5	Spring-Summer
Row Crops ²			
Corn, grain	4 ¹	6.5	Fall-Spring
Corn, silage	4 ¹	8	Fall-Spring
Cotton	3 ¹	3	Fall-Spring
Grain sorghum & sweet sorghum	4 ¹	4	Fall-Spring
Sorghum silage	4 ¹	8	Fall-Spring

¹Decrease the total application rate by 25% if incorporated immediately after application.

²Application rates should not be applied on cropland with greater than 8% slope. For recommendations, contact your local Natural Resource Conservation Service or Cooperative Extension office.

Table 6. Crop Fertilization Guidelines		
Crop	lb N/RYE¹	lb P₂O₅/RYE¹
Corn (grain)	135 lb/150 bu	53 lb/150 bu
Corn (silage)	100/4.5 T	37/4.5 T
Cotton (seed & lint)	63/2600 lb	25/2600 lb
Sorghum (grain)	50/60 bu	25/60 bu
Wheat (grain)	50/40 bu	25/40 bu
Rye (grain)	35/30 bu	10/30 bu
Barley (grain)	35/40 bu	15/40 bu
Oats	50/80 bu	20/80 bu
Bermudagrass (hay^{2,3})	400/8 T	92/8 T
Tall fescue (hay^{2,3})	135/3.5 T	65/3.5 T
Orchardgrass (hay^{2,3})	300/6 T	100/6 T
Sorghum-Sudangrass (hay^{2,3})	319/8 T	122/8 T
¹ RYE = Realistic Yield Expectation ² Annual maintenance guideline ³ Reduce N rate by 25% when grazing Reference Sources: The Fertilizer Institute, The Potash and Phosphate Institute, North Carolina CES Circular AG-439-16		

Appendix

Estimating Annual Farm Manure Production

A-1

Broilers

- a. Number of broilers produced (total annual) _____
- b. Pounds of manure per broiler 2.5
- c. Total pounds of manure ($a \times b = c$) _____
- d. Tons of manure ($c \div 2000$) _____

Breeders

- a. Number of breeders _____
- b. Pounds of manure per breeder 44
- c. Total pounds of manure ($a \times b = c$) _____
- d. Tons of manure ($c \div 2000$) _____

Pullets

- a. Number of pullets (total annual) _____
- b. Pounds of manure per pullet 8.0
- c. Total pounds of manure ($a \times b = c$) _____
- d. Tons of manure ($c \div 2000$) _____

Commercial Layers

- a. Number of layers _____
- b. Pounds of manure per layer 30
- c. Total pounds of manure ($a \times b = c$) _____
- d. Tons of manure ($c \div 2000$) _____

Poultry Litter Utilization Record

A-2

[illegible]

Field Record — Litter Application

A-3

Farm Owner
Spreader Operator

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

¹ SI = soil incorporated (plowed, disced); BR = broadcast (surface applied)

Field Record — Liquid Manure Application

A-4

Farm Owner

Spreader Operator

[illegible]

¹ SI = soil incorporated (plowed, disced); BR = broadcast (surface applied); IR = irrigated

Litter/Manure Removal Record

A-5

Farm Location _____

Farm Owner _____

Litter/Manure Type Produced _____

Date Removed

Tons Removed

Name of Recipient

Phone Number

[illegible]

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	3.5 tons	_____
3. Nitrogen guidelines per unit of yield (Table 6)	38 lb/ton	_____
4. Crop nitrogen requirement (2×3)	135 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 ($4 - [5 + 6]$)	135 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 ($a \times b$)	44.8 lb/ton	_____
9. Poultry manure application rate ($7 \div 8\ c$)	3.0 ton/acre	_____
10. Acres of crop to be grown	50 acres	_____
11. Total poultry manure required (9×10)	150 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	3.5 tons	_____
3. Phosphorus guidelines per unit of yield (Table 6)	18 lb/ton	_____
4. Crop phosphorus requirement (2 x 3)	65 lb/acre	_____
5. Commercial fertilizer phosphorus added	0 lb/acre	_____
6. Crop phosphorus need from poultry manure (4 - 5)	65 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)	43.2 lb/ton	_____
8. Poultry manure application rate (7 ÷ 8c)	1.5 ton/acre	_____
9. Acres of crop to be grown	50 acres	_____
10. Total poultry manure required (8 x 9)	75 tons	_____

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