COOPERATIVE EXTENSION SERVICE
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Using Animal Manures as Nutrient Sources

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Animal manures can be an economical and effective source of crop nutrients. Land application of animal manures is also a Best Management Practice for protecting water quality when it is carried out properly. Correct land application of animal manures depends on the producer knowing:

- the manures' nutrient content.
- best application times and methods.
- availability of manure nutrients to crops.
- how to balance crop nutrient needs using manures, fertilizers, and other nutrient sources.

This publication provides information on proper use of animal manures as nutrient sources for crops.

Dry manures can be transported and used economically some distance from where they are produced, but liquid manures cannot.

Nutrient Content

Nutrient content of manures varies, depending on the:

- type of animal.
- type and amount of bedding used.
- manure's moisture content.
- time and method of storage.

The best way to determine manure's nutrient content is to have manure samples tested as near the time of use as possible. In many cases, however, this is not practical or is nearly impossible to do. However, tabular values for the nutrient concentration of manure or the results of previous testing of similar manures can be used to determine application rates for good crop production and water quality protection.

Table 1 provides a good estimate of nutrient values of some manures available for use in Kentucky. These values should be used unless manure test results are available for the materials actually being used. Manure test data for a particular farm, either current or historical, will allow a more accurate calculation of available nutrients being applied, but Table 1 still should be used as a base reference.

It is often hard to obtain a representative sample of manures, so results that vary significantly from the values in Table 1 should be questioned. For guidelines on taking manure samples, see UK Cooperative Extension Service publication *Livestock Waste Sampling and Testing* (ID-123).

Table 1. Nutrient content of manures commonly used in Kentucky. (All values on an "as-is" moisture basis.)

		N	P_2O_5	K_2O	Moisture (%)
Solid Manures (lb/ton)					
Beef		11	7	10	80
Dairy		11	9	12	80
Swine		9	9	8	82
Broiler	(fresh)	55	55	45	20
	(stockpiled)	40	80	35	20
	(cake)	60	70	40	30
	(pullet)	40	68	40	25
	(breeder)	35	55	30	40
Layer		30	40	30	40
Liquid Manures (lb/1,000 gal)					
Holding Pit	Swine	36	27	22	96
	Dairy	31	15	19	94
Lagoon	Swine	4	2	4	99
	Dairy	4	2	3	98

Availability to Crops

Some manure nutrients are not as readily available to crops as those in commercial fertilizers, especially nitrogen. Its availability to a crop depends on:

- the crop being grown.
- the type of manure used.
- when and how the manure is applied.

Dry manures accumulating inside grower houses are protected from rain, but they need to be stored properly once removed to prevent surface and ground water contamination.

Calculating Manure Application Rates

The rates of manure application for a particular crop depend on:

- nutrient needs of the crop based on soil test results.
- nutrients available from the manure.
- the amount of a priority nutrient to be supplied by the manure (nitrogen, phosphorus, or potassium).

The worksheet on the facing page can be used to calculate how much manure should be applied to provide the nutrient most needed by a crop. A balance sheet (Nos. 8 and 9 in the worksheet) also calculates nutrients that may need to be added from other sources.

An example calculation in the first column shows fresh broiler litter being used to provide the nitrogen needs of a corn crop. Fertilizer recommendations from soil test results call for 180 pounds of nitrogen, 70 pounds of phosphate, and 125 pounds of potash. No preplant fertilizer is used in the example, but 2 tons per acre of broiler litter would have been applied the previous year and in four out of the last 10 years. The litter is to be broadcast on the surface, and corn is planted no-till. The amount of manure required to supply the priority nutrient needed by the crop—in this example, nitrogen—is calculated.

Table 2 lists nutrient availability situations most likely to occur on Kentucky farms.

Nitrogen tends to be more readily available from poultry or liquid manures than other manures, primarily because these manures have a higher nitrogen-to-carbon ratio, which increases microbial activity. However, time of application and whether or not the manure is mixed with the soil are the most important factors in nitrogen availability. Growing crops have the greatest ability to take up nitrogen, so manure applied close to the time of maximum crop growth will have the least risk of nitrogen loss.

The most extreme example of low nitrogen availability shown in Table 2 is that of manure applied in the fall with no cover crop. In that case, only 15 to 20 percent of the nitrogen remains available for the next year's corn crop. Most of the nitrogen loss from applying manure in the fall could be prevented by growing a cover crop. A cover crop would take up nitrogen as it becomes available and release it as the cover crop decomposes and the corn crop grows. Manure applied to pastures of cool-season grass in fall or early spring has a high nitrogen availability because volatilization losses are less at these times of year. Nitrogen can be taken up by the grass all year as the nitrogen is released from the decomposing manure.

Mixing of manure with the soil—especially during warm weather—increases nitrogen availability to crops, which is reflected in the coefficients in Table 2 for spring-applied manure for corn. If the manure is not incorporated within seven days of application, the nitrogen availability coefficient decreases by 15 points. As little as ½ inch of rainfall after manure is applied also helps move nitrogen into the soil and prevent its loss. Excess rainfall, on the other hand, can cause nitrogen loss through runoff or leaching. The risk of nitrogen loss is small, however, unless manure is applied on soil that is already wet or frozen.

Unlike nitrogen, phosphate is not readily lost from manure and the soil, but the availability of manure phosphate to the first year's crop is somewhat less than that of fertilizer phosphate. For this reason, the phosphate availability coefficient of manure in Table 2 is set at 80. Potash in manure is comparable in availability to fertilizer potash and is given an availability coefficient of 100.

Table 2. Percent nutrients from manure available to a crop for one year from the time of application. *Percentages are availability coeffcients as compared to commercial fertilizers.*

Nutrient	Crop	Management	Poultry or Liquid (%)	Other Manures (%)
Nitrogen	Corn or Annual Grasses, Spring Applied	2 days or less[a]	60	50
		3-4 days[a]	55	45
		5-6 days[a]	50	40
		7 or more days[a]	45	35
	Corn or Annual Grasses, Fall Applied	No cover crop	15	20
		Cover crop	50	40
	Small Grains	Applied preplant	50	40
	Pasture or Hay, Cool Season	Applied in spring or fall	80	60
	Bermudagrass	Applied spring or summer	50	40
Phosphate (P_2O_5)			80	80
Potash (K_2O)			100	100

[a]Incorporation shown, referring to how long after application manure is mixed into the soil.

Worksheet

Calculations	Example	Your Field
1. Crop to Be Grown	Corn	
2. Fertilizer Recommendation		
a. Nitrogen (lb N/A)	180	
b. Phosphorus (lb P_2O_5/A)	70	
c. Potassium (lb K_2O/A)	125	
3. Preplant Fertilizer		
a. N	0	
b. P_2O_5	0	
c. K_2O	0	
4. Residual N from Manure (Units[a] of manure applied previous year x lb N/unit x availability coefficient—see Table 3)	2T x 55 lb/T x .07 = 8 lb	
5. Net Nutrient Needs		
a. N (2a - 3a - 4)	172 lb	
b. P_2O_5 (2b - 3b)	70	
c. K_2O (2c - 3c)	125	
6. Available Nutrients with As-Is Moisture in Manure (lb/unit)		
a. N (lb N/unit) (Table 1 or test results) x available coefficient (Table 2)	55 x .45 = 25	
b. P_2O_5 (lb P_2O_5/unit [Table 1] x .8)	55 x .8 = 44	
c. K_2O (lb K_2O/unit [Table 1])	45	
7. Application Rate to Supply Priority Nutrient		
a. Priority nutrient	N	
b. Amount needed (5a, b, or c)	172	
c. Manure needed (7b ÷ 6a, b, or c)	172 ÷ 25 = 6.9 T	
8. Nutrients Supplied by 7c		
a. N (7c x 6a)	6.9 x 25 = 172	
b. P_2O_5 (7c x 6b)	6.9 x 44 = 304	
c. K_2O (7c x 6c)	6.9 x 45 = 310	
9. Additional Nutrients Needed[b] (-) = need; (+) = excess		
a. N (8a - 5a)	172 - 172 = 0	
b. P_2O_5 (8b - 5b)	304 - 70 = 234	
c. K_2O (8c - 5c)	310 - 125 = 185	

[a] *Units = tons, 1,000 gal, or acre inches, depending on the type of manure used (1 acre inch equals approximately 27,000 gal).*
[b] *The example calculation shows that 6.9 tons of broiler litter per acre can supply all the nitrogen needed by the crop. However, an excess of 234 pounds of phosphate and 185 pounds of potash per acre is supplied by this much manure. These amounts will result in higher soil test levels of phosphate and potash. Repeated overapplication of phosphate could restrict the amount of manure that can be applied to a field in future years.*

Growing animals in large numbers leads to accumulation of manure that must be stored and used carefully to provide the maximum benefit to the farmer and minimum risk to the environment.

Carry-Over

Some of the nitrogen contained in manure is released slowly and becomes available in subsequent years. Significant amounts of this carry-over nitrogen can accumulate with frequent manure applications. Estimates of availability of carry-over nitrogen are shown in Table 3. This residual nitrogen should be taken into account by subtracting it from crop nitrogen recommendations when calculating a crop's nitrogen needs.

Phosphate and potash from manure also can be held in the soil and carried over. They are not likely to be lost through runoff or leaching if good conservation practices are used. Instead, they stay in the soil and help build fertility for future crops. Phosphate and potash carried over from manure applied in previous years will be reflected in soil test results.

Table 3. Estimated available nitrogen from manure as percentage of manure nitrogen applied previous year.

Frequency of Annual Application over 10-Year Period	Poultry or Liquid Manure	Other Manures
< 4	3	5
4-8	7	15
8 >	12	25

Source: D.B. Beegle, Penn State University.