

# The Value and Use of Poultry Manures as Fertilizer

Poultry manure, properly handled, is the most valuable of all manures produced by live-stock. It has historically been used as a source of plant nutrients and as a soil amendment. However, in areas of intense poultry production, overfertilization of pasture land with poultry manure occurs. The result is suspected ground water and surface water problems as excess nutrients run off the land or leach into ground water supplies.

To obtain maximum economic value of plant nutrients in poultry manure and to protect our water supplies from excessive nutrient runoff or leaching, poultry manure should be applied to match nutrient needs of crops.

## Nutrient Analysis Of Broiler Litter

Two basic types of poultry wastes are produced in Alabama: broiler litter and caged layer manure. Broiler litter, for the purposes of fertilization, includes all floor-type birds such as broilers, pullets, and floor layers. Bedding material such as wood shavings or peanut hulls is used to absorb liquids. Caged layer manure is usually free from litter material and generally has a higher moisture content. Both types of waste will contain feathers and some wasted feed.

Chemical analysis of either type of manure varies due to moisture, temperature (more N will be lost at higher temperatures), amount and kind of bedding, amount of soil picked up

while a house is cleaned, number of batches consecutively reared, and conditions under which the manure was stored and handled prior to spreading. Alabama broiler litter is less variable than caged layer manure.

**Between 0.5 and 0.7 pound of litter is produced per pound of market weight.** Because broiler production has become more efficient in recent years, there is less waste produced per pound of market weight than 10 years ago when the value was around 1 pound of litter per pound of market weight. The decrease in waste per pound is due to drier litter (less than 20 percent moisture compared to more than 30 percent 10 years ago), improved feed conversion, and more birds on less bedding.

Layer manure is highly variable because each operation collects, stores, and handles manure differently. Nutrient content in broiler litter and layer manure from different sources and surveys is reported in Tables 1 and 2.

Caged layer manure generally contains between 1 and 2 percent N on a fresh weight basis (4 to 7 percent on a dry weight basis) if collected at 1- to 3-week intervals. However, under high-rise houses where layer manure sometimes accumulates for long periods of time, some N is lost into the air as ammonia gas. At the same time, manure dries which increases concentration of all nutrients.

Moisture is the most important variable to consider when manure is spread by the ton. Manure will average 70 to 77 percent moisture

when excreted. However, broiler litter dries under normal house conditions and will average about 20 percent moisture. Caged layer manure is much more variable depending upon the storage system. Because manures and litter are spread by the ton as they are re-

**Table 1. Average Nutrient Composition Of Alabama Broiler Litter On A Fresh Weight Basis.**

	Weighted Mean <sup>a</sup>
Number of samples	207.0
Moisture, %	19.7
<i>Primary Plant Nutrients</i>	
Total N, %	3.10
P <sub>2</sub> O <sub>5</sub> , %	2.77
K <sub>2</sub> O, %	2.04
<i>Secondary Plant Nutrients</i>	
Ca, %	1.79
Mg, %	0.38
S, %	0.34
<i>Micronutrients</i>	
Cu, ppm	332
Fe, ppm	1,950
Mn, ppm	277
Zn, ppm	252
B, ppm	55
<i>Other Analyses</i>	
As, ppm	281.0
Ash, %	18.8

<sup>a</sup>Weighted mean is calculated from four separate surveys conducted in Alabama from the mid-1980s through 1993. The surveys included a total of 207 samples.

**Table 2. Nutrient Composition Of Fresh, Caged Layer Manure.**

	Pennsylvania <sup>a</sup> caged layers	Pennsylvania <sup>b</sup> caged layers	Alabama caged layers	North Carolina <sup>c</sup>		
				fresh	scraped	high rise
Moisture, %	60	50	70	—	—	—
<i>Primary Plant Nutrients</i>						
Total N, %	1.94	2.0	1.5	1.3	1.4	1.9
P <sub>2</sub> O <sub>5</sub> , %	2.85	2.0	1.3	1.1	1.6	2.8
K <sub>2</sub> O, %	1.61	1.0	0.5	0.5	1.0	1.5
<i>Secondary Plant Nutrients</i>						
Ca, %	6.15	3.50	—	—	2.10	4.30
Mg, %	0.15	0.25	—	—	0.30	0.30
S, %	—	0.25	—	—	0.35	0.44
<i>Micronutrients</i>						
Cu, ppm	—	15	—	—	18	22
Fe, ppm	—	450	—	—	260	900
Mn, ppm	—	150	—	—	135	260
Zn, ppm	—	150	—	—	160	185
B, ppm	—	20	—	—	25	23
Na, %	—	—	—	—	0.22	0.25

<sup>a</sup>Patterson, P. H., 1994. Estimating manure production based on nutrition and production: Laying hens. Proc. 1994 Poultry Waste Management Symp. pp. 90-96.

<sup>b</sup>Shipp, R. F., H. C. Jordan, W. W. Hinish, and D. B. Beegle. 1981. Spec. Cir. 274. The Pennsylvania State Univ. College of Agriculture, Extension Service. University Park, PA.

<sup>c</sup>Zublena, J. P., J. C. Barker, and T. A. Carter. 1993. Poultry manure as a fertilizer source. North Carolina Coop. Ext. Serv. Soil Facts. Raleigh, NC.

moved from the house or from storage, analyses should be compared on a fresh weight basis.

## Nutrient Availability

Poultry manure is managed primarily for its nitrogen (N) value. However, N availability from broiler litter is the most difficult of the three primary nutrients to predict. About one-third of the total N in broiler litter is in the ammonium form (NH<sub>4</sub>-N) and the rest is in an organic form. The amount of N available for plant uptake is ammonium nitrogen plus the amount of organic nitrogen that mineralizes during the growing season.

From Table 1, broiler litter has the following average nutrient content:

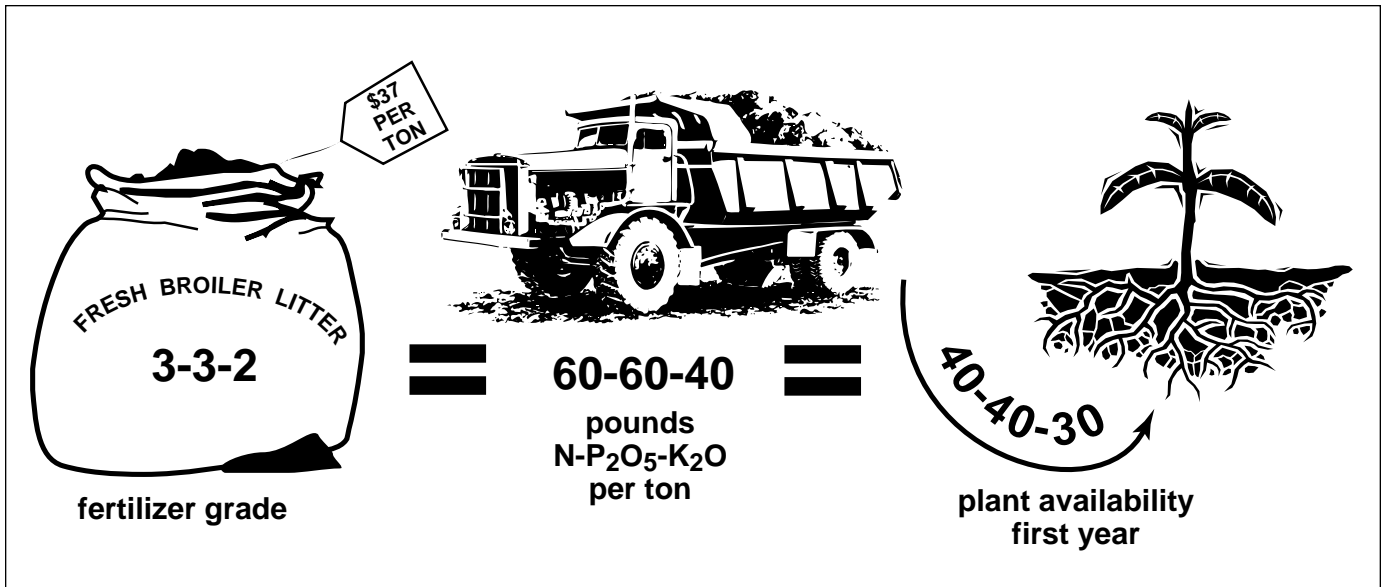
Fertilizer grade:	3-3-2 (N-P <sub>2</sub> O <sub>5</sub> -K <sub>2</sub> O)
Total nutrients (lb./ton):	60-60-40
Available nutrients first season (lb./ton):	40-40-30

**Ammonium N.** The ammonium N fraction (NH<sub>4</sub>-N) is subject to conversion to ammonia gas (NH<sub>3</sub>) and atmospheric loss (volatilization). When manure has a strong ammonia odor or is spread on the surface of a soil and not incorporated, significant N will be lost to the air. Losses typically range from 15 to 50 percent of the ammonium fraction (5 to 20 percent of total N) when broiler litter is surface applied. If layer manure is spread as a liquid or slurry, as much as 75 percent of the ammonium N (one-fourth of total N) could be lost within 7 days after spreading when the weather is hot and dry and manure is not soil-incorporated. Of course, incorporation is not practical or even desirable in some situations such as pastures or hay fields, and ammonium N loss should be deducted from the total amount to be applied.

**Organic N.** The organic N fraction gradually becomes avail-

able for crop uptake as the manure decomposes (mineralizes). Mineralization rates can range from 40 to 90 percent depending on environmental conditions. For broiler litter in Alabama, assume that 60 percent of the organic N may be released during the first year following application. Therefore, around 70 percent of the total N in broiler litter will be available to the crop the first year after application.

**Phosphorus (P) And Potassium (K).** The P and K fractions are considered to be about 75 percent as effective as commercial fertilizers during the first year of application. If litter is applied at rates that will supply all N needed by the crop, P and K applications greater than those needed by the crop may occur. Under frequent manure applications, P will build up in soils to extremely high levels. Potassium may also build up unless large quantities of hay or forage are removed.



## Fertilizer Value Of Broiler Litter

Estimated value per pound of nutrient is based upon the 1995 retail cost for ammonium nitrate (34-0-0), liquid N solution (32-0-0), concentrated superphosphate (0-46-0), and muriate of potash (0-0-60):

N	.....	\$0.29/pound
P <sub>2</sub> O <sub>5</sub>	.....	0.23/pound
K <sub>2</sub> O	.....	0.15/pound

Using an average fertilizer grade of 3-3-2 (Table 1), a reasonable estimate of the value of broiler litter would be about \$37 per ton. If only readily available nutrients are considered, then the value would be around \$25 per ton.

## Land Application

When applying poultry manure to cropland, pastureland, and hayfields, consider the following:

- Determine the nutrients in the manure prior to spreading. An analysis by a commercial laboratory determines moisture, total N, and other plant nutrients and allows the farmer to calculate the value of the manure and how much to apply. If a chemical analysis is not made, average nu-

trient contents of broiler litter can be used such as 60-60-40 pounds total N-P<sub>2</sub>O<sub>5</sub>-K<sub>2</sub>O per ton or 40-40-30 pounds of available nutrients per ton. If litter is analyzed for available nutrients, keep in mind that stored litter can change over time unless protected.

- Credit previous manure applications. If more than 4 tons per acre of broiler litter has been applied during the past 2 years, residual soil organic N should be considered. About 5 pounds of N per ton of litter applied last year will become available to this year's crop. This amount needs to be subtracted from the total N recommended for the crop.

- Soil test for residual nutrients. Soil testing provides the best estimate of residual P and K in the soil and other soil amendments (such as lime) that should be applied for optimum yields and efficient nutrient use. If soil test P is rated very high (VH) or extremely high (EH), consider using a commercial fertilizer that does not contain P, such as 15-0-15 or ammonium nitrate (34-0-0). Continued application of manures, especially broiler litter, will increase soil P to the point that surface water enrichment with P could result. If soil test P is not VH or EH, apply litter or manure based upon

recommended N rate for the crop to be grown. The N recommendation is given on the soil test report. Exceeding recommended rates for available nutrients by more than 50 percent could result in excessive N leaching in some soils or potential surface runoff into streams.

- Calculate litter or manure needs based upon N availability. For example, 60 pounds of N per acre is recommended for fescue pasture in the fall and again in the spring. If 1 ton of litter contains 40 pounds of available N, then 1.5 tons should be applied per acre in the fall and again in the spring.

- Check application rates. Check the actual rate that is applied by calibrating spreading equipment. A drop cloth to collect and weigh the litter that is spread on the field is a quick way to estimate application rate (See Circular ANR-889 "Calibrating Poultry Litter Spreaders").

- Apply litter at the right time. Timing of application should correspond to the time of year when the crop can use the nutrients. Applying litter when there is no actively growing crop or at a time of the year when the crop is dormant is inefficient use of plant nutrients and could result in surface and ground water contamination.

# Additional Facts About Using Poultry Manure

**Broiler Litter Storage.** Broiler litter is most valuable immediately after it is removed from the house. The N in the litter can be preserved if it is stored in an enclosed structure (dry stack barn) or in a deep pile that is covered (See Circular ANR-839, "Broiler Litter Storage"). **Never store litter outside and exposed to the weather!** Broiler litter should be handled like commercial fertilizers. Rain can leach valuable nutrients into surface waters. Manure stored outside and exposed to the weather will decompose rapidly. An ashy-gray appearance indicates a loss of nutrient value.

**Composted Broiler Litter.** When broiler litter is exposed to air and moisture, the ammonium N component is converted to organic N. Therefore, N in composted litter or litter that has been exposed to the weather for several months is less available to the crop. The moisture content of composted litter is generally around 40 percent compared to 20 percent in fresh litter. Composting also reduces its value. Composted litter may have a fertilizer grade of 1.5-3-1 compared to a 3-3-2 for fresh litter.

**Poultry Mortality Composts.** Composted dead birds from a broiler operation have about the same nutrient concentration as fresh litter on a fresh weight basis. A survey of 30 composters in Alabama found an average moisture of 36 percent. On a fresh weight basis, the average fertilizer grade of the secondary compost was 2.4-2.6-1.6 (48-52-32 pounds N-P<sub>2</sub>O<sub>5</sub>-K<sub>2</sub>O per ton).

**Ammonia Odors.** To conserve N in poultry manure and to reduce ammonia odor and associated N loss, superphosphate can be applied at the rate of 100 pounds per ton of manure in the house. The phosphate will trap the ammonia as ammonium phosphate. However, the increased P in the litter may not be needed by the crop.

**Hydrated Lime.** Hydrated lime (calcium hydroxide) will help dry out litter, reduce fly problems, and maintain good litter condition. However, it will also increase ammonia volatilization and N loss. Do not use it when the ammonia level in the house is high. Use lime at the rate of 50 pounds per 1,000 square feet of floor space. **Never apply agricultural lime to poultry houses!**

**Litter Disposal.** Where excess quantities of manure must be disposed on the land, choose a cropping system to maximize N uptake. Row crops are poor users of soil N because of a limited root system. Corn or cotton may take up only 50 to 60 percent of the N applied. Grasses, such as hybrid bermudagrass and bahiagrass, produce large amounts of dry matter and are efficient N users. As much as 90 percent of the applied N could be recovered by a good bermudagrass sod. Cool season grasses such as fescue and ryegrass are not as efficient because most of their growth is in the early spring. Harvest excess forage frequently to remove N from the land. These practices will minimize potential surface and ground water contamination from excess N applied in manure.

**Liming Value Of Poultry Manures And Broiler Litter.** Because layers are fed ground limestone, the manure has some liming value. Even broiler litter may increase the soil pH slightly. However, layer manure and broiler litter should be applied for its nutrient value. Monitor soil pH with routine soil testing and apply additional agricultural lime if needed.



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**Charles C. Mitchell**, *Extension Agronomist*, Professor, Agronomy and Soils, and **James O. Donald**, *Extension Agricultural Engineer*, Professor, Agricultural Engineering, both at Auburn University

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500, Reprinted Jan 1999, ANR-244