Kansas Agricultural Experiment Station Research Reports

Volume 0
Issue 10 *Swine Day (1968-2014)*

Article 640

1996

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Recommended Citation

Murphy, James P. (1996) "Swine Manure Management," *Kansas Agricultural Experiment Station Research Reports*: Vol. 0: Iss. 10. https://doi.org/10.4148/2378-5977.6480

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Abstract

Manure nutrients help build and maintain soil fertility. Manure also improves tilth, increases waterholding capacity, lessens wind and water erosion, improves aeration, and promotes beneficial organisms. When wastes include runoff or dilution water, they can supply water as well as nutrients to crops. The economic value of manure fertilizer is calculated from its available nitrogen (N), phosphorus (P), and potassium (K) at commercial fertilizer prices. These values change with the costs of fertilizer and handling practices.; Swine Day, Manhattan, KS, November 21, 1996

Keywords

Swine day, 1996; Kansas Agricultural Experiment Station contribution; no. 97-142-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 772; Swine; Manure management

SWINE MANURE MANAGEMENT

J. P. Murphy[1]

Land Application

Manure nutrients help build and maintain soil fertility. Manure also improves tilth, increases waterholding capacity, lessens wind and water erosion, improves aeration, and promotes beneficial organisms. When wastes include runoff or dilution water, they can supply water as well as nutrients to crops. The economic value of manure fertilizer is calculated from its available nitrogen (N), phosphorus (P), and potassium (K) at commercial fertilizer prices. These values change with the costs of fertilizer and handling practices.

Applying excess wastes can harm crop growth, contaminate soil, cause surface and groundwater pollution, and waste nutrients. Although most soils have a tremendous capacity to absorb P, very high soil P levels can interfere with plant nutrition by inhibiting uptake of metallic trace elements such as iron, zinc, and copper. When plant residue or manure is added to soil, an immediate and marked drop in O_2 and an increase in CO_2 occur in the soil air, which can inhibit plant growth.

The carbon-nitrogen ratio (C/N) of applied wastes affects both microbial and plant growth. If a waste having a high C/N ratio, such as manure with a lot of bedding, is added to a soil, organisms decomposing the organic matter grow until available mineral and N become limiting. All the immediately available N is bound by the microorganisms. In the short run, N is unavailable for plant use and more chemical fertilizer may have to be added than before the waste application.

Heavy manure applications can increase soil salinity, especially in arid regions where little or no leaching occurs. Salts can inhibit plant growth and depress yields. If salinity becomes a problem, consult a crop specialist. Sodium and K can alter soil structure and reduce water movement rates. Field equipment, such as heavy manure wagons, compacts wet soils, alters soil structure, and reduces water movement.

Nutrient Losses during Collection and Storage

Table 1 gives the nutrient content of swine manure as produced. Housing and waste handling systems affect the nutrient composition of wastes. Bedding and water dilute manure, resulting in less nutrient value per pound. Much N can be lost to the air as ammonia. Runoff and leaching in open lots can remove N. Much less N is lost from compost pits, liquid storage systems, or roofed feeding areas as shown in Table 2.

Phosphorus and K losses are negligible except for open lots or lagoons. About 20% to 40% of the P and 30% to 50% of the K can be lost by runoff and leaching in open lots. However, much of the P and K can be recovered by runoff control systems such as settling basins and holding ponds. Up to 80% of the P in lagoons can accumulate in bottom sludges and is not applied to land unless the sludge is removed.

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Application

Manure is usually:

- Broadcast (top dressed) with plowing or disking.
- Broadcast without plowing or disking.
- Knifed (injected under the soil surface).
- Irrigated.

Table 3 shows average N losses by method of application. The greatest nutrient response follows land application and immediate incorporation into the soil. Incorporate solid manure as soon as possible to minimize N loss and to begin release of nutrients for plant use. Most losses occur in the first 24 hours after application. Injecting, chiseling, or knifing liquids into the soil minimizes odors and nutrient losses to the air and/or to runoff.

Nitrogen loss as ammonia from land is greater during dry, warm, windy days than during humid or cold days. Ammonia loss is generally greater during the spring and summer months. Uniform application prevents local concentrations of ammonium or inorganic salts that can reduce seed germination and yields.

Crop Nutrient Removal

Apply manure so additional nutrients do not greatly exceed crop needs (see Table 4). Before heavy manure applications, have your soil tested for fertilizer needs and nutrient imbalance. Adjust waste application rates for your soil conditions against soil tests for N, P, and K.

Available N is N the plant can use. Total N is mostly organic and ammonium N. Ammonium N is equivalent to commercial fertilizer and, except for that lost to the air, can be used by plants in the application year. Organic N must be released before plants can use it but is slow releasing.

Variable amounts of organic N are released in a plant-available form during the first cropping year after application. Organic N released during the second, third, and fourth cropping years after initial application is usually about 50%, 25%, and 12.5%, respectively, of that mineralized during the first cropping season.

Nearly all of the P and K in animal wastes are available for plant use in the year of application. After a few years of regular waste applications, the amounts available are about the same as those for one year's application.

Manure Management Plan

All swine producers are encouraged to develop a manure management plan for their operations. The N loss tables point out the variability of N content of swine manure. That variability coupled with the inherent variabilities of soil type, tillage practices, weather patterns, and crop response means that the swine producer can estimate N application from manure only within broad ranges. For three different swine production systems, Table 5 gives an estimate of acres needed for 100 lb of available N per year using various methods of manure collection, storage, and field application.

Each producer must fine-tune manure management. Swine producers should develop a fertilizer application plan that first maximizes the use of manure nutrients and then supplement these nutrients with commercial fertilizer only if additional nutrients are needed for the crop. The major elements of such a plan include: 1) periodic analysis of the manure produced, 2) a routine soil testing program, 3) keeping records of manure applications and soil tests over time to minimize nutrient and salt buildup.

Diligent and conscientious management of swine manure is necessary to minimize water contamination and odor production, while maximizing the nutrient value of the manure.

Table 1. Nutrients in Swine Manure as Produced

Animal	Size, lb	Nutrients Produced per Animal per Year		
		N, lb	P_2O_5, lb	K_2O, lb
Nursery pig	35	7.3	4.4	4.4
Growing pig	65	11	8.0	8.4
Finishing pig	150	26	18	20
	200	33	24	26
Gestating sow	275	26	18	18
Sow and litter	375	37	20	20
Boar	350	33	23	23

Table 2. Nitrogen Losses during Handling and Storage[a]

System	Nitrogen Lost, %
Solid	
Daily scrape and haul	20-35
Manure pack	20-40
Open lot	40-55
Liquid	
Anaerobic pit	15-30
Aboveground storage	10-30
Earth storage	20-40
Lagoon	70-85

[a]Typical losses between excretion and land application adjusted for dilution in the various systems. These values are in addition to land application losses, based on Purdue University data.

Table 3. Nitrogen Losses during Land Application[a]

Application Method	Type of Waste	Nitrogen Lost, %
Broadcast	Solid	15-30
	Liquid	10-25
Broadcast with immediate cultivation	Solid	1-5
	Liquid	1-5
Injection into soil	Liquid	0-2
Sprinkler irrigation	Liquid	15-40

[a]Percent of N applied that is lost within 4 days of application.

Table 4. Crop Nutrient Utilization[a]

Crop	Yield	N	P_2O_5	K_2O
		lb/acre		
Corn	80 bu	121	42	77
	100 bu	160	60	120
	150 bu	185	80	215
	180 bu	240	100	240
Corn silage	16 tons	130	45	102
	32 tons	200	80	245
Soybeans	30 bu	123	32	52
	40 bu	180	45	80
	50 bu	257	48	120
	60 bu	336	65	145
Grain sorghum	4 tons	150	90	200
Wheat	40 bu	70	30	50
	60 bu	125	50	110
	80 bu	186	54	162
Oats	80 bu	75	35	95
	100 bu	150	55	150
Barley	65 bu	74	32	63
	100 bu	150	55	150
Alfalfa	4 tons	180	40	180
	8 tons	450	80	480
Bromegrass	5 tons	166	66	254
Tall fescue	3.5 tons	135	65	185
Bluegrass	3 tons	200	55	180
Sorghum-sudan grass	8 tons	319	122	467

[a]Values are for the aboveground portion of the plants. Source: Potash Phosphate Institute of America.

Table 5. Acres Needed for Land Application of Manure

Manure Handling Method	Acres/100 Sows to Yield 100 lb N/Acre		
	Feeder Pig Production	Farrow to Finish	Pigs Fed 50-220 lb
Anaerobic pit			
Broadcast	13	129	9
Broadcast/cultivate	16	152	10
Injection	16	155	10
Irrigation	12	113	8
Open lot			
Broadcast	11	102	7
Broadcast/cultivate	14	128	9
Lagoon			
Irrigation	5	48	3

[a]Values based on 100 lb. of available N per year for one time capacity of swine facilities.
[b]Based on 16 pigs sold/productive sow-yr. Manure production per productive sow accounts for all animals in the operation.