



Soil Facts

Swine Manure as a Fertilizer Source

Swine manure can be an excellent source of nutrients for crop production. The key to proper management is determining the nutrient content of the manure, the percentages of those nutrients that are available to the plant, and the nutrient requirements of the plant. Considered together, these three factors will help you apply the proper amount.

Nutrient Content of the Manure

Because the nutrient content of swine manure varies among operations and over time, the manure must be analyzed before you apply it to the land. Waste samples can be analyzed for \$4.00 by contacting the North Carolina Department of Agriculture (NCDA), Agronomic Division, Plant and Waste Analysis Lab, P.O. Box 27647, Blue Ridge Road Center, Raleigh, NC 27611. Other qualified private laboratories are also available (fees vary).

Samples collected for analysis should be representative of the pit or lagoon. If the waste is to be applied as a slurry, the storage pit or basin should be agitated before sampling. Collect approximately 3/4 of a pint of material in an expandable container, being sure to leave air space.

If you cannot have a sample analyzed, determine the application rate by using the average nutrient values for different swine manure systems shown in Table 1. Table 2 shows the average amounts of secondary and

Table 1. Nutrient Composition of Swine Manure

Manure Type	Total N	Ammonium NH ₄ -N	Phosphorus P ₂ O ₅	Potassium K ₂ O
lb/ton				
Fresh	12	7	9	9
Scraped ¹	13	7	12	9
lb/1,000 gallons				
Liquid slurry ²	31	19	22	17
Anaerobic lagoon sludge	22	6	49	7
lb/acre-inch				
Anaerobic lagoon liquid	136	111	53	133

Source: Abridged from *North Carolina Agricultural Chemicals Manual*.

¹Collected within 1 week.

²Six-12 months accumulation of manure, urine, and excess water usage; does not include fresh water for flushing or lot runoff.

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micronutrients present in swine manures. These values can be used as planning guidelines, as long as you realize that they are not as accurate as a sample analysis.

Nutrient Availabilities

The total nutrient content reported on a manure analysis report (or the levels shown in Tables 1 and 2) is not immediately available to the crops when the manure is applied. Some elements are released when the organic matter is decomposed by soil microorganisms. Other elements can combine with soil constituents and be made unavailable. Nitrogen may also be lost to the atmosphere through volatilization or denitrification, depending on the application method and soil moisture levels.

Table 3 lists the proportion of nutrients available for crop use during the first year of application for given application methods. When determining the application rate, refer to the availability coefficient for the appropriate application method, and then multiply that number by the corresponding nutrient value on the waste analysis report (or by the values shown in Tables 1 and 2). Waste analysis reports from the NCDA's Agronomic Division show the nutrient availabilities for the first crop.

The most recently applied waste is not the only source of nutrients; they are also available from previous applications of manures or from

Table 3. First-Year Availability Coefficients for Swine Manure

Manure Type	Soil			
	Injection ¹	Incorporation ²	Broadcast ³	Irrigation ⁴
	P ₂ O ₅ and K ₂ O availability coefficients			
All manure types	0.8	0.8	0.7	0.7
	N availability coefficient			
Scraped paved surface	—	0.6	0.4	—
Liquid manure slurry	0.8	0.7	0.4	0.3
Anaerobic lagoon liquid	0.9	0.8	0.5	0.5
Anaerobic lagoon sludge	0.6	0.6	0.4	0.4

¹Manure injected directly into soil and immediately covered.

²Surface-spread manure plowed or disked into soil within two days.

³Surface-spread manure uncovered for one month or longer.

⁴Sprinkler-irrigated liquid uncovered for one month or longer.

legumes crops. With the exception of nitrogen, updated soil tests are the best means of determining nutrient reserves from manure applications. Table 4 can be used to estimate available nitrogen carry-over from legumes.

Application Rates

Land application rates of manure are generally determined by matching the available nitrogen or phosphorus content of the wastes to the nutrient requirements of the crops. In most cases, nitrogen determines the application rate unless the area is designated "nutrient sensitive" and indicates that phosphorus movement

off-site could contaminate surface waters. In areas not designated as nutrient sensitive, phosphorus movement can be adequately controlled with conservation methods that minimize soil and nutrient runoff. The conservation methods include grass field borders, grassed waterways, contour planting, and reduced tillage. Leaching of phosphorus is extremely limited on mineral soils and should not contribute to groundwater contamination.

Nitrogen recommendations for various crops are listed in Table 5. Use these rates as guidelines with the realistic yield capabilities for each crop and field. With feed and forage crops, excessive manure

Table 2. Secondary and Micronutrient Content of Swine Manures

Manure Type	Ca	Mg	S	Na	Fe	Mn	B	Mo	Zn	Cu
	lb/ton									
Fresh	7.9	1.7	1.8	1.6	0.39	0.04	0.074	0.00066	0.12	0.029
Paved lot scraped	12.0	2.3	2.2	1.6	1.03	0.19	0.015	0.00007	0.35	0.15
	lb/1,000 gallons									
Liquid slurry	8.6	2.9	4.7	3.7	0.69	0.15	0.069	0.0011	0.39	0.11
Lagoon sludge	15.8	4.5	8.3	2.9	1.8	0.28	0.023	0.0095	0.67	0.23
	lb/acre-inch									
Lagoon liquid	25.5	8.3	10.0	57.7	2.4	.34	0.18	0.0045	1.5	0.3

Source: Biological and Agricultural Engineering Department, NCSU.

Table 4. Estimated Residual Nitrogen Provided by a Good Stand of Legumes Grown in Rotation

Legume	Residual Nitrogen Available (lb/acre)
Alfalfa ¹	80-100
Harry vetch ¹	80-100
Crimson clover ¹	60-75
Austrian winter pea ¹	50-60
Soybeans ²	15-30
Peanuts ²	20-40

¹Killed before planting current spring crop.

²Legume planted in previous year or season. More nitrogen will be available if the fall-planted crop immediately follows the legume. On sandy soils and in years with normally high precipitation, less nitrogen will be available to spring-planted crops.

Table 5. Nitrogen Fertilization Guidelines

Commodity	lb N/RYE ¹
Corn (grain)	1.0 - 1.25 lb N/bu
Corn (silage)	10 - 20 lb N/ton
Cotton	0.06 - 0.12 lb N/lb lint
Sorghum (grain)	2.0 - 2.5 lb N/cwt
Wheat (grain)	1.7 - 2.4 lb N/bu
Rye (grain)	1.7 - 2.4 lb N/bu
Barley (grain)	1.4 - 1.6 lb N/bu
Triticale (grain)	1.4 - 1.6 lb N/bu
Oats	1.0 - 1.3 lb N/bu
Bermudagrass (hay ^{2,3})	40 - 50 lb N/dry ton
Tall fescue (hay ^{2,3})	40 - 50 lb N/dry ton
Orchardgrass (hay ^{2,3})	40 - 50 lb N/dry ton
Small grain(hay ^{2,3})	50 - 60 lb N/dry ton
Sorghum-sudangrass (hay ^{2,3})	45 - 55 lb N/dry ton
Millet (hay ^{2,3})	45 - 55 lb N/dry ton
Pine and hardwood trees ⁴	40 - 60 lb N/acre/year

¹RYE = Realistic Yield Expectation

²Annual maintenance guidelines

³Reduce N rate by 25 percent when grazing

⁴On trees less than 5 feet tall, N will stimulate undergrowth competition

application can produce high nitrate concentrations, which can harm livestock (through nitrate poisoning) and promote nutrient imbalances that may lead to grass tetany. If loading rates are based on phosphorus, apply the amount suggested by soil test recommendations. Other nutrients such as potassium, magnesium, and the micronutrients manga-

nese, zinc, and copper may not be supplied in sufficient quantities for normal crop production. In such cases, apply the supplemental nutrients with a commercial fertilizer as recommended by a current soil test.

In addition to the supply of nutrients, proper soil pH is required to promote organic matter decompo-

sition, improve crop yields, and ensure nutrient availability. The biological conversion of organic matter to nitrate is an acid-forming process that will continue to reduce soil pH unless you follow an adequate sampling and liming program.

To help you determine land application rates, a worksheet is provided at the end of this publication.

Timing of Manure Applications

In addition to carefully calculating the application rate, you must also minimize the delay between applying the manure and planting the crop. Precise timing increases the amount of nitrogen used by the crop and thus reduces leaching. The risk of surface water and groundwater contamination is greater in areas of high rainfall and where manures are applied in the fall or winter for spring crops. On sandy-textured soils, apply manures at low rates throughout the growing season, wherever possible, to reduce nitrogen leaching caused by the soil's low nutrient-holding capacity.

Exercise caution when applying lagoon liquid through irrigation onto standing crops that are undergoing stresses.

Acres Requirements for New Facilities

Whenever samples of manure or lagoon liquid are available for analysis, the specific results should be used to determine application rates and acreage requirements. However, when you are planning new facilities, average values can help determine the approximate acreage requirements for a given size swine operation. Table 6 can be used to determine the minimum acreage a new unit will need for manure use.

An example will make these methods clear. A producer is interested in starting a 500-sow farrow-

to-finish operation using an anaerobic lagoon collection system. The producer is considering spraying the lagoon liquid effluent on bermudagrass being grown for hay. The realistic yield expected for this field is 6 dry tons per acre. How many acres of bermudagrass would be needed?

Using Table 5, the maximum nitrogen (N) rate required is 300 lb per acre (6 tons x 50 lb N/ton). Go now to Table 6 under surface broadcast column 300, and you will find

that each sow would require 0.0867 acres to utilize its waste. A 500-sow operation would thus require 43.4 acres (0.0867 x 500 = 43.4).

Value of Manure

To compare the value of manure to commercial fertilizer, convert the manure nutrients to available nutrients by using their availability coefficients. In the example that follows, the amount of available nitrogen (N), phosphorus (P₂O₅), and

potassium (K₂O) in each inch of lagoon liquid is approximately 68, 37, and 93 pounds per acre, respectively. At \$0.225 per pound of nitrogen, \$0.22 per pound of phosphate, and \$0.12 per pound of potash, the manure's gross worth is (68 x \$.225) + (37 x \$.22) + (93 x \$.12)

or
\$15.30 + \$8.14 + \$11.16 = \$34.60 per acre for each inch of lagoon liquid.

Table 6. Minimum Amount of Land Needed to Apply Swine Manure as a Nitrogen Fertilizer Based on the Nitrogen Rate Required by the Crop.

Manure Handling and Production Unit	Soil Incorporated ¹				Surface Broadcast ²			
	lb N/acre/year							
	100	200	300	400	100	200	300	400
	Acres/animal unit capacity							
Paved Lot Scraped Manure								
Weanling-to-feeder per head	0.025	0.012	0.0082	0.0062	0.0158	0.0074	0.0049	0.0037
Feeder-to-finish per head	0.12	0.061	0.041	0.030	0.073	0.036	0.024	0.018
Farrow-to-weanling per sow	0.29	0.14	0.095	0.071	0.17	0.085	0.057	0.043
Farrow-to-feeder per sow	0.34	0.17	0.11	0.086	0.21	0.10	0.069	0.051
Farrow-to-finish per sow	1.4	0.70	0.47	0.35	0.84	0.42	0.28	0.21
Liquid Manure Slurry								
Weanling-to-feeder per head	0.031	0.015	0.010	0.0077	0.019	0.0095	0.0063	0.0047
Feeder-to-finish per head	0.15	0.076	0.051	0.038	0.094	0.0470	0.031	0.023
Farrow-to-weanling per sow	0.36	0.18	0.12	0.089	0.22	0.11	0.073	0.055
Farrow-to-feeder per sow	0.43	0.21	0.14	0.11	0.26	0.13	0.088	0.066
Farrow-to-finish per sow	1.7	0.87	0.58	0.44	1.1	0.54	0.36	0.27
Anaerobic Lagoon Sludge								
Weanling-to-feeder per head	0.0019	0.0010	0.0006	0.0005	0.0016	0.0008	0.0005	0.0004
Feeder-to-finish per head	0.0094	0.0047	0.0031	0.0024	0.0078	0.0039	0.0026	0.0019
Farrow-to-weanling per sow	0.015	0.0074	0.0049	0.0037	0.018	0.0091	0.0061	0.0046
Farrow-to-feeder per sow	0.018	0.0089	0.0059	0.0044	0.022	0.011	0.0073	0.0055
Farrow-to-finish per sow	0.11	0.054	0.036	0.027	0.089	0.045	0.030	0.022
Anaerobic Lagoon Liquid								
Weanling-to-feeder per head	0.0075	0.0038	0.0025	0.0019	0.0048	0.0024	0.0016	0.0012
Feeder-to-finish per head	0.037	0.018	0.012	0.0092	0.023	0.012	0.0078	0.0058
Farrow-to-weanling per sow	0.084	0.042	0.028	0.021	0.054	0.027	0.018	0.013
Farrow-to-feeder per sow	0.10	0.051	0.034	0.025	0.065	0.032	0.022	0.016
Farrow-to-finish per sow	0.41	0.21	0.14	0.10	0.26	0.13	0.088	0.066

¹Incorporated within 2 days

²Not incorporated for 1 month or longer; lagoon liquid irrigated.

This value does not include labor or irrigation equipment costs, nor does it include the value of any secondary or micronutrients available in the manure. In addition, it assumes that the soil test has indicated a need for each nutrient, when, in fact, many nutrients may not be needed. Nutrients not needed should not be considered in assessing the financial value of the manure.

Land Application Worksheet

Farmer Jones has a swine operation in which lagoon liquid is applied through a travel gun to fertigate a field for corn. His yield goal is about 120 bushels per acre, and he decides to apply the equivalent of 120 pounds of nitrogen per acre (Table 5). His land is not subject to erosion, nor is it in a nutrient sensi-

tive watershed. The corn crop will be planted in the same field that had soybeans last year. He has grass borders on his field to further reduce the potential of nutrient or pesticide runoff.

Farmer Jones uses a starter fertilizer on his corn crop at a rate to supply 10 pounds of nitrogen per acre and 34 pounds of P_2O_5 per acre. He intends to supply the remainder of nitrogen from liquid swine lagoon

Worksheet: Determining the Nutrient Needs of Your Crop

	Example	Your Farm
1. Crop to be grown	corn	_____
2. Total nutrients required		
a. N (Table 5) (lb/acre)	120	_____
b. P_2O_5 (soil test) (lb/acre)	50	_____
c. K_2O (soil test) (lb/acre)	50	_____
3. Pounds of starter or preplant fertilizer used		
a. N (lb/acre)	10	_____
b. P_2O_5 (lb/acre)	34	_____
c. K_2O (lb/acre)	0	_____
4. Residual N credit from legumes (Table 4) (lb/acre)	20	_____
5. Net nutrient needs of crop (lb/acre)		
Nitrogen: Total need (item 2a) minus additional N from starter (item 3a), minus legume (item 4)		
a. N: $120 - 10 - 20$ (lb/acre)	90	_____
Phosphorus and potassium: Total need (items 2b and 2c) minus additional nutrients from starter (items 3b and 3c)		
b. P_2O_5 : $50 - 34$ (lb/acre)	16	_____
c. K_2O : $50 - 0$ (lb/acre)	50	_____

RATE OF MANURE TO APPLY

6. Nutrient totals in manure (from Table 1 or waste samples). If analysis report already gives available nutrients, skip this item.		
a. Total N (lb/acre-inch)	136	_____
b. P_2O_5 (lb/acre-inch)	53	_____
c. K_2O (lb/acre-inch)	133	_____

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effluent. How much effluent does he need to apply to meet the nitrogen needs of his corn crop? How much

will be needed to supplement the crop with additional K_2O or P_2O_5 to satisfy his soil test recommendations

of 50 pounds of each nutrient per acre? The answers are given in the worksheet.

Worksheet (continued)

	Example	Your Farm
7. Nutrients available to crop (items 6a, 6b, and 6c) times availability coefficients (Table 3)		
a. Available N: 136×0.5 (lb/acre-inch)	68	_____
b. Available P_2O_5 : 53×0.7 (lb/acre-inch)	37	_____
c. Available K_2O : 133×0.7 (lb/acre-inch)	93	_____
8. Application rate to supply priority nutrient		
a. Priority nutrient	nitrogen	_____
b. Amount of priority nutrient needed (lb/acre from item 5a)	90	_____
c. Rate of manure needed to supply priority nutrient (item 8b)/(item 7a): $90/68$ (acre-inch)	1.32	_____
9. Pounds per acre of all nutrients supplied at the application rate required to meet the needs for the priority nutrient. For each nutrient, multiply the available nutrients (items 7a, 7b, and 7c) by manure rate (item 8c).		
a. N supplied: 68×1.32 (lb/acre)	90	_____
b. P_2O_5 supplied: 37×1.32 (lb/acre)	49	_____
c. K_2O supplied: 93×1.32 (lb/acre)	123	_____
10. Nutrient Balance: Net nutrient need (-) or excess (+) after application of manure at calculated rate. Subtract the net nutrient needs of the crop (items 5a, 5b, and 5c) from the nutrient rate applied (items 9a, 9b, and 9c).		
a. N balance: $90 - 90$ (lb/acre)	0	_____
b. P_2O_5 balance: $49 - 16$ (lb/acre)	+33	_____
c. K_2O balance: $123 - 50$ (lb/acre)	+73	_____

Source: Calculation format modified from Pennsylvania Department of Environmental Resources, Field Application of Manure, October 1986.

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