Using Poultry Litter as Fertilizer

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Poultry litter is an excellent, low cost fertilizer if used properly. Land application of litter returns nutrients and organic matter to the soil, building soil fertility and quality. In addition to the macronutrients, N, P and K, poultry manure contains calcium, magnesium, sulfur, and micronutrients.

Land application of poultry manure should be managed to recycle plant nutrients rather than for disposal. Increasing environmental concerns about agricultural non-point source pollution make it imperative to use poultry litter in the manner most beneficial for the environment – both on and off the farm. Steps to proper litter management are:

1. Determine crop nutrient requirement based on a realistic yield goal and soil test data.
2. Determine the nutrient content of litter.
3. Determine the fraction of litter nutrients available to the crop in the first year of application.
4. Determine litter application rate to supply crop nutrient needs.
5. Determine supplemental nutrients needed for optimum crop growth.

These steps will assure that the proper amount of litter is applied. Avoiding excess litter application minimizes its impact on water quality.

Crop Nutrient Requirement

Poultry litter should not be applied to soil beyond the limits of the growing crop's nutrient needs. This will ensure efficient use of manure nutrients and minimize nutrient leaching or runoff into the surface and ground water systems. Any soils scheduled to receive poultry litter should first be tested to determine fertility level. Periodic soil testing is recommended to monitor the nutrient supplying capability of the soil. Fertilizer recommendations based on soil test results are the only reliable way to determine the crop nutrient requirement.

Soil testing is available through OSU Soil, Water and Forage Analytical Laboratory in Stillwater, as well as, a number of commercial laboratories. Crop nutrient needs are given in the interpretations and requirements section of the soil test report. You can also determine crop nutrient needs using Extension Fact Sheet PSS-2225, OSU Soil Test Interpretations. Contact the local extension office for instructions and supplies for taking and submitting soil samples.

Fertilizer Value of Litter

The nutrient content of poultry litter varies quite a bit. Fertilizer value depends on the type of birds, age of the litter, and litter moisture content. It is always a good idea to take a sample and test the litter for nutrients prior to cleaning out a poultry house. Use the test results to calculate how much litter to apply to fields.

Litter samples should be representative of the entire house or litter pile in the storage. See OSU Extension Facts PSS-2248, Sampling Animal Manure for Analyses for details of manure sampling. Results are reported as pounds of nutrient per ton on a "dry" and "as is" basis. "As is" means the amount of nutrients per ton at the moisture content when the sample was taken. Normally, "as is" numbers are used for rate calculation. Table 1 shows "as is" fertilizer values from a number of studies. As you can see, the values cover quite a range. Much of the variability is due to moisture content. You can overcome the moisture factor by using the "as is" values and calibrating spreading equipment based on weight of material actually spread.

Table 1. "As is" Broiler Litter Fertilizer Concentrations.

Source	Total N	P_2O_5	K_2O
	lbs/Ton		
Arkansas	56	48	36
Oklahoma	57	62	49
Missouri	54	26	32
Delaware	59	64	41
Alabama	78	74	50
Georgia	70	30	44
Tennessee	67	71	47
Texas	67	62	46
Average	64	55	43

Availability of Litter Nutrients to Crops

The values listed in Table 1 are total nutrients in litter. These are not equivalent to nutrients in commercial fertilizer because not all the nutrients listed on a manure analysis report are readily available to a crop in the year of application. Some elements are released when organic matter is decomposed by microorganisms. Nitrogen may be lost to the atmosphere by ammonia volatilization and denitrification, or lost below the root zone through leaching.

Nitrogen availability during the year of application varies greatly and ranges from about 30 to 80 percent. Nitrogen is present in both organic and inorganic forms. Organic Nitrogen must be converted (mineralized) into inorganic nitrogen to become available to plants. The amounts of organic N converted to plant-available forms during the first cropping year after application vary according to environmental conditions and manure handling systems. About 25% to 50% of the organic N becomes available during the year of application. All of the inorganic N, ammonium-N (NH_4-N) and nitrate-N (NO_3-N), is readily available to plants. However, if litter lays exposed on the soil surface, considerable NH_4-N may be released to the air as ammonia (NH_3) gas. Ammonium worked into the soil is subject to nitrification (rapid conversion to NO_3-N). Nitrate-N is readily available to plants, but if excess water is present, it can be lost through leaching or denitrification (conversion of NO_3-N to N_2 gas). Combining inorganic N, and N available from organic N, gives the total N available to crops. This is sometimes called plant available nitrogen, PAN.

Table 2 shows the approximate availability of nitrogen in the first three years after application. Notice that more nitrogen is available for plant use if the litter is incorporated into the soil soon after application. Incorporation reduces ammonia volatilization losses.

Few studies have been done on P and K availability in poultry litter; however, availability is considered to be about 80-100 % of P and K available in commercial fertilizer. In general, 90% availability is assumed when determining an application rate based on P.

Application Rate

Land application rates should be based on the nutrient requirement of the crop. Too little manure application will not provide sufficient nutrients for the desired crop production. Excess nutrients are a waste of resources, resulting in soil phosphorus buildup which may cause water contamination.

Soil testing, litter analysis, and proper estimation of yield goal are necessary to calculate proper agronomic application rates of litter. Develop a manure nutrient management plan that consumes manure nutrients, then supplement with commercial fertilizers to balance crop needs. Follow the steps in the attached worksheet to calculate the agronomic application rate. Nitrogen credits should be given to previous years' applications in Step 1b if litter is applied to the same field continuously. The State of Oklahoma has regulations on poultry litter land application. Check NRCS Code 590 for details.

Table 2. Estimated Poultry Litter Nitrogen Availability Based on Application Method.

Year after Application	Surface Application	Soil Incorporation
First Year	50%	60%
Second Year	15%	15%
Third Year	6%	6%

Application Timing

Proper timing of litter application is essential for efficient use of nutrients and pollution prevention. Litter should be applied as near to field crop planting dates and as close to the vegetative growth of the plant as possible. Applying manure outside of crop growth periods decreases nutrient availability, and may increase the risk to environmental quality.

Grasses or pasture offer some flexibility when crop fields are not available. Litter applied during spring provides starter nutrients and releases mineralized nitrogen throughout the growing season. Applying litter in the fall generally results in greater nutrient loss than does spring application for warm season grasses, especially if the litter is not incorporated. Early fall application may be desirable to supply nutrients to cool season grasses. Winter application is the least desirable because litter must remain on the soil surface for 3 to 4 months ahead of the crop's active growing period.

Benefits of Application

Fifty pounds of nitrogen per acre is needed to produce one ton of grass forage. This is true whether the nitrogen comes from commercial fertilizer or poultry litter. Poultry litter has been shown to improve the quality of forage, as well as increase yields. Table 3 compares the effects of poultry litter and commercial nitrogen fertilizer on the production of Bermuda grass in southeastern Oklahoma. Poultry litter not only increased forage yields but also increased protein content over control and commercial fertilizer plots. Higher yields and protein content at similar rates of litter and commercial fertilizer may result from the fact that litter provides a slow release nitrogen fertilizer, improves soil quality, and reduces soil acidity.

Table 3. Average Forage Yield and Crude Protein Content of Bermuda Grass in Southeastern Oklahoma at Four Nitrogen Treatments.

Treatment	Forage Yield Tons/Acre	Crude Protein %
No N	2.77	8.0
300 lbs/Acre Ammonium Nitrate (96 lbs Total N/Acre)	3.44	8.8
2 Tons/Acre Poultry Litter (approximately 130 lbs Total N/Acre)	3.54	11.4
4 Tons/Acre Poultry Litter (approximately 260 lbs Total N/Acre)	4.82	12.6

Poultry Litter Agronomic Application Rate Calculation Work Sheet

		Example:			Your numbers:		
1a	**Nutrient needs of crop (lbs/acre)**	N	=	200	N	=
	Recommendations based on soil test results	$P_2 0_5$	=	80	$P_2 0_5$	=
	and a realistic yield goal.	$K_2 0$	=	40	$K_2 0$	=
1b	**Nutrients carried over in last 2 years' applications (lbs/acre)**	N	=	25	N	=
	See Table 2.	$P_2 0_5$	=	0	$P_2 0_5$	=
		$K_2 0$	=	0	$K_2 0$	=
1c	**Nutrient needs to meet with litter**	N	=	175	N	=
	Subtract line 1b from line 1a.	$P_2 0_5$	=	80	$P_2 0_5$	=
		$K_2 0$	=	40	$K_2 0$	=
2	**Total nutrients available in litter (lb/ton)**	N	=	64	N	=
	Based on litter analysis of representative sample	$P_2 0_5$	=	55	$P_2 0_5$	=
	collected close to time of application.	$K_2 0$	=	43	$K_2 0$	=
3	**Determine available nutrients (lb/ton)**	N	=	32	N	=
	Multiply the value in step 2a by availability, 50% for N	$P_2 0_5$	=	50	$P_2 0_5$	=
	and 90% for P and K.	$K_2 0$	=	39	$K_2 0$	=
4a	**Calculate application rates to supply N, and**	N	=	5.5	N	=
	$P_2 0_5$ needs (tons/acre)	$P_2 0_5$	=	1.6	$P_2 0_5$	=
	Divide values from Step 1c by values from Step 3.					
4b	**Choose between N or $P_2 0_5$ application rate (tons/acre)**	Rate	=	1.6	Rate	=
	Select highest rate in Step 4a to use litter as complete fertilizer.					
	Select lowest rate to maximize nutrient use.	(based on P)				
5a	**Determine amount nutrients applied at chosen**	N	=	51	N	=
	rate (lbs/acre)	$P_2 0_5$	=	80	$P_2 0_5$	=
	Multiply the rate chosen in step 4b by available	$K_2 0$	=	62	$K_2 0$	=
	nutrients in step 3.					
5b	**Determine supplemental nutrients (lbs/acre)**	N	=	124	N	=
	Subtract the nutrients applied, step 5a from nutrients	$P_2 0_5$	=	0	$P_2 0_5$	=
	needed, step 1c. If the difference is negative, enter 0.	$K_2 0$	=	0	$K_2 0$	=

This worksheet calculates the rate of application based on crop nutrient needs, either on N or P requirement. However, NRCS Code 590 Guideline dictates how much can be applied, depending on soil test P and locations.

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Issued in furtherance of Cooperative Extension work, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, Robert E. Whitson, Director of Cooperative Extension Service, Oklahoma State University, Stillwater, Oklahoma. This publication is printed and issued by Oklahoma State University as authorized by the Vice President, Dean, and Director of the Division of Agricultural Sciences and Natural Resources and has been prepared and distributed at a cost of 20 cents per copy. 0909 Revised GH