University of Missouri Extension

WQ223, New May 1994

Spreading Poultry Litter With Lab Analysis and With Soil Tests

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Editor's note
The printed version of this publication includes illustrations.

A primary need and concern for most poultry producers is managing litter. You must protect ground and surface water and fulfill regulatory requirements. Usually, the goals are met by applying litter to the land in a way that uses potentially polluting nutrients, such as nitrogen (N), phosphorus (P), potash (K_2O) and organic matter.

Litter as a fertilizer

View litter as a fertilizer resource and manage it like commercial fertilizer in your fertility program. You can damage water quality by meeting fertility requirements with commercial fertilizer then applying litter for good measure.

Missouri waste application regulations are based on the rate of nitrogen applied. With this plan, the phosphate (P_2O_5) and potash applied may exceed crop needs greatly.

The best fertility plan may apply less nitrogen from waste than the crop needs and buy supplemental nitrogen to balance the fertility program. Applying phosphorus to fields with a Bray 1-P test level of more than 800 pounds per acre may aggravate surface water quality problems.

It is highly recommended that you analyze a representative sample of poultry litter for nutrient values immediately before spreading. The analysis, in addition to soil tests, determines the land application rate.

This publication provides guidance for application of waste with the benefit of a lab analysis and a soil test. Other publications in this series address application of dairy waste with other plans.

Managing litter as a fertilizer

Unlike commercial fertilizers, poultry litter is a highly variable substance. Even within a given animal specie, waste can vary up to 50 percent. Other management styles peculiar to poultry operations, such as building cleaning on a certain schedule, dictate a different management technique than commercial fertilizer that can just be ordered and spread.

In contrast to commercial fertilizer, litter has the potential for nutrients (primarily ammonia nitrogen) to be lost to the atmosphere after field spreading. Table 1 shows the available ammonia nitrogen as a function of time until incorporated into the soil.

Table 1
Litter ammonia nitrogen loss by days until incorporated into the soil. Unavailable portion is lost to the atmosphere

Days until incorporation	Percent of ammonia N available for crops
0 to 2	80
2 to 4	60
4 to 7	40
more than 7	20

Table 2 lists the percent of available organic nitrogen available by year. Table 3 gives the percent of various nutrients available in the growing season after application.

Table 2
Litter organic nitrogen available by year

Manure applied	Percent of organic N available during current year
Current year	40 to 60
One year ago	10
Two years ago	5
Three years ago	5

Table 3
Other minerals and micronutrients available in litter

Nutrient	Percent of ammonia N available in growing season
P	80
K	100
S, Mn, Cu, Zn	80
Ca, Mg	100

Table 4
Lab analysis for litter and rate of past applications

Nutrient	Nutrient content of broiler litter (pounds per ton)			
	This year	1 year ago	2 years ago	3 years ago
Total N	64	52.0	69.0	71.0
NH_4-N	10	9.0	15.0	18.0
Organic N	54	43.0	54.0	53.0
P_2O_5	60	44.0	63.0	68.0
K_2O	40	33.0	40.0	45.0
Tons per acre applied	?	2.5	2.0	2.0

This publication details a procedure for calculating the amount of litter to apply to meet the soil test recommendations for nitrogen using a poultry litter of known nutrient analysis. The soil test may call for more than 100 pounds of nitrogen per acre to be added to satisfy crop needs. This exceeds the 100 pounds per acre allowed under the conservative management approach.

However, you may wish to use this worksheet with the conservative approach of applying 100 pounds of N to see what happens with P and K.

Blank worksheets are included for actual applications.

This approach cannot be used if the Department of Natural Resources has issued a letter of approval based on the conservative approach of applying not more than 100 pounds of nitrogen per year, regardless of the crop and the production level of the crop.

Example 1

A fescue hay field soil/plant filter is available for receiving broiler litter. The accompanying soil test contains fertilizer recommendations for a yield goal of 3 tons of fescue hay per year from the soil/plant filter area.

From the soil test, the following nutrient applications are recommended:

- 120 pounds N per acre
- 75 pounds P_2O_5 per acre
- 140 pounds K_2O per acre

Given this information and the laboratory analysis of the broiler litter (Table 4), how many tons per acre of broiler litter should be applied to meet the nitrogen needs of the fescue?

Litter has been applied the past three years with the rates and analyses noted in Table 4. The litter applied will not be incorporated into the soil. Ammonia nitrogen loss is 80 percent.

Worksheet 1
Broiler litter on fescue

1. Crop nutrient requirements (from soil test)
   "Fescue"
   Yield "3" tons per acre
   Nitrogen "120" pounds per acre
   P_2O_5 "75" pounds per acre
   K_2O "140" pounds per acre
2. Available ammonia nitrogen (NH_4-N)
   NH_4-N pound per ton x percent available = NH_4-N pound per ton (Percent from Table 1, NH_4-N from Table 4)
   "10" pounds per ton x "0.2" percent available = "2" pounds per ton
3. Nitrogen available from this year's organic fraction
   N pounds per ton x percent available = N pounds per ton (Percent from Table 2, organic N from Table 4)
   "54" pounds per ton x "0.5" percent available = "27" pounds per ton
4. Residual nitrogen available from past years' organic fraction
   Tons per acre x N pounds per ton x percent available = N pounds per acre (Percent from Table 2,

organic N from Table 4)

1 year ago	"2.5" tons per acre x "43" pounds per ton x "0.10" percent available	= "10.8" pounds per acre
2 years ago	"2.0" tons per acre x 54 pounds per ton x "0.05" percent available	= "5.4" pounds per acre
3 years ago	"2.0" tons per acre x 53 pounds per ton x "0.05" percent available	= "5.3" pounds per acre
Total		= "21.5" pounds per acre

5. Manure application rate to supply nitrogen

$$\frac{\text{(Crop N (line 1))} - \text{(residual N (line 4))}}{\text{(Available } NH_4\text{-N (line 2))} + \text{(available organic nitrogen (line 3))}} = \text{application rate tons per acre}$$

$$\frac{120 - 21.5}{2 + 27} = 3.4 \text{ tons per acre}$$

6. Phosphate available at calculated application rate for nitrogen
   Tons per acre x P_2O_5 pounds per ton x percent available = P_2O_5 pounds per acre (P_2O_5 per ton from Table 4, percent from Table 3)
   "3.4" tons per acre x "60" pounds per ton x "0.8" percent available = "163*" pounds per acre

***Note**
163 pounds per acre P_2O_5 is applied vs. 75 pounds per acre recommended by soil test.

7. Potash available at calculated application rate for nitrogen
   Tons per acre x K_2O pounds per ton x percent available = K_2O pounds per acre (K_2O per ton from Table 4, percent from Table 3)
   "3.4" tons per acre x "40" pounds per ton x "1" percent available = "136*" pounds per acre

***Note**
136 pounds per acre K_2O is applied vs. 140 pounds per acre recommended by soil test.

Example 2

The information is the same as Example 1, except no litter was applied the past three years. Use only the information for this year (Table 4).

Worksheet 2
Broiler litter on fescue with no litter applied past three years

1. Crop nutrient requirements (from soil test)
   "Fescue"
   Yield "3" tons per acre
   Nitrogen "120" pounds per acre
   P_2O_5 "75" pounds per acre
   K_2O "140" pounds per acre
2. Available ammonia nitrogen (NH_4-N)
   NH_4-N pounds per ton x percent available = NH_4-N pounds per ton (Percent from Table 1, NH_4-N from Table 4)
   "10" pounds per ton x "0.2" percent available = "2" pounds per ton
3. Nitrogen available from this year's organic fraction

N pounds per ton x percent available = N pounds per ton (Percent from Table 2, organic N from Table 4)
"54" pounds per ton x "0.5" percent available = "27" pounds per ton

4. Residual nitrogen available from past years' organic fraction
   No litter applied the past three years.
5. Manure application rate to supply nitrogen

$$\frac{\text{(Crop N (line 1))} - \text{(residual N (line 4))}}{\text{(Available } NH_4\text{-N (line 2))} + \text{(available organic nitrogen (line 3))}} = \text{application rate tons per acre}$$

$$\frac{120 - 0}{2 + 27} = 4.1 \text{ tons per acre}$$

6. Phosphate available at calculated application rate for nitrogen
   Tons per acre x P_2O_5 pounds per ton x percent available = P_2O_5 pounds per acre (P_2O_5 per ton from Table 4, percent from Table 3)
   "4.1" tons per acre x "60" pounds per ton x "0.8" percent available = "196.8*" pounds per acre

***Note**
196.8 pounds per acre P_2O_5 is applied vs. 75 pounds per acre recommended by the soil test.

7. Potash available at calculated application rate for nitrogen
   Tons per acre x K_2O pounds per ton x percent available = K_2O pounds per acre (K_2O per ton from Table 4, percent from Table 3)
   "4.1" tons per acre x "40" pounds per ton x "1" percent available = "164*" pounds per acre

***Note**
164 pounds per acre K_2O is applied vs. 140 pounds per acre recommended by the soil test.

Example 3

Broiler litter is spread on corn ground, according to the soil test and the lab analysis of the litter (Table 4). The litter is not incorporated into the soil within seven days. Ammonia nitrogen loss is 80 percent. Litter was spread on the area the past three years at the rates listed in Table 4. The yield goal for corn is 160 bushels per acre. Nutrient requirements are noted in the soil test for corn. A previous soybean (legume) crop provides a 30 pound per acre nitrogen credit as noted on the soil test sheet.

Worksheet 3
Broiler litter on corn

1. Crop nutrient requirements (from soil test)
   "Corn"
   Yield "160" tons per acre
   Nitrogen "160*" pounds per acre
   P_2O_5 "95" pounds per acre
   K_2O "96" pounds per acre

***Note**
Since soybeans were the last crop, N = 190 - 30 = 160 pounds per acre

2. Available ammonia nitrogen (NH_4-N)
   NH_4-N pounds per ton x percent available = NH_4-N pounds per ton (Percent from Table 1, NH_4-N from Table 4)
   "10" pounds per ton x "0.2" percent available = "2" pounds per ton
3. Nitrogen available from this year's organic fraction
   N pounds per ton x percent available = N pounds per ton (Percent from Table 2, organic N from Table 4)
   "54" pounds per ton x "0.5" percent available = "27" pounds per ton
4. Residual nitrogen available from past years' organic fraction
   Tons per acre x N pounds per ton x percent available = N pounds per acre (Percent from Table 2, organic N from Table 4)

1 year ago	"2.5" tons per acre x "43" pounds per ton x "0.10" percent available	= "10.8" pounds per acre
2 years ago	"2.0" tons per acre x "54" pounds per ton x "0.05" percent available	= "5.4" pounds per acre
3 years ago	"2.0" tons per acre x "53" pounds per ton x "0.05" percent available	= "5.3" pounds per acre
Total		= "21.5" pounds per acre

5. Manure application rate to supply nitrogen

$$\frac{\text{(Crop N (line 1))} - \text{(residual N (line 4))}}{\text{(Available } NH_4\text{-N (line 2))} + \text{(available nitrogen (line 3))}} = \text{application rate tons per acre}$$

$$\frac{160 - 21.5}{2 + 27} = 4.8 \text{ tons per acre}$$

6. Phosphate available at calculated application rate for nitrogen
   Tons per acre x P_2O_5 pounds per ton x percent available = P_2O_5 pounds per acre (P_2O_5 per ton from Table 4, percent from Table 3)
   "4.8" tons per acre x "60" pounds per ton x "0.8" percent available = "230*" pounds per acre

***Note**
230 pounds per acre of P_2O_5 is applied vs. 95 pounds per acre recommended by the soil test.

7. Potash available at calculated application rate for nitrogen
   Tons per acre x K_2O pounds per ton x percent available = K_2O pounds per acre (K_2O per ton from Table 4, percent from Table 3)
   "4.8" tons per acre x "40" pounds per ton x "1" percent available = "192*" pounds per acre

***Note**
192 pounds per acre of K_2O is applied vs. 95 pounds per acre recommended by the soil test.

Worksheet 4
Litter fertility worksheet

1. Crop nutrient requirements (from soil test)

   Yield tons per acre
   Nitrogen pounds per acre
   P_2O_5 pounds per acre
   K_2O pounds per acre
2. Available ammonia nitrogen (NH_4-N)

NH_4-N pound per ton x percent available = NH_4-N pound per ton (Percent from Table 1, NH_4-N from lab test)
pounds per ton x percent available = pounds per ton

3. Nitrogen available from this year's organic fraction
   N pounds per ton x percent available = N pounds per ton (Percent from Table 2, organic N from lab test)
   pounds per ton x percent available = pounds per ton
4. Residual nitrogen available from past year's organic fraction
   Tons per acre x N pounds per ton x percent available = N pounds per acre (Percent from Table 2, organic N from lab test)

1 year ago:	tons per acre x pounds per ton x percent available	= pounds per acre
2 years ago:	tons per acre x pounds per ton x percent available	= pounds per acre
3 years ago:	tons per acre x pounds per ton x percent available	= pounds per acre
Total		= pounds per acre

5. Manure application rate to supply nitrogen

   (Crop N requirement (line 1)) - (residual N (line 4)) = application rate tons per acre
   _____
   (Available NH_4-N (line 2)) + (available organic nitrogen (line 3))

   _____ - _____ = tons per acre
   _____
   _____ + _____

6. Phosphate available at calculated application rate for nitrogen
   Tons per acre x P_2O_5 pound per ton x percent available = P_2O_5 pounds per acre (Percent from Table 3)
   Tons per acre x pounds per ton x percent available = pounds per acre
7. Potash available at calculated application rate for nitrogen
   Tons per acre x K_2O pound per ton x percent available = K_2O pounds per acre (Percent from Table 3)
   Tons per acre x pounds per ton x percent available = pounds per acre

WQ223, new May 1994

Related MU Extension publications

- MWPS18, Livestock Waste Facilities Handbook
  http://extension.missouri.edu/publications/DisplayPub.aspx?P=MWPS18
- WQ220, Spreading Poultry Litter Without Lab Analysis or Soil Tests
  http://extension.missouri.edu/publications/DisplayPub.aspx?P=WQ220
- WQ221, Spreading Poultry Litter With Lab Analysis but Without Soil Tests
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