University of Missouri Extension

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Spreading Poultry Litter With Lab Analysis but Without Soil Tests

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A primary need and concern for most poultry producers is managing litter. You need to protect ground and surface water and fulfill regulatory requirements.

You can meet the goals by applying litter to the land in such a way that nutrients such as potassium, phosphorus, nitrogen and organic matter are used by the soil/plant complex and are not allowed to enter the ground and surface water.

Use litter as a fertilizer resource

Look at litter as fertilizer and manage it the same as a commercial fertilizer. You can damage water quality if you apply commercial fertilizer then add litter for good measure.

In general, Missouri's waste application regulations are based on the rate of nitrogen (N) applied. With this plan, the phosphate (P_2O_5) and potash (K_2O) applied may greatly exceed crop needs.

The best plan to use plant nutrients may be to apply less nitrogen from waste than the crop needs and buy supplemental nitrogen to balance those needs. 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 the litter for nutrient levels immediately before spreading. This, in addition to soil tests, will help determine land application rates.

The purpose of this publication is to provide guidance for applying waste with a lab analysis but without a soil test. Additional publications in this series address applying poultry litter with other plans.

Managing litter as a fertilizer

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 2 lists the percent of available organic nitrogen available with time. Table 3 gives the percent of other nutrients available in the growing season after application. Table 4 provides a basis for estimating the expected nitrogen release from soil organic matter for major annual crops without a soil test. Table 5 lists nitrogen credits for crops following legumes.

Table 1
Manure ammonia nitrogen available by days until incorporated into the soil. The 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
Manure organic nitrogen available by year

Manure applied	Percent of organic N available during current year
Current year	40 to 60
1 year ago	10
2 years ago	5
3 years ago	5

Table 3
Other minerals and micronutrients in manure

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

Table 4
Expected nitrogen release from soil organic matter for major annual crops when a current soil test is not available. Assumes a cation exchange capacity from 10.1 to 18 meq per 100 grams and organic matter content equal or less than 2 percent. No credit given for nitrogen released with perennial crops such as fescue

Expected nitrogen release	
Summer annuals (corn, etc.)	Winter annuals (wheat, etc.)
pounds nitrogen per acre	pounds nitrogen per acre
40	20

Table 5
Nitrogen supplied by legumes for the next crop

Legume crop	Nitrogen added (pounds per acre) next year
Alfalfa 80 to 100 percent stand 40 to 60 percent stand less than 50 percent stand	120 to 140 40 to 60 0 to 20

Sweet clover (green manure)	100 to 120
Red clover (pure stand)	40 to 60
Soybeans (add 1 pound per bushel)	15 to 60

Table 6
Nitrogen, phosphate and potash removal from soil by various crops.[1]

Crop	Pounds removed per unit production			
	Units	N	P_2O_5	K_2O
Corn, grain	bushel	1.0	0.4	0.3
Corn, stover	ton	20.6	7.5	37.2
Corn, silage	ton	7.4	2.9	8.9
Soybeans, grain	bushel	3.4	1.0	1.5
Soybeans, residue	ton	15.0	6.5	15.8
Wheat, grain	bushel	1.3	0.5	0.3
Wheat, straw	ton	13.0	3.6	24.6
Oats, grain	bushel	0.7	0.3	0.2
Oats, straw	ton	12.4	4.6	32.9
Barley, grain	bushel	1.0	0.4	0.3
Barley, straw	ton	13.5	4.7	31.0
Sorghum, grain	bushel	1.1	0.4	0.3
Sorghum, silage	ton	7.0	2.6	10.0
Rye, grain	bushel	1.0	0.5	0.3
Rye, straw	ton	10.0	6.0	16.9
Alfalfa	ton	49.0	11.0	50.0
Reed canary grass	ton	60.0	13.4	49.0
Orchard grass	ton	50.0	16.6	62.5
Brome grass	ton	33.2	13.2	50.8
Tall fescue	ton	55.0	18.6	52.9
Blue grass	ton	25.8	18.3	60.0
Clover grass	ton	41.0	13.3	38.9
Timothy	ton	37.5	13.8	62.5
Sorghum-Sudan grass	ton	39.9	15.3	55.9

[1]**About 70 percent of the above nitrogen in inoculated legumes is fixed from the air. The percentage goes down when adequate nitrogen is available from the soil.**

Table 7
Laboratory analysis for broiler litter and rate of past year's application

Litter nutrient content (pounds per ton)				
Nutrient	This year	1 year ago	2 years ago	3 years ago
Total N	64.0	52.0	69.0	71.0
NH_4-N	10.0	9.0	15.0	18.0
Organic N	54.0	43.0	54.0	53.0
P_2O_5	60.0	44.0	63.0	68.0
K_2O	40.0	3.0	40.0	45.0
Ton per acre applied	?	2.5	2.0	2.0

Other considerations

Other management techniques unique to poultry operations, such as building cleaning on a certain schedule, dictate different management than commercial fertilizer that can just be ordered and spread.

If soil tests are not available for nutrient application rates, use a standard rate of 100 pounds of N per acre per year. This application rate is in line with regulatory guidelines for sizing soil/plant filters under the conservative management approach.

This publication gives a plan for estimating the amount of manure to apply for the projected crop needs for nitrogen, which may exceed the 100 pounds per acre allowed under the conservative management approach. You may wish to use this worksheet with 100 pounds of N per acre applied under the conservative approach to see what happens with P and K. Two blank worksheets are included for actual applications.

If the projected crop needs for N exceed 100 pounds per acre, 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 its production level.

Example 1

A fescue hay field soil/plant filter is available for receiving broiler litter. How many tons per acre of litter should be applied for a yield goal of 3 tons per acre? Table 7 gives previous years' application rates and analyses for the litter.

Since no soil test is available, use the nitrogen requirement for fescue. Litter will supply nitrogen for the yield goal. It will not be incorporated into the soil. The ammonia-nitrogen loss is 80 percent (Table 1). For fescue, a perennial, no credit is given for nitrogen release from soil organic matter or from a previous legume crop.

For a yield goal of 3 tons per acre per year, we calculate the following nutrient removal by fescue hay (Table 6):

- 55 pounds N per ton x 3 tons per acre = 165 pounds N per acre
- 18.65 pounds P_2O_5 per ton x 3 tons per acre = 56 pounds P_2O_5 per acre
- 52.9 pounds K_2O per ton x 3 tons per acre = 159 pounds K_2O per acre

Worksheet 1
Broiler litter on fescue.

- Crop nutrient requirements (data from Table 6)
  Crop "Fescue"
  Yield "3" tons per acre
  N "165" pounds per acre
  P_2O_5 "56" pounds per acre
  K_2O "159" pounds per acre
- Available ammonia nitrogen (NH_4-N)
  NH_4-N pounds per ton x percent available = NH_4-N per ton (percent from Table 1, NH_4-N from Table 7) "10" pounds per ton x "0.2" percent available = "2" pounds per ton
- 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 7)
  "54" pounds per ton x "0.5" percent available = "27" pounds per ton
- Residual nitrogen available from last years' organic fraction (from Table 7)

Tons per acre x N pounds per ton x percent available = N pounds per acre (percent from Table 2)

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

- Manure application rate to supply nitrogen

= application rate tons per acre

(Crop N (line 1))- (residual N (line 4)) - (N from O.M. (Table. 4))- (legume N (Table 5))
_____
(Available NH_4-N (line 2)) + (available organic nitrogen (line 3))

= 4.9 tons per acre

"165 - 21.5 - 0 - 0
_____
2 + 27

- 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 7, percent from Table 3) "4.9" tons per acre x "60" pounds per ton x "0.8" percent available = "235*" pounds per acre

> ***Note**
> 235 pounds per acre of P_2O_5 is applied vs. 56 pounds per acre removed by crop.

- 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 7, percent from Table 3) "4.9" tons per acre x "40" pounds per ton x "1" percent available = "196*" pounds per acre

> ***Note**
> 196 pounds per acre of K_2O is applied vs. 159 pounds per acre removed by crop.

Example 2

The same broiler litter is applied to a soil/plant filter area for corn silage. The litter is incorporated into the soil immediately, losing 20 percent ammonia nitrogen (Table 1).

Because no litter was applied to the area in the past 3 years, use this year's data (Table 7). The yield goal is 20 tons per acre. The soil/plant filter was in alfalfa (50 percent stand) last year. The calculations for nutrient requirements for a yield goal of 20 tons with no soil test are as follows:

- 7.4 pounds N per ton x 20 tons per acre = 148 pounds N per acre
- 2.9 pounds P_2O_5 x 20 tons per acre = 58 pounds P_2O_5 per acre
- 8.9 pounds K_2O x 20 tons per acres = 178 pounds K_2O per acre
- Because the corn silage follows alfalfa, an estimated 50 pounds per acre N is expected to be available (Table 5). The corn silage is a summer annual crop. Nitrogen released from organic matter is 40 pounds per acre (Table 4).

Worksheet 2
Broiler litter on corn silage.

- Crop nutrient requirements (data from Table 6)
  Crop "Corn silage"
  Yield "20" tons per acre
  N "148" pounds per acre
  P_2O_5 "58" pounds per acre
  K_2O "178" pounds per acre
- 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 7)
  "10" pounds per ton x "0.8" percent available = "8" pounds per ton
- 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 7)
  "54" pounds per ton x "0.5" percent available = "27" pounds per ton
- Residual nitrogen available from past years organic fraction
  None applied last three years.
- Manure application rate to supply nitrogen

$$\frac{\text{(Crop N (line 1)) - (residual N (line 4)) - (N from O.M. (Table 4)) - (legume N (Table 5))}}{\text{(Available } NH_4\text{-N (line 2)) + (available organic nitrogen (line 3))}} = \text{application rate tons per acre}$$

$$\frac{148 - 0 - 40 - 50}{8 + 27} = 1.7 \text{ tons per acre}$$

- 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 7, percent available from Table 3) "1.7" tons per acre x "60" pounds per ton x "0.8" percent available = "82*" pounds per acre

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*Note
82 pounds per acre of P_2O_5 is applied vs. 58 pounds per acre removed by crop.

- Potash available at calculated application rate for nitrogen
  Tons per acre x K_2O pounds per ton x percent available = K_2O K_2O pounds per acre (K_2O per ton from Table 7, percent from Table 3) "1.7" tons per acre x "40" pounds per ton x "1" percent available = "68*" pounds per acre

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*Note
68 pounds per acre of K_2O is applied vs. 178 pounds per acre removed by crop.

Example 3

Apply the broiler litter to a soil/plant filter area in preparation for winter wheat, a winter annual. The litter is not incorporated into the soil. The area has received litter applications the last three years (Table 7). Take a nitrogen credit of 20 pounds per acre N (Table 4).

Choose a yield goal of 60 bushels per acre. No soil test data is available.

Use Table 6 to calculate nutrient requirements:

- 1.3 pounds N per bushel x 60 bushels per acre = 78 pounds N per acre
- 0.5 pounds P_2O_5 x 60 bushels per acre = 30 pounds P_2O_5 per acre
- 0.3 pounds K_2O x 60 bushels per acre = 18 pounds K_2O per acre

Worksheet 3
Broiler litter on wheat.

- Crop nutrient requirements (data from Table 6)
  Crop "Wheat"
  Yield "60"
  N "78" pounds per acre
  P_2O_5 "30" pounds per acre
  K_2O "18" pounds per acre
- 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 7)
  "10" pounds per ton x "0.2" percent available = "2" pounds per ton
- 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 7
  "54" pounds per ton x "0.5" percent available = "27" pounds per ton
- Residual nitrogen available from past years' organic fraction (data from Table 7)
  Tons per acre x N pounds per ton x percent available = N pounds per acre (percent from Table 2)

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

- Manure application rate to supply nitrogen

$$\frac{\text{(Crop N (line 1))} - \text{(residual N (line 4))} - \text{(N from O.M (Table 4))} - \text{(legume N (Table 5))}}{\text{(Available NH}_4\text{-N (line 2))} + \text{(available organic nitrogen (line 3))}} = \text{application rate tons per acre}$$

$$\frac{78 - 21.5 - 20 - 0}{2 + 27} = 1.3 \text{ tons per acre}$$

- 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 7, percent from Table 3) "1.3"
  tons per acre x "60" pounds per ton x "0.8" percent available = "62.4*" pounds per acre

> ***Note**
> 62.4 pounds per acre of P_2O_5 is applied vs. 56 pounds per acre removed by crop.

- 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 7, percent available from Table 3) "1.3" tons per acre x "40" pounds per ton x "1" percent available = "52*" pounds per acre

> ***Note**
> 52 pounds per acre of K_2O is applied vs. 18 pounds per acre removed by crop.

Worksheet 4
Litter fertility worksheet.

- Crop nutrient requirements (from data in Table 6)
  Crop _____
  Yield _____
  Nitrogen _____ pounds per acre
  P_2O_5 _____ pounds per acre
  K_2O _____ pounds per acre
- Available ammonia nitrogen (NH_4-N)
  NH_4-N pounds per ton x percent available = NH_4-N pounds per ton (Percent from Table 2, NH_4-N from lab test)
  _____ pounds per ton x _____ = _____ pounds per ton
- Nitrogen available from this year's organic fraction
  N pounds per ton x percent available = N pounds per ton (Percent from Table 3, organic N from lab tests)
  _____ pounds per ton x _____ = _____ pounds per ton

- Residual nitrogen available from past years organic fraction
  Ton per acre x N pounds per ton x percent available = N pounds per acre (Percent available from Table

3, organic N from lab tests)

1 year ago	____ tons per acre x ____ pounds N per ton x ____ percent available		= ____pounds per acre
2 years ago	____ tons per acre x ____ pounds N per ton x ____ percent available		= _____pounds per acre
3 years ago	____ tons per acre x ____ pounds N per ton x ____ percent available		= ____pounds per acre
Total			= _____ pounds per acre

- Manure application rate

$$\frac{\text{(Crop N (line 1))} - \text{(residual N (line 4))} - \text{(N from O.M. (Table 4))} - \text{(legume N (Table 5))}}{\text{(Available NH}_4\text{-N (line 2))} + \text{(available organic nitrogen (line 3))}} = \text{application rate tons per acre}$$

$$\frac{_____ - _____ - _____ - _____}{_____ + _____} = \text{tons per acre}$$

- Phosphate available at calculated application rate for nitrogen
  Ton per acre x P_2O_5 pounds 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
- Potash available at calculated application rate for nitrogen
  Ton per acre x K_2O pounds 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

WQ221, 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
- WQ222, Spreading Poultry Litter Without Lab Analysis but With Soil Tests
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