CLEMSON EXTENSION

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StudyWeb

LAND APPLICATION OF ANIMAL MANURE

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Animal manure can be an economical source of crop nutrients. There are three key steps to utilizing manure in an environmentally and economically sound manner:

- know the nutrient content of the manure,
- apply a uniform rate based on crop nutrient needs, and
- adjust the rate of supplemental fertilizer to compensate for the nutrients applied in the manure.

Use of manure and fertilizer as nutrient sources for crop production must be managed properly to ensure that they do not contaminate ground or surface water.

Additional information can be obtained from the **Extension publications of the University of Georgia.**

Nutrient Content

Nutrient content of animal manure is variable, depending on the type and age of animal, feed source, housing type, handling method, temperature, and moisture content. Because of this variability in nutrient content, individual land application decisions should be based on the nutrient content of the manure to be applied.

Average nutrient contents **(Table 1 and Table 2)** are useful in determining overall waste management plans, but should not be used to determine actual land application rates. Application rates are usually based on nitrogen (N), phosphorus (P expressed as P_2O_5) and/or potassium (K expressed as K_2O) contents. Quantities of secondary and micronutrients applied in manure are generally sufficient to prevent deficiency.

Why Measure the Nutrient Content of Manure ?

Not knowing the nutrient content of the manure to be applied can result in large errors in application rate. For instance, the plant-available N content of broiler litter can easily range from 25 to 50 lb N/ton. To supply 125 lb N/acre to a corn crop, 5 ton/acre of the low N litter is needed, but only 2.5 ton/acre of the high N litter is required. If 5 ton/acre of the high N litter were applied, an extra 125 lb N/acre would be added to the soil, wasting valuable nutrients and increasing the potential for ground and surface water contamination. Two and one-half ton/acre of the low N litter would only provide 63 lb N/acre and would be insufficient to produce the intended yield.

What Happens When I Stockpile Manure ?

Stockpiling solid manure uncovered and exposed to rainfall results in a reduction in the N and K_2O content. Also, the manure becomes sticky and difficult to spread uniformly. Leaching of N and run-off of N and P from the stockpiled manure may pollute ground and surface water.

Improper storage of manure can result in water pollution. The nutrient content of the manure, as well as the ability to spread it uniformly, are reduced with rainfall.

Excessive Algal growth due to phosphorus run-off into a pond. Click here for a larger photo.

Manure Sampling

Nutrient analysis of animal manure for land application can be obtained from the **Agricultural Service Laboratory.** Analyses include moisture, organic-N, ammonium-N, available-N, P_2O_5, K_2O, calcium (Ca), magnesium (Mg), sulfur (S), zinc (Zn), copper (Cu), manganese (Mn), and sodium (Na). The fee is $10 to $15 per sample and depends on the analyses requested. Manure samples can also be submitted to the **Soil, Plant and Water Analysis Lab** at the University of Georgia, or to the **Auburn University Soil Test Lab.**

Obtaining a representative sample is one of the most important tasks in manure management because application rates are based on the concentration of nutrients in the manure. Samples should be taken as close as possible to the time of application. If several weeks elapse between sampling and land application, or if the manure gets altered by rainfall or manure additions, another sample should be obtained.

To take a representative sample, obtain a quart of waste from 15 to 20 locations in the pile or lagoon and

place in a large clean plastic bucket. Mix this bulk sample thoroughly, then place about a quart in a clean plastic bag or bottle. Seal tightly, but leave room for the sample to expand. Keep the sample cool. If the sample is not mailed to the laboratory on the same day it is sampled, it should be refrigerated.

Nutrient Availability

Although manure application rates are usually based on N availability, managing manures for their P_2O_5 and K_2O contents can also be important. The availability of P_2O_5 and K_2O in manures in the year of application is similar to that of fertilizer sources, so basing application rates on the manure's P_2O_5 and K_2O content should be adequate. Determine how much P_2O_5 and K_2O are applied in the manure and supplement with fertilizer, if necessary. On soils testing high in P_2O_5 and K_2O (no P_2O_5 and K_2O recommended from soil test), consider using the manure on other fields requiring P_2O_5 and K_2O. Incorporation of the manure into the soil as soon as possible and controlling erosion and runoff minimizes the impact of P on surface water quality.

Nitrogen availability from animal manure is difficult to predict. Availability of N is dependent on release of N from the waste and loss from the soil. Nitrogen is in manure in three forms--organic, ammonia/ammonium, and nitrate. The quantity of each is difficult to predict because of the dependence on the same environmental factors that affect nutrient content. The three forms of N have different plant availabilities and are lost from the soil in different ways.

Often, organic-N is the predominant form of N in animal manure. Organic-N is not available to crops until it has been decomposed to ammonium. The speed and extent of degradation are dependent on the type of manure, soil type, soil moisture and temperature and how well the manure is mixed with the soil. Estimates of organic-N availability range from 30 to 80 percent of the organic-N available in the first cropping season. We are currently assuming an average of 60 percent availability of organic-N from animal manure in the first cropping season after incorporation. Since many factors influence the decomposition rate of organic-N, its actual decomposition can be more or less than this estimate. Organic-N is lost from the soil only by erosion.

Considerable quantities of ammonia/ammonium N occur in most manures. Ammonia (NH_3) is a gas, and ammonium (NH_4^+) is a charged molecule dissolved in the soil water. Ammonia and NH_4^+ are rapidly interchangeable, dependent on the pH of the solution. Increasing pH increases the amount of NH_3 and decreases NH_4^+. Most crops will take up NH_4^+ as well as any other form of N but do not accumulate NH_3 to any extent. Ammonia is readily lost to the atmosphere from the soil. As much as 15 percent of the NH_3 from surface applied manure can be lost each day with breezy, warm, moist conditions on sandy soils with a high pH. Considerable losses of NH_3 can occur when manure is applied to pasture. Leaching losses of NH_4^+ from soil are small.

Do We Get Any Benefit From The Manure After The First Cropping Season ?

The organic-N that is not decomposed to ammonium in the first cropping season may be released in subsequent seasons. Unfortunately, there is not enough research to make recommendations on how much

becomes available. There is probably little N released after the first season from one-time applications at rates to provide the crop N requirement in the first season. However, for fields with a long-term manure history--annual applications for five years or more--the amount of N released from previous seasons' applications may be significant.

How Fast Is NH_4 Converted To The Leachable Form Of Nitrogen--Nitrate ?

Ammonium does not persist in soils in South Carolina if soil temperatures exceed 40º F, because it is rapidly converted to nitrate (NO_3-). For example: Dairy wastewater high in NH_4+ was applied to the soil in February. Within twelve days after application, most of the NH_4+ had been converted to NO_3-. (Fig. 1)

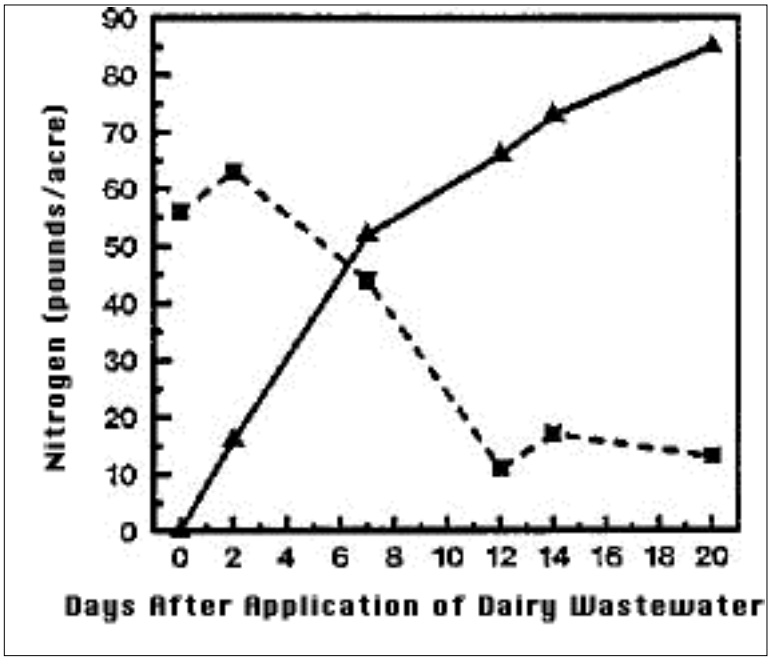

Figure 1. Changes in soil nitrate and ammonium after an application of dairy wastewater in February containing 56 lb/acre of organic-N and 56 lb/acre of ammonium-N.

Some NO_3- is found in manure but usually not much. However, the fate of NO_3- is important, because organic-N and NH_4+ are converted to NO_3-. Although NO_3- is readily accumulated by crops, it can be lost from the soil by two ways. Excess rainfall or irrigation that results in water movement through the crop rooting zone will result in loss of NO_3- by leaching. When soils are saturated, but leaching does not occur, NO_3- can be converted to several gaseous N forms and lost to the atmosphere. These processes can occur readily; therefore, it is best to apply manure or fertilizer to provide N at the time the crop's requirement for N is greatest.

Application Rates

The rate of manure applied is usually based on the plant-available N content of the manure and the recommended N rate for the crop to be grown. Available-N is calculated as 60 percent of the organic-N and 80 percent of the NH_4^+ for the first year after application, if the manure is incorporated into the soil immediately. Plant-available NH_4^+ should be reduced 15 percent per day for every day the manure remains unincorporated. Recommended N rates for crops are as low as 70 lb N/acre for cotton and tobacco to as much as 400 lb N/acre for bermudagrass hay. A portion or all of the crop's N need can be provided with manure. If manure rates provide more available-N than is required by the crop, excess NO_3 in the soil may contaminate groundwater, if rainfall or irrigation leach it from the rooting zone.

- ***Use the worksheet at the end of this web page to assist you in determining the proper application rate.***

- ***John Chastain has provided the following tables which are useful for determining the application rate of lagoon effluent or waste once the Nitrogen requirement of the crop is known.***

- ***Also, the University of Georgia has available a software program called UGFERTEX where the application rate of animal wastes are automatically calculated from soil test data and animal waste composition information. More information about this program can be obtained from Owen Plank.***

Application rates of solid manures are determined in one of two ways. The most common method is to weigh a truck load of manure, spread it until the truck is empty, determine the acres spread, and then calculate the rate of application. An alternative method is to spread several plastic sheets on the soil surface, weigh the manure that lands on each sheet, and then calculate the rate. Although both methods give an average rate of application, the second method measures the variability of the application and allows one to spread the first truck load of manure at the intended rate.

Incorporate as soon after application as possible to conserve nitrogen and phosphorus and reduce odors and flies.

Direct manure injection below the soil surface reduces Nitrogen loss and odor. Click here for a larger photo.

Are Applications Of Manure Variable ?

*The rate of poultry manure applied by several South Carolina farmers was measured by the sheet method **(Table 3).** The actual application rate was significantly less than the farmers intended, and the range in application rates from place to place in the field was generally twofold. Determining the application rate, as well as the nutrient content, of manure enables one to add known amounts of plant nutrients.*

Liquid manure application rates can be determined by knowing the quantity of liquid applied to a known acreage or measuring the inches of liquid applied with a rain gauge. One acre-inch of liquid is equivalent to 27,154 gallons. Variability of liquid manure application rate can be high and is dependent on the type of application equipment.

Uniform application of manure is important, because managing the crop will become more difficult as variability increases. Variability in application often leads to over-fertilization of the majority of the field to compensate for small areas receiving inadequate nutrient supplies.

Determining the Dollar Value of Manure Nutrients

The value of manure nutrients is dependent on the nutrient status of the field to which it is applied, the nutrient needs of the crop to be grown, the nutrient content of the manure, and the cost of purchased nutrients. For example: A farmer has three fields of different fertility status--testing low, medium and high for P and K. The farmer wishes to grow 120 bu/acre corn and follows Clemson's nutrient recommendations. The farmer has poultry manure with a nutrient content of 40 lb available-N/ton, 60 lb P_2O_5/ton, and 40 lb K_2O/acre. The farmer applies 3 ton manure/acre to provide all of the N needed to grow the crop. Purchased N, P_2O_5, and K_2O cost 30, 27, and 16 cent/pound, respectively. The value of the manure per ton for each field can be calculated using the following formulas.

When applying manure at a rate to satisfy the N needs of a crop, P_2O_5 and K_2O are usually applied in excess of need. The value of manure as a nutrient source is greatest when applied to a soil of low fertility status. Excess nutrients are not given any value. Hauling and application costs were not considered in this analysis but should be determined on an individual basis.

Soil Testing Low in P + K

NUTRIENT	RECOMMENDED APPLICATION	AMOUNT APPLIED WITH MANURE	VALUE	EXCESS NUTRIENTS
.	----------lb / acre----------		$/3 ton	lb / acre
N	120	120	120 X .30 = 36.00	0
P_2O_5	80	180	80 X .27 = 21.60	100
K_2O	80	120	80 X .16 = 12.80	40

The nutrient value of this manure on a soil testing low in P and K is $23.47/ton. When the manure is added to a low fertility soil, 80 lb/acre of P_2O_5 and K_2O are recommended from soil analysis and credited with value.

Soil Testing Medium in P + K

NUTRIENT	RECOMMENDED APPLICATION	AMOUNT APPLIED WITH MANURE	VALUE	EXCESS NUTRIENTS
.	----------lb / acre----------		$/3 ton	lb / acre
N	120	120	120 X .30 = 36.00	0
P_2O_5	50	180	50 X .27 = 13.50	130
K_2O	50	120	50 X .16 = 8.00	70

The nutrient value of the manure on a soil testing medium in P and K is $19.17/ton. Partial credit is given to the P and K content of the manure, because only 50 lb P_2O_5 and K_2O/acre were recommended from soil analysis.

Soil Testing High in P + K

NUTRIENT	RECOMMENDED APPLICATION	AMOUNT APPLIED WITH MANURE	VALUE	EXCESS NUTRIENTS
.	----------lb / acre----------		$/3 ton	lb / acre
N	120	120	120 X .30 = 36.00	0
P_2O_5	0	180	0 X .27 = 0	180
K_2O	0	120	0 X .16 = 0	120

The nutrient value of the manure on a soil testing high in P and K is $12.00/ton. In this situation, no credit is given to the P and K content of the manure, because no P and K were recommended from soil analysis.

Plant and Soil Analysis

Because of the uncertainty in decomposition of organic-N in manure, as well as unquantifiable losses of NH_3 and NO_3-, it is recommended that the N status of the crop be monitored with plant and soil analysis. Sampling representative plant tissues on a regular basis--every two weeks, for instance--gives one the ability to track the nutrient status of the plant and take corrective measures, if necessary. Repeated sampling is most often used to follow the N status of the plant, because soil tests for N are not currently available. For small grains, corn, and many other crops, the plant part to be sampled and sufficiency ranges for several nutrients, including N, can be found in **Bob Lippert's "Frequently Asked Questions" Web Page.**

Use some method to calibrate your spreader so you can add the proper amount of nutrients to each field. This is the plastic sheet method.

To determine the sufficiency of nutrients other than N, it is acceptable to take diagnostic tissue samples. These samples should be taken once a season at easily identified crop growth stages, such as heading for small grains and silking for corn. The sufficiency range for the plant tissue sampled will be included with the plant analysis. Yearly sampling can be used not only to assess the level of several nutrients in that year, but to follow changes in soil fertility over several seasons.

Currently, there are no guidelines for determining if soil supplies of N are adequate for crop growth. However, soil sampling of the root zone and determination of NO_3- can be useful. Several of the requirements for taking a representative soil sample for NO_3- analysis are the same as those for taking traditional soil samples. Fields should be separated into different soil types. Areas that were cropped, fertilized, or manured differently should be sampled separately. Soil samples should represent no more than 10 acres, and each sample should be comprised of fifteen or more cores.

The major differences between soil sampling for NO_3- analysis and traditional soil sampling are the depth and time of sampling and sample handling. Nitrate is easily leached from the sandy surface soil but can accumulate in the clay subsoil. Because of this, NO_3- samples need to be taken deeper than the traditional 6-inch soil sample and as close to fertilization time as possible.

Soil samples for NO_3- analysis should represent a major portion of the crop rooting zone, which is at least 3 feet for most crops. The samples should be taken in onefoot increments to a depth of 3 feet. Each one-foot sample should be sent to the laboratory as a separate sample. Soil samples for NO_3- analysis should be spread thinly to air dry within one hour of sampling. This minimizes changes in NO_3- content that will occur in moist soil. After the samples have dried, send them to a soil testing laboratory and request a NO_3- analysis or use a portable NO_3- test kit. The results will be reported in ppm (parts per million) of NO_3--N. Multiply the ppm value for each onefoot increment by 4 to convert the results into lb N/acre. Add the lb N/acre in each increment to determine the total NO_3--N content of the entire sampling depth. This will serve as an indicator of whether excess N is being applied.

How Do I Calculate The Amount Of NO_3--N Available To My Crops Fom Soil NO_3- Analysis Results ?

Soil Increment	NO_3--N ppm	NO_3--N lb / acre
0 - 1'	2	8
1 - 2'	3	12
2 - 3'	6	24
TOTAL	.	44

Multiply* NO_3--N *in ppm times 4 to convert to* NO_3--N *in lb / acre when the sampling increment is 1 foot.

ODOR CONTROL

John P. Chastain, Agricultural and Biological Engineering, Clemson University

For an odor to be detected downwind, odorous compounds must be (a) formed, (b) released to the atmosphere, and (c) transported to the receptor site. These three steps provide the basis for most odor control. If any one of the steps is inhibited, the odor will diminish.

Follow this link to further investigate **Odor Control.**

MINI-PITS: A Short-Term Manure Storage Alternative For Freestall Dairy Facilities That Haul Daily Or Use Sand Bedding

John P. Chastain, Agricultural and Biological Engineering, Clemson University

The Value And Use Of Poultry Manures As Fertilizer

Charles C. Mitchell, Extension Agronomist, and James O. Donald, Extension Agricultural Engineer, Auburn University.

***Note: Additional information can be found at this Auburn Extension Publication site.**

WORKSHEET:
Determining The Nutrient Needs Of Your Crop*

Use a copy of this worksheet to determine how much manure to apply to your field.

.	EXAMPLE	YOUR FARM
1. Crop to be grown.	corn	_____
2. Clemson nutrient recommendation based on soil test. a. N (lb/acre) b. P_2O_5 (lb/acre) c. K_2O (lb/acre)	 120 50 50	 _____ _____ _____
3. Nutrients applied preplant or at planting. a. N (lb/acre) b. P_2O_5 (lb/acre) c. K_2O (lb/acre)	 20 0 0	 _____ _____ _____
4. Net nutrient needs of crop (lb/acre). Nitrogen, phosphorus, and potassium: total need (item 2a,2b,2c) minus additional nutrients from preplant or at planting (item 3a,3b,3c) a. N: 120-20 (lb/acre) b. P_2O_5: 50-0 (lb/acre) c. K_2O: 50-0 (lb/acre)	 100 50 50	 _____ _____ _____

5. Available nutrients in manure based on laboratory analysis. a. Available-N (lb/ton) b. P_2O_5 (lb/ton) c. K_2O (lb/ton)	 40 60 40	 _____ _____ _____
6. Application rate to supply priority nutrient. a. Priority nutrient b. Amount of priority nutrient needed (lb/acre from 4a) c. Rate of manure needed to supply priority nutrient (6b) divided by (5a): 100/40(ton/acre)	 N 100 . 2.5	 _____ _____ _____
7. Pounds per acre of all nutrients supplied at the application rate required to meet the needs for the priority nutrient: for each nutrient enter the available nutrients (5a,5b,5c) times manure rate (6c). a. N supplied: 40 X 2.5 (lb/acre) b. P_2O_5 supplied: 60 X 2.5 (lb/acre) c. K_2O supplied: 40 X 2.5 (lb/acre)	 100 150 100	 _____ _____ _____
8. Nutrient balance: net nutrient need (-) or excess (+): amount of nutrient applied by manure (7a,7b,7c) minus net amount needed by crop (4a,4b,4c). a. N balance: 100-100 (lb/acre) b. P_2O_5 balance: 150-50 (lb/acre) c. K_2O balance: 100-50 (lb/acre)	 0 +100 +50	 _____ _____ _____

***Calculation format adapted from SoilFacts - Poultry Manure as a Fertilizer Source. North Carolina Agricultural Extension Service Fact Sheet AG-439-5. July 1990.**

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Owen Plank, Soil Testing and Plant Analysis, University of Georgia.

MINI-PITS: A SHORT-TERM MANURE STORAGE ALTERNATIVE FOR FREESTALL DAIRY FACILITIES THAT HAUL DAILY OR USE SAND BEDDING

John P. Chastain
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Introduction

Many dairy producers in South Carolina land apply manure from freestall barns or outside lot areas daily. The primary advantage of a daily haul waste system is lower initial cost. However, daily application of dairy manure has the following disadvantages.

(1) Manure must be spread during rainy weather. Application of manure on wet fields or pastures can damage forage stands, degrade soil structure, and create polluted runoff that could pollute surface water.

(2) Manure can not always be spread of forage or crop land at a time when the nitrogen can be taken up by the plants. For example, if manure nitrogen is applied several weeks before planting corn or when hay crops are not actively growing then a portion of the nitrogen may leach out of the plant root zone. Ground water pollution could occur in regions of South Carolina that have sandy soils.

(3) Manure must be removed from freestall alleys at least twice each day to keep cows clean. If a short-term structure is not provided the manure would need to be hauled to the fields twice each day. Most producers do not have time to haul manure twice each day. As a result, cow cleanliness suffers if some sort of manure containment is not provided.

(4) Hauling manure daily is not an efficient use of labor on a dairy farm. Short-term storages that allow manure to be hauled every 2 to 8 weeks are more efficient.

A ramped, concrete mini-pit **(shown in Figure 1)** can provide a low-cost, short-term storage that will improve labor efficiency, allow implementation of a environmentally sound manure utilization plan, and allow better management of the freestall area. A mini-pit is also a short-term storage alternative that works well with sand-bedded freestalls.

Location of Mini-pits

A mini-pit should be located off the end of a 2 or 3-row freestall barn or south of the cross alley of a drive-through barn. Locate the mini-pit so that it will not interfere with farm vehicle, or cow traffic. Manure is scraped from the building into the pit with a skid-steer loader. When selecting the location of the mini-pit be sure to provide adequate room for maneuvering loaders and manure spreaders. Consider factors such as water drainage, roof runoff, and long-term impact of the location on vehicle or animal traffic.

A mini-pit to provide for 2 weeks of covered storage for the manure produced by 100 cows. Click here for a larger photo.

Water drainage is a critical factor in selecting the location for a mini-pit. Do not locate the pit where runoff will flow towards the pit. Also use gutters or channels on grade to divert all rainwater from the roof of the freestall barn so that it will not enter the mini-pit. If significant attention is not given to drainage the short-term storage will fill with rainwater.

Mini-pits can be located on the end of the alleys inside the freestall barn. Covering the mini-pit with a roof has the advantage of limiting the amount of rain that will enter the mini-pit, and will prevent an overflow caused by rain. An old hay shed or similar building could be used to cover a large mini-pit if it is near the site of the proposed freestall barn.

• Construction

Poured-in-place concrete is a popular material for mini-pits. However, prefabricated panels can be used for the sidewalls. Walls are typically 6 inches thick and steel reinforced. Concrete wall design is provided in the following publications:

Farm and Home Concrete Handbook (MWPS-35); and
Concrete Manure Storages Handbook (MWPS-36).

Both of these publications can be obtained from the Agricultural and Biological Engineering Department at Clemson University (864-656-3167).

Storage Capacity

A mini-pit is typically sized to provide 1 to 4 weeks of storage. However, producers that use sand bedding in freestalls have constructed ramped concrete pits to provide 2 to 4 months storage. In South Carolina the minimum storage period that is desirable is 2 weeks to allow storage of all manure during and after periods of heavy rainfall. The actual storage period needed for a given farm will depend on the diversity of the crops and forages grown. Provide storage capacity for the longest period when manure can not be applied based on the waste management plan of the farm.

Dairy producers that plan to spread manure every 2 to 4 weeks should carefully plan crop rotations, to provide land for spreading during the growing season. Some practices that can provide multiple ³windows² to spread manure throughout the year are:

- double or triple crop all row crop fields,
- spread manure after cutting hay,
- spread manure on pasture,
- plant a variety of annual and perennial forage crops that will provide nutrient uptake 9 to 12 months out of the year,
- contract with neighbors to spread manure on crop or forage land once or twice each year, or
- spread a portion of the manure on forest land to increase wood production. Dimensions and storage capacities of several mini-pits are given in **the Tables** .

Ramp Slope

Slope the ramp to drop a maximum of 1 ft per 10 ft of ramp length to allow convenient access with a skid-steer or large bucket loader. If the ramp is too steep then the loader will not be able to drive up the ramp during warm weather. Providing grooves across the ramp will improve traction.

Safety Fence

Provide a steel pipe fence on three sides of the mini-pit. Position the bottom rail so that manure can be pushed beneath the fence (see Figure 1). Manure can be pushed into the pit from all three sides and will allow frozen manure to be pushed into the pit in multiple locations. Provide additional security fencing that will keep children and livestock from entering the pit area.

Filling and Emptying

Manure is scraped from the alleys into the pit using a skid-steer loader, or tractor and bucket. Mini-pits are intended to provide short-term storage for manure from freestall facilities. Parlor and milk house wastewater should not be included. Addition of wastewater will make the manure more difficult to remove from the pit with a bucket loader. If wastewater is mixed with sand-laden manure large amounts of sand will settle out, and cleaning out the pit will be more time consuming. If desired, a pto-driven, manure auger (12 to 15 inches in diameter) can be used to quickly lift sloppy manure from the pit into a spreader during most of the year. A portion of the manure solids (and sand) will be deposited on the ramp and bottom, but they can be easily scraped toward the auger or removed with a bucket loader.

A PTO driven auger can be used to unload dairy manure from mini-pits. Click here for a larger photo.

Summary

Mini-pits can provide a method to improve the labor efficiency of handling manure in freestall barns that would normally use daily haul. The minimum storage period that is recommended in South Carolina is 2 weeks. However, the mini-pit must be sized to store manure for the longest period for which manure can not be spread. Dairy producers that use sand bedding in freestalls may want to consider using a mini-pit to provide short-term storage for sand-laden manure.

Return to The Land Application of Animal Manure.

Table 1. Nutrient content of different sources of animal manure.

MANURE TYPE AND HANDLING	INFO. SOURCE	TOTAL N	AMMONIUM-N	PHOSPHORUS P_2O_5	POTASSIUM K_2O
BROILER		**---------- lb / ton ----------**			
all types	a	51	13	64	48
fresh (no litter)	b	26	10	17	11
broiler litter	b	72	11	82	46
roaster litter	b	73	12	75	45
breeder litter	b	31	7	54	31
stockpiled litter	b	36	8	80	34
all types	d	59	15	63	40
TURKEY		**---------- lb / ton ----------**			
all types	a	61	18	57	41
fresh (no litter)	b	27	8	25	12
brooder litter	b	45	9	52	32
grower litter	b	57	16	72	40
stockpiled litter	b	36	8	72	33
LAYER		**---------- lb / ton ----------**			
all types	a	35	14	42	28
fresh (no litter)	b	26	6	22	11
under cage scraped	b	28	14	31	20
highrise stored	b	38	18	56	30
all types	d	39	15	57	30
.		**---------- lb / 1000 gallon ----------**			
liquid slurry	b	62	42	59	37
anaerobic lagoon sludge	b	26	8	92	13
.		**---------- lb / acre-inch ----------**			
anaerobic lagoon liquid	b	179	154	46	266
SWINE		**---------- lb / ton ----------**			
fresh	c	12	7	9	9
scraped	c	13	7	12	9
.		**---------- lb / 1000 gallon ----------**			
liquid slurry	c	31	19	22	17
anaerobic liquid sludge	c	22	6	49	7
all types	d	40	19	37	23
.		**---------- lb / acre-inch ----------**			

anaerobic lagoon liquid	c	136	111	53	133
DAIRY		**---------- lb / 1000 gallon ----------**			
all types	d	28	11	19	25
HORSE		**---------- lb / 10 ton ----------**			
all types	d	90	6	58	109

a - Data compiled by J. J. Camberato, Extension Agronomist, 1990-91.
b - Soil Facts-Poultry Manure as a Fertilizer Source. North Carolina Agricultural Extension Service Fact Sheet AG-439-5. J. P. Zublena, J. C. Barker, and T. A. Carter.
c - Soil Facts-Swine Manure as a Fertilizer Source. North Carolina Agricultural Extension Service Fact Sheet AG-439-4. J. P. Zublena, J. C. Barker, and J. W. Parker.
d - Using Manure to Cut Fertilizer Costs. University of Maryland Cooperative Extension Service Fact Sheet 512. V. Allan Bandel.

Table 2. Secondary and selected micronutrient content of different sources of animal manure.

MANURE TYPE AND HANDLING	INFO. SOURCE	Ca	Mg	S	Mn	Zn	Cu
BROILER		**---------- lb / ton ----------**					
all types	a	41	8	12	0.5	0.5	1.0
broiler litter	b	41	8	15	0.7	0.6	0.5
roaster litter	b	43	9	14	0.7	0.7	0.5
breeder litter	b	94	7	9	0.6	0.5	0.2
stockpiled litter	b	54	8	12	0.6	0.6	0.3
all types	d	30	13	10	0.4	0.4	0.3
TURKEY		**---------- lb / ton ----------**					
all types	a	32	7	10	0.7	0.6	0.6
brooder litter	b	28	6	8	0.5	0.5	0.4
grower litter	b	42	7	10	0.7	0.6	0.5
stockpiled litter	b	42	7	10	0.6	0.6	0.3
LAYER		**---------- lb / ton ----------**					
all types	a	85	5	6	0.4	0.3	<0.1
under cage scraped	b	43	6	7	0.3	0.3	<0.1
highrise stored	b	86	6	9	0.5	0.4	<0.1
all types	d	101	14	6	0.2	0.2	0.1
.		**---------- lb / 1000 gallon ----------**					
liquid slurry	b	35	7	8	0.4	0.4	0.1
lagoon sludge	b	71	7	12	2.3	0.8	0.1
.		**---------- lb / acre-inch ----------**					
lagoon liquid	b	25	7	52	0.2	0.7	0.2
SWINE		**---------- lb / ton ----------**					
fresh	c	8	2	2	<0.1	0.1	<0.1
paved lot scraped	c	12	2	2	0.2	0.4	0.2
.		**---------- lb / 1000 gallon ----------**					
liquid slurry	c	9	3	5	0.2	0.4	0.1
lagoon sludge	c	16	5	8	0.3	0.7	0.2
all types	d	11	8	5	0.1	0.3	0.1
.		**---------- lb / acre-inch ----------**					
lagoon liquid	c	26	8	10	0.3	1.5	0.3

DAIRY		**---------- lb / 1000 gallon ----------**					
all types	d	23	7	3	0.1	<0.1	<0.1
HORSE		**---------- lb / 10 ton ----------**					
all types	d	156	62	16	0.8	0.1	0.1

*See footnotes following Table 1.

Lagoon effluent and slurry application rates (inches/crop or year) based on plant available nitrogen (PAN) and crop needs.

.	Plant Nitrogen Needs (lb N / acre)						
lb PAN per 1,000 gal.	**50**	**75**	**100**	**125**	**150**	**175**	**200**
.	**-------- Inches of Wastewater Per Application or Year --------**						
0.5	3.68	5.52	7.36	9.20	11.04	12.88	14.72
1	1.84	2.76	3.68	4.60	5.52	6.44	7.36
2	0.92	1.38	1.84	2.30	2.76	3.22	3.68
3	0.62	0.92	1.23	1.54	1.85	2.15	2.46
4	0.46	0.69	0.92	1.15	1.38	1.61	1.84
5	0.37	0.56	0.74	0.93	1.11	1.30	1.48
6	0.31	0.46	0.61	0.76	0.92	1.07	1.22
7	0.27	0.40	0.53	0.66	0.80	0.93	1.06
8	0.23	0.35	0.46	0.58	0.69	0.81	0.92
9	0.21	0.31	0.41	0.51	0.62	0.72	0.82
10	0.19	0.28	0.37	0.46	0.56	0.65	0.74
12	0.16	0.23	0.31	0.39	0.47	0.54	0.62
15	0.13	0.19	0.25	0.31	0.38	0.44	0.50
18	0.10	0.15	0.20	0.25	0.30	0.35	0.40
21	0.09	0.14	0.18	0.23	0.27	0.32	0.36

Solid manure application rates (tons/acre) based on plant available nitrogen (PAN) and crop needs.

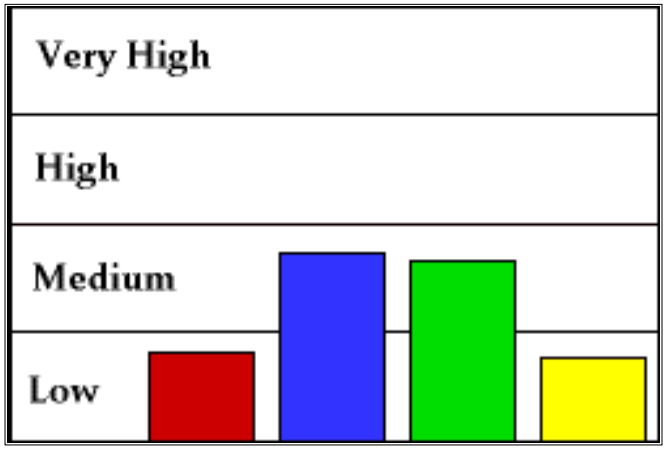
.	Plant Nitrogen Needs (lb N / acre)						
lb PAN per Ton	**50**	**75**	**100**	**125**	**150**	**175**	**200**
.	**-------- Tons of Manure Per Application or Year --------**						
5	10	15	20	25	30	35	40

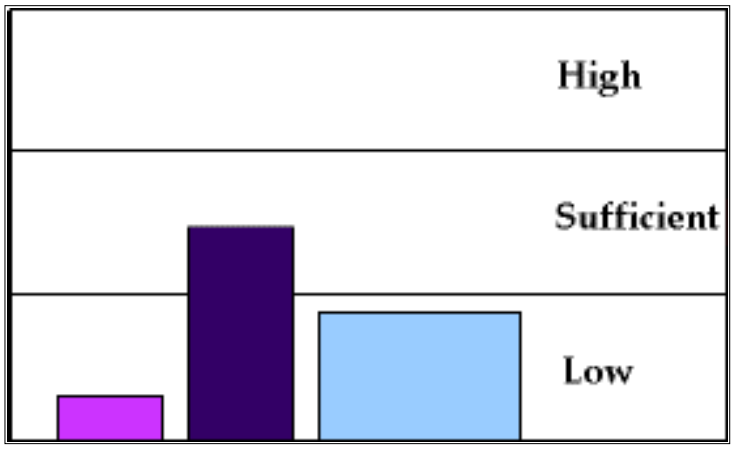
10	5	7.5	10	12.5	15	17.5	20
15	3.3	5.0	6.7	8.3	10	11.7	13.3
20	2.5	3.8	5.0	6.3	7.5	8.8	10
25	2.0	3.0	4.0	5.0	6.0	7.0	8
30	1.7	2.5	3.3	4.2	5.0	5.8	6.7
35	1.4	2.1	2.9	3.6	4.3	5.0	5.7
40	1.3	1.9	2.5	3.1	3.8	4.4	5.0
45	1.1	1.7	2.2	2.8	3.3	3.9	4.4
50	1.0	1.5	2.0	2.5	3.0	3.5	4.0

UGFERTEX Software Results

Client:		Field ID:	
County:		Date:	
Soil Group:	**Coastal Plain**	Plow Depth:	**8 inches**
Crop:	**Corn**	Previous Crop:	**Unknown**
Yield Goal:	**100 bu**	Irrigated:	**N**

Results





.	Phosphorus	Potassium	Calcium	Magnesium	Zinc	Manganese	Soil pH	.
Soil Test Index	**25 lbs/Acre**	**112 lbs/Acre**	**456 lbs/Acre**	**23 lbs/Acre**	**1 lbs/Acre**	**12 lbs/Acre**	**5.8 (7.5 Lime Index)**	Soil Test Index
Build up:	Soil P: **0** Soil K: **0**		P_2O_5 Required: **0** K_2O Required: **0**		Years Required For Buildup: **1**	Starter:		N: **0** P_2O_5: **0**

Recommendations and or Needs

Limestone	Nitrogen (N)	Phosphate (P_2O_5	Potash (K_2O	Calcium (Ca)	Magnesium (Mg)	Sulfur (S)	Boron (B)	Manganese (Mn)	Zinc (Zn)
1000 lbs/Acre	**120 lbs/Acre**	**60 lbs/Acre**	**60 lbs/Acre**	**0 lbs/Acre**	**25 lbs/Acre**	**10 lbs/Acre**	**0 lbs/Acre**	**0 lbs/Acre**	**3 lbs/Acre**

Manure Recommendation:

Residual Credits	Manure Rate Tons/Acre	Nutrients Supplied	Nutrient deficit from manure can be met by applying commercial fertilizer

lbs N/Acre		N	P_2O_5	K_2O			
0	**1.5**	**60**	**69**	**60**	N	P_2O_5	K_2O
.					----------lbs/A----------		
Method of Application: Broadcast - immediate incorporation.					**60**	**0**	**0**
Broiler - Litter		Ammonium Factor: 95%					

Comments:

If the recommended amount of N is not supplied by the manure, use a commercial source of N and apply the remainder as a sidedress application when the corn is 18-24 inches tall.

Avoid spreading manure near streams, wells, ponds, or environmentally sensitive areas.

Use conservation practices which minimize runoff and erosion.

Calibrate application equipment.

Return to The Land Application of Animal Manure.

Table 3. Rates of Manure Application, Fall 1990

LOCATION	TARGET RATE	ACTUAL RATE	RANGE IN RATE	NO. TIMES MEASURED
.	----------TON / ACRE----------			.
LAYER MANURE				
McCormick	3.0	1.8	1.3 - 2.6	4
Greenwood 1	2.5	1.4	0.9 - 2.0	4
Greenwood 2	3.0	4	2.0 - 6.4	10
Darlington	3.0	3.2	1.5 - 4.6	4
Lee	4.0	1.3	0.7 - 1.6	6
BROILER / TURKEY MANURE				
Newberry 1	2.5	2.7	1.4 - 3.9	6
Newberry 2	5.0	3.8	3.4 - 4.1	2
Clarendon	4.5	3.4	2.6 - 5.0	10
Lee 1	2.5	0.5	0.2 - 2.0	5
Lee 2	2.5	0.9	0.5 - 1.0	6

BOB LIPPERT'S FREQUENTLY ASKED QUESTIONS REGARDING SOIL TESTING, PLANT ANALYSIS AND FERTILIZERS

StudyWeb

Department of Crop & Soil Environmental Science

Clemson University Extension Service, South Carolina, U.S.A.

The following is a listing of questions I have been frequently asked during my past 15 years with the Clemson University Extension Service. To find the answer, simply click on the appropriate question. To ask your own question, please send it to me via email BLPPRT@Clemson.edu I would also appreciate any suggestions about how to improve this site to make it as useful as possible. Thanks!

SAMPLING

- My soil sample has been sitting in the hot cab of my truck for several weeks. If I have it tested by the Ag Service Lab, will the results still be OK?
- How do I sample the soil for Conservation Tillage/No-Till situations?
- How do I sample the soil for pastures?
- What is a general guideline for sampling plant tissue?
- Where can I find leaf sampling guidelines and mineral sufficiency ranges for specific agronomic crops?
- Is splitting soil samples between two labs a good method for comparing lab quality?
- How do I save fertilizer and money by sampling the subsoil of the Coastal Plains soils? How should I do the sampling?

TESTING

- What is the buffer pH value on the soil test report?
- How reliable are the soil test kits found in gardening stores?
- Where and how should I get compost tested?
- What is the value of the organic matter test for soil samples?
- I noticed that the routine soil test doesn't include nitrogen. Is there any advantage in requesting that

the lab test my soil for nitrogen?
- What is the use for the cation exchange capacity (CEC) and the percent base saturation on the soil test report?
- How should I interpret the copper and boron results on the soil test reports?
- How are the cation exchange capacity (CEC) and the percent base saturation calculated for the soil test report?
- Can Clemson University's fertilizer recommendations be used with the analytical results from other soil testing laboratories?
- What is a soil test extractant?
- What is the Mehlich-1 extractant?
- What is the Mehlich-3 extractant?
- What is the Bray P-1 extractant and is it used in the Southeast?
- Why do some states use the Mehlich-1 extractant and other states use the Mehlich-3 extractant?
- How does the Mehlich-3 extractant compare to the Mehlich-1 extractant?

SPECIFIC NUTRIENTS

- Is there a problem with loss of urea when used as a source of nitrogen?
- Why is phosphorus expressed as P2O5 and potassium expressed as K2O in the soil test report recommendations and by the fertilizer companies?
- How should starter fertilizer be used for row crops?

LIMING MATERIALS

- What is calcium carbonate equivalent?
- How safe is it to use wood ashes as a liming material?
- Can lime and fertilizer be applied at the same time?

SOIL AMENDMENTS AND MISCELLANEOUS

- What is gypsum? How does it help the soil? How much should I apply?
- My soil pH is too high. How can I bring it back down to the optimum pH range?
- How do flooded soil conditions affect the soil pH value and plant nutrient availability?
- How does the chlorine in pool water affect nearby plants?

Odor Control

John Chastain, Agricultural and Biological Engineering, Clemson University

For an odor to be detected downwind, odorous compounds must be (a) formed, (b) released to the atmosphere, and (c) transported to the receptor site. These three steps provide the basis for most odor control. If any one of the steps is inhibited, the odor will diminish.

Follow these links to further investigate odor control.

Use the major chapter headings or use the searchable **table of contents** below.

- **Management**
- **Planning**

What about **chemical or biological additives** to eliminate odor?

Odor Control Table of Contents

Odor Control	Management	Buildings & Facilities	Ventilation System	Mechanical Ventilation
				Natural Ventilation
			Floor Design	
			Dust Control	
		Manure Storage Systems	Storage Options	Advantages & Disadvantages of Manure Storage
				Odor Control for Manure Storage
			Treatment Lagoon Options	Management & Startup
				Temperature
				Lagoon Loading Rate

				Ration
		Land Application		
	Planning	Separation Distance & Neighbors		
		Wind Direction		
		Topography		
		Farm Visibility and Screens		
		Design & Construction		
	Chemical & Biological Additives			

*Click here for a printout of the table of contents.

Return to The Land Application of Animal Manure.

ALABAMA COOPERATIVE Extension SYSTEM

CIRCULAR ANR-244
(11/95)

ALABAMA A&M AND AUBURN UNIVERSITIES

THE VALUE AND USE OF POULTRY MANURES AS FERTILIZER

Charles C. Mitchell, Extension Agronomist, Agronomy and Soils
James 0. Donald, Extension Agticultural Engineer, Agricultural Engineering

Poultry manure, properly handled, is the most valuable of all manures produced by livestock. 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 I 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

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

	Weighted Mean[a]
Number of samples	207.0
Moisture, %	19.7
Primary Plant Nutrients	
Total N, %	3.10
P_2O_5, %	2.77
K_2O	2.04

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

Secondary Plant Nutrients	
Ca, %	1.79
Mg, %	0.38
S, %	0.34
Micronutrients	
Cu, ppm	332
Fe, ppm	1,950
Mn, ppm	277
Zn, ppm	252
B, ppm	55
Other Analysis	
As, ppm	281.0
Ash, %	18.8

[a] 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 [a] caged layers	Pennsylvania [b] caged layers	Alabama caged layers	North Carolina [c]		
				fresh	scraped	high rise
Moisture, %	60	50	70	--	--	--
Primary Plant Nutrients						
Total N, %	1.94	2.0	1.5	1.3	1.4	1.9
P_2O_5, %	2.85	2.0	1.3	1.1	1.6	2.8
K_2O, %	1.61	1.0	0.5	0.5	1.0	1.5
Secondary Plant Nutrients						
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
Micronutrients						
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

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

[b] 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.

[c] 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.

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_4-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.

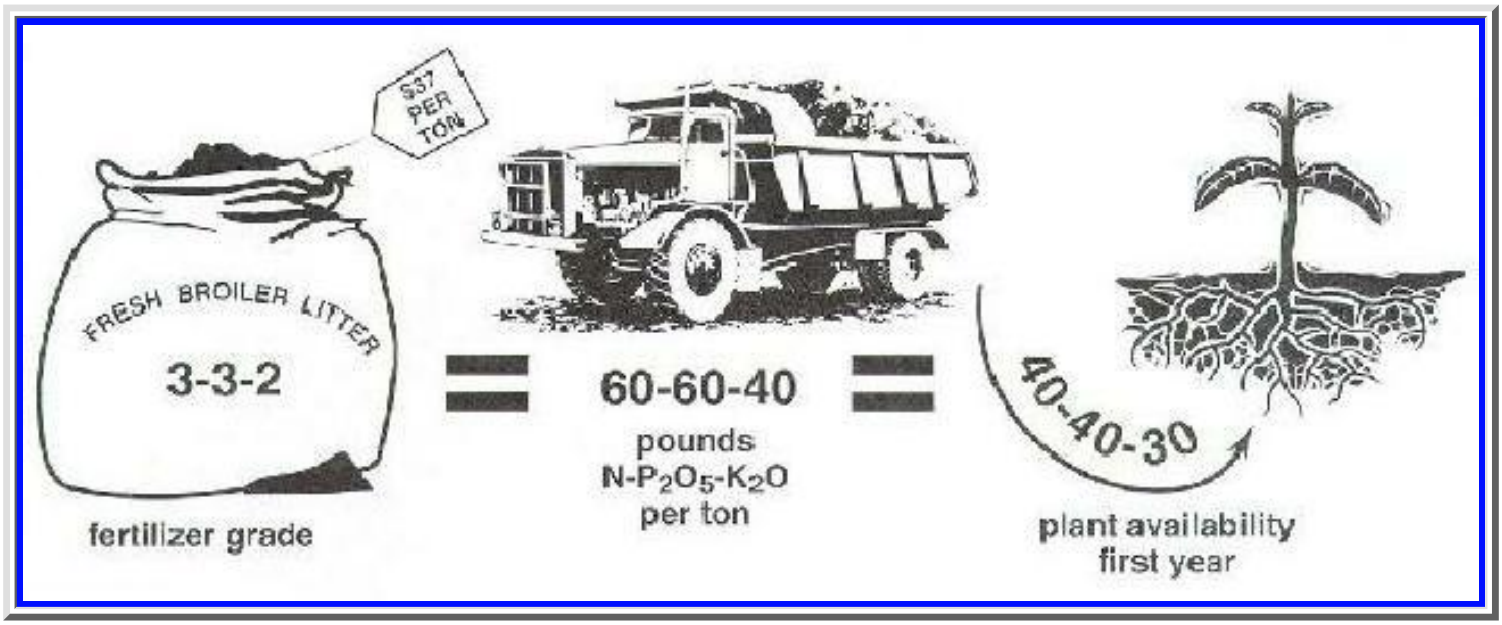
From **Table 1** , broiler litter has the following average nutrient content:

Fertilizer grade:	3- 3- 2 (N-P_2O_5-K_2O)
Total nutrients (lb./ton):	60-60-40
Available nutrients first season (lb./ton):	40-40-30

Ammonium N. The ammonium N fraction (NH_4-N) is subject to conversion to ammonia gas (NH_3) 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 available 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
$P_2 0_5$..... 0.23/pound
$K_2 0$..... 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 nutrient contents of broiler litter can be used such as 60-60-40 pounds total N-P_2O_5-K_2 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_2 O_5-K_2O 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 chose 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.

Return to Cotton Fertility Training Schedule

THE VALUE AND USE OF POULTRY WASTE AS FERTILIZER.

Agriculture & Natural Resources Agronomy
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James O. Donald, Extension Agricultural Engineer
John Martin, Consulting Agronomist

The Alabama poultry industry (broilers and layers) produces more than 735 million birds a year. These birds produce about 1.7 million tons of manure and litter.

The nutrients in this manure could adequately fertilize every acre of corn, cotton, wheat, and sorghum produced in Alabama or 800,000 acres of bermuda or fescue pasture.* In fact, the nitrogen (N), phosphate (p2o5), and potash (K2o) in poultry manure represent about 40 percent of the N, 90 percent of the P2O5, and 40 percent of the K2O spread each year in commercial fertilizers in Alabama.

Poultry manure, if properly handled, is the most valuable of all manures produced by livestock. It has historically been used as a source of plant nutrient and soil amendment. However, in areas of intense poultry production, excess manure represents a waste problem for producers.

In some areas, over-fertilizing pastureland with poultry manure has resulted in groundwater and surface water problems. These problems developed as excess nutrients washed off the land or leached into groundwater supplies.

To obtain the maximum economic value of the plant nutrients in poultry manure and to protect the water supply from excessive nutrient run-off or leaching, apply poultry manure to match the nutrient needs of the crop.

Nutrient Analysis

Two basic types of poultry wastes are produced in Alabama-broiler

litter and caged layer manure (Table 1). Broiler litter, for fertilizing purposes, includes all floor-type birds such as broilers, pullets, and floor layers. Some type of bedding or litter material is used on the floor of these houses.

Caged layer manure is free from litter material and generally has a higher moisture content than manure from broiler houses. Both types of waste will contain feathers and some wasted food.

The chemical analysis of either type of manure is highly variable due to several factors. These include

Table 1. Estimation of Poultry Manure Production.

Type Of Poultry	Percent Moisture	Grow-Out Time Interval	Tons Produced Per 1,000 Birds
Broilers	20	6 to 7 weeks	2
Caged Layers	75	1 year	35 to 44

* Based on six grow-out cycles per year on pine shavings or peanut hull bedding.

moisture, temperature, amount and kind of litter, amount of soil picked up in cleaning a house, the number of batches of broilers fed on the litter, and the conditions under which the manure was stored and handled before spreading.

Table 2 shows both the average and range of nutrient composition of broiler litter sampled in Alabama from 1977 through 1987. During this 11-year period, the litter from 147 broiler houses had an average moisture content of 19.7 percent and an average fertilizer content on a dry-weight basis of 3.9 percent N, 3.7 percent P_2O_5, and 2.5 percent K_2O.

Table 2. Nutrient Composition Of Litter (Dry-Weight Basis) From 147 Broiler Houses Sampled In Alabama, 1977-1987.

	Average Analysis (percent)	Range (percent)
Moisture	19.7	15.0 to 39.0
Nitrogen (N)	3.9	2.1 to 6.0
Phosphate (P_2O_5)	3.7	1.4 to 8.9
Potash (K_2O)	2.5	0.8 to 6.2
Calcium (Ca)	2.2	0.8 to 6.1
Magnesium (Mg)	0.5	0.2 to 2.1
Sulfur (S)	0.4	0.01 to 0.8

In 1981, litter from two slat-breeder houses and one pullet house

and manure from two high-rise caged layer houses were analyzed for moisture and nitrogen. Results are given in Table 3.

The nitrogen content of litter from the pullet house was only about one-third the nitrogen content of broiler litter (Table 2). The nitrogen content of litter from the slatbreeder house was about half that of broiler litter.

Table 3. Nitrogen Content (Dry-Weight Basis) From HighRise Caged Layer, Pullet, And Slat-Breeder Houses In Cullman County Sampled In July 1981.

Type Of Poultry House	Moisture (percent)	Nitrogen (percent)
Caged Layer *	63.4	1.2**
Pullet	22.0	1.2
Slat Breeder*	16.8	2.1

* An average of two houses.
** The caged layer manure had been accumulating for about 12 months and had lost much of the ammonium nitrogen.

Caged layer manure generally contains about 4 to 7 percent nitrogen if collected at one to three week intervals. However, under high-rise houses where layer manure sometimes accumulates for long periods of time, much of the nitrogen is lost into the air as ammonia. The nitrogen content of the accumulated caged layer manure given in Table 3 was only 1.2 percent.

Moisture is perhaps the single most important variable associated with spreading manure by the ton. Manure from all classes of chickens will average 70 to 77 percent moisture when excreted. However, broiler manure with litter dries under normal house conditions and will average about 20 percent moisture. Caged layer manure will average about 70 percent moisture.

Analyses should be reported on both a dry-weight basis (oven dried) with little moisture and on a wet-weight basis just as the sample was taken. Reporting on a dry-weight basis eliminates the moisture variable when comparing manures.

When spreading manures, the moisture adds weight and can reduce the value of the product in proportion to the moisture present (Table 4). Be sure the value you use when spreading manure by the tone is on a wet-weight basis or just as the manure sample was taken.

Table 4. Estimated Analysis And Value Of Poultry Manure On A Wet-Weight And Dry-Weight Basis (0-Percent Moisture).

Type	Percent Moisture*	Percent Nutrients (N-P2O5-K2O)	Pounds Per Ton (N-P2O5-K2O)	Value Per Ton**
Broiler	20	3.1-3.0-2.0	62-60-40	$33.25
Broiler	Oven-dry	3.9-3.7-2.5	78-74-50	$41.80
Caged layer	70	1.5-1.3-0.5	30-26-10	$14.20
Caged layer	Oven-dry	5.0-4.3-1.7	100-86-34	$47.30

*Use the higher moisture value when buying or spreading manures as it comes from the house.
** Calculations based on N at 25 cents per pound, P2O5 at 20 cents per pound, and K2O at 15 cents per pound.

Nutrient Availability
Poultry manure should be managed for its N value. However, N availability is the most difficult of the three major nutrients to predict. About 25 to 30 percent of the total N in broiler litter is in the urea and ammonium forms (Figure 1). It is readily available for plant uptake just as fertilizer ammonium and fertilizer urea.

When litter analyses are run by a laboratory, the readily available N is reported as ammonium N or NH4-N. Fertilizer urea and manure urea are likely to convert to ammonia gas (NH3) and then to evaporate.

When manure has a strong ammonia odor or is spread on the surface and not incorporated into the soil, significant nitrogen will be lost. As much as 75 percent of the ammonium N (22 percent of total N) could be lost within seven days after spreading if the weather is hot and dry and the manure is not soil-incorporated.

Of course, incorporation is not practical or even desirable in situations such as pastureland or hay fields, and ammonium N loss should be included in the total amount to be applied.

The organic N fraction gradually becomes available for crop uptake as the manure decomposes. Scientists in Virginia estimated that for broiler litter, about 50 percent of the organic N is released during the first year following application, 12 percent within the second, 5 percent during the third, and 2 percent during the fourth.

The percentages would be similar for North Alabama, but decomposition will be somewhat faster when manure is incorporated into the sandy soils of South Alabama. Therefore, the total amount of N available from manure applications is the sum of that

available from applications being made at a given time plus that available from previous applications (residual N).

The P and K fractions are considered to be about 75 percent as effective as commercial fertilizers during the year of application. However, manure applications should be based on the N requirement of the crop because excess nitrogen can leach into groundwater or run off into streams, creating environmental concerns. If litter is applied at rates that will supply the N needed by the crop, adequate P and K are generally available.

Under frequent manure applications, P will build up in Alabama soils to very high levels. Potash may leach in sandy soils and some fertilizer K applications may be necessary to meet the needs of certain crops, particularly hay crops.

Land Application
When applying poultry manure to cropland, pastureland, and hay fields, consider the following.

1) Determine the nutrients in the manure or litter prior to spreading. An analysis by a commercial laboratory would determine exactly how much moisture, ammonia N, organic N, and other plant nutrients are in the sample. This will allow you to calculate the value of the manure and how much to spread. If a chemical analysis is not made, a good estimate of the fertilizer content of litter is as follows: A ton of broiler litter with 20-percent moisture contains 60 pounds of nitrogen, 60 pounds of phosphate, and 40 pounds of potash. However, keep in mind that stored litter can change over time unless it is protected, and an analysis may take as long as two weeks.

2) Determine the nutrients needed by the crop to be grown. Soil testing provides the best estimate of residual P and K in the soil and other soil amendments (e.g., lime) that should be applied for optimum yields and nutrient use efficiency. Recommended N rates are given for each crop on the soil test report. Exceeding the recommended rates by more than 30 percent could result in excessive N leaching in some soils or the potential for surface run-off into streams.

3) Estimate the availability of N in the manure. The calculate a rate of application that is consistent with the requirements from the soil test report (see Circular ANR -244a, "Worksheet For Calculating Poultry Waste").

Other Recommendations

Reducing ammonium odors. To conserve N in poultry manure and to reduce the ammonia odor and associated N loss, apply superphosphate at the rate of 100 pounds per ton of manure in the house. The phosphate will trap the ammonia as ammonium phosphate, and it will increase the fertilizer value of the final litter. Fermentation losses in broiler litter may be reduced by using litter materials which rapidly dry the manure. The most effective means of reducing N losses is to dry the manure in the poultry house.

Adding hydrated lime. Hydrated lime (calcium hydroxide) will help maintain good litter condition and reduce fly problems. However, it will also increase ammonia volatilization and N loss. Do no 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.

Outside storage problems. Manure stored outside and exposed to the weather will decompose rapidly. An ashy gray appearance indicates a loss of nutrient value. The N and organic matter will be greatly reduced and K may be lost due to leaching. You get maximum fertilizer value when manure or litter is protected from the weather.

N-use efficiency. Where excess quantities of manure must be disposed of on the land, choose a system to maximize N uptake by a crop. Row crops are poor users of soil N because of limited root systems. Corn or cotton may take up only 50 to 60 percent of the N applied. Grasses, such as hybrid bermudagrasses, 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 are not quite as efficient because most of their growth is in the early spring. The mineral N in manure applied in the summer and winter to cool-season crops such as tall fescue may be lost through leaching. Apply manure to crops to maximize N uptake and N-use efficiency. Harvest excess forage frequently to remove the N from the land. These practices will minimize potential surface and groundwater contamination from excess N applied in manure.

CIRCULAR ANR-244

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WORKSHEET:

DETERMINING THE NUTRIENT NEEDS OF YOUR CROP

Use this worksheet to determine how much manure to apply to your field.

.	EXAMPLE	YOUR FARM
1. Crop to be grown.	corn	_____
2. Clemson nutrient recommendation based on soil test. a. N (lb/acre) b. P_2O_5 (lb/acre) c. K_2O (lb/acre)	 120 50 50	 _____ _____ _____
3. Nutrients applied preplant or at planting. a. N (lb/acre) b. P_2O_5 (lb/acre) c. K_2O (lb/acre)	 20 0 0	 _____ _____ _____
4. Net nutrient needs of crop (lb/acre). Nitrogen, phosphorus, and potassium: total need (item 2a,2b,2c) minus additional nutrients from preplant or at planting (item 3a,3b,3c) a. N: 120-20 (lb/acre) b. P_2O_5: 50-0 (lb/acre) c. K_2O: 50-0 (lb/acre)	 100 50 50	 _____ _____ _____
5. Available nutrients in manure based on laboratory analysis. a. Available-N (lb/ton) b. P_2O_5 (lb/ton) c. K_2O (lb/ton)	 40 60 40	 _____ _____ _____
6. Application rate to supply priority nutrient. a. Priority nutrient b. Amount of priority nutrient needed (lb/acre from 4a) c. Rate of manure needed to supply priority nutrient (6b) divided by (5a): 100/40(ton/acre)	 N 100 2.5	 _____ _____ _____

7. Pounds per acre of all nutrients supplied at the application rate required to meet the needs for the priority nutrient: for each nutrient enter the available nutrients (5a,5b,5c) times manure rate (6c). a. N supplied: 40 X 2.5 (lb/acre) b. P_2O_5 supplied: 60 X 2.5 (lb/acre) c. K_2O supplied: 40 X 2.5 (lb/acre)	 100 150 100	 _____ _____ _____
8. Nutrient balance: net nutrient need (-) or excess (+): amount of nutrient applied by manure (7a,7b,7c) minus net amount needed by crop (4a,4b,4c). a. N balance: 100-100 (lb/acre) b. P_2O_5 balance: 150-50 (lb/acre) c. K_2O balance: 100-50 (lb/acre)	 0 +100 +50	 _____ _____ _____