

Production and Characteristics of Swine Manure



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Digestive System

To understand the makeup of swine manure, you must have a basic knowledge of the hog's digestive system. Figure 1 shows the digestive tract of a mature hog. The body of the pig is more or less built around its digestive system. Like humans, pigs are monogastric, meaning they have a simple stomach. One of the stomach's main functions is to break down complex proteins. Broken down proteins are converted to amino acids and absorbed in the small intestine. The small intestine also absorbs fats, starches, sugars, and some water. The large intestine, or colon, however, absorbs the largest percent of water. Much of the final processing of feed takes place in the colon, where it is converted into a bacterial mass called feces. Although the kidneys are not considered a part of the digestive system, they are very important. Kidneys filter waste material from nutritive material in the blood stream and send the wastes to the bladder to be excreted as urine. Manure is the combination of feces and urine. Manure is approximately 60 percent feces and 40 percent urine.

From the perspective of the manure manager, the digestive system is a long hollow tube. Feed goes in one end; manure comes out the other end.

Basic Swine Diet

The make up of a hog ration is determined by the hog's age, sex, and weight. The diet of mature animals depends on reproduction stage. The five components of hog rations are energy, protein, minerals, vitamins, and water. Carbohydrates and fats supply energy to the pig. Carbohydrates are supplied as plant sugars or starches. Corn and sorghum are the primary sources of carbohydrates in swine diets. Soybean meal is a common protein source.

The major distinguishing characteristic of hog diets is the relationship of protein to energy in the diet. Energy level is similar in all diets (1,400 to 1,500 kcal/lb), but protein level changes as the pig grows. Starter pig rations contain 18 to 20 percent crude protein. The crude protein decreases to 14 to 15 percent by the time a finished hog reaches 250 pounds. Crude protein content of breeding stock is approximately 14 percent. Lactating sows are fed up to 16 percent crude

protein. These percentages are important since protein is the major source of nitrogen and sulfur in manure. Nitrogen and sulfur compounds contribute the lion's share of manure odor.

Manure Production

Table 1 shows the daily production of manure as it is excreted by the animal. This table was calculated using a corn-based ration. Notice how the manure characteristics change as the diet changes for different animals in different stages of life. Manure characteristics are broken down into four broad categories: quantity, organic matter, plant nutrients, and salts.

Quantity

The largest single factor in determining manure quantity is the amount of feed the animal receives. Manure quantity increases as pigs grow from nursery pigs to slaughter weight. There is also a large jump in quantity between gestating and lactating sows, largely due to the increase in feed the lactating sow and her litter receive.

Organic Matter

The total amount of organic matter excreted by hogs also is largely determined by the amount of feed they receive. The energy content of manure, as measured by oxygen demand, increases slightly as finisher hogs reach maturity. The bulk of manure organic matter is contained in feces.

Plant Nutrients

The percent concentration of plant nutrients in manure does not change considerably throughout the hog's life. Phosphorus content is a nearly constant 2.5 percent of total solids for all hog types. Nitrogen concentration in nursery pig manure (5.7 percent of total solids, C:N ratio = 8) is actually lower than for breeding stock (7.5 percent of total solids, C:N ratio = 6), even though the younger pigs receive a higher protein diet. This shows the amazing ability of modern hog breeds to convert feed to body mass. Urine contains soluble nutrients such as ammonia. Feces contain more organic nutrients.

Table 1. Daily Manure Production As Excreted.

<i>Component</i>	<i>Units</i>	<i>Nursery</i>	<i>Grower Pigs 50-125 lb.</i>	<i>Finisher 125-175 lb.</i>	<i>Finisher 175-250 lb.</i>	<i>Replacement Gilt</i>	<i>Boar</i>	<i>Gestating Sow</i>	<i>Sow + Litter</i>
Quantity									
Weight	lbs/day	3.7	6.0	8.0	9.4	8.2	8.2	8.2	26
Volume	ft ³ /day	0.056	0.095	0.13	0.15	0.13	0.13	0.13	0.41
Total Solids	lbs/day	0.37	0.60	0.80	0.94	0.82	0.76	0.75	2.6
Organic Matter									
Volatile Solids	lbs/day	0.31	0.54	0.72	0.85	0.73	0.68	0.65	2.3
COD	lbs/day	0.34	0.60	0.82	0.96	0.78	0.55	0.72	2.5
C:N Ratio		8	7	7	7	7	6	6	7
Plant Nutrients									
N	lbs/day	0.021	0.040	0.053	0.062	0.060	0.060	0.058	0.18
P	lbs/day	0.0087	0.015	0.020	0.024	0.020	0.020	0.019	0.064
K	lbs/day	0.012	0.021	0.028	0.033	0.033	0.040	0.037	0.12

*Average daily production for weight range noted. Increase solids and nutrients by 4% for each 1% feed waste more than 5%.

Salt

When thinking about salt in the hog ration, it is interesting to note that all the salt that goes into the hog will eventually be excreted in some form or another. Seventy-five percent of salt is excreted in urine and 25 percent in feces.

Altering Manure Characteristics through Diet Manipulation

Quantity

Since the values in Table 1 are calculated from a corn-based ration, they will be different if you change the ration. The digestibility of a sorghum ration is not as high as corn, so it will take slightly more feed to satisfy the hog's nutrition requirements. This also means the quantity of manure will increase slightly.

Nitrogen

Increasing nitrogen in the ration will increase nitrogen excreted. One way to reduce dietary nitrogen is to feed the essential amino acids as a diet supplement and reduce feed protein sources such as soybean meal. This is not very practical because the cost of soybean meal is relatively low compared to amino acid supplements. Besides, one of the problems with land application of manure is that the ratio of phosphorous to nitrogen in manure is higher than what most crops remove from the soil. It makes more sense to preserve

nitrogen in the handling system. We can reduce nitrogen handling losses by feeding additives which tie up nitrogen. A few feed additives that have been investigated for nitrogen binding are yucca plant extracts, zeolites and activated carbon. Tentative results show that some nitrogen binding agents can be effective in reducing ammonia losses in storage.

Phosphorus

Hogs cannot absorb 100 percent of the phosphorus they are fed, primarily because 60 to 70 percent of plant phosphorus is organically bound in the form of phytate. Feeding a commercial product called Phytase improves plant phosphorous digestion. You can greatly reduce supplemental phosphorus by using Phytase. Reduction in price may eventually make feeding Phytase more cost effective than adding inorganic phosphorous to the diet.

Sulfur

Sulfur is a large contributor to the odors associated with hog production. One way to increase the digestibility of sulfur and reduce odors is to feed only one of the three sulfur-containing amino acids — methionine, cysteine, and cystine. In practice, this means selecting protein sources with lower sulfur contents. Reducing the sulfur content of common feedstuffs is an area of active research.

Table 2. Farm Manure Production Values - as excreted.

Farm Type	Unit	Manure Volume (gal/unit/day)	Organic Matter (lbs VS/unit-day)	Nutrients in Fresh Manure		Nitrogen Available to Plants after Handling (lb/unit-year)	
				N (lb/unit-year)	P ₂ O ₅ (lb/unit-year)	Lagoon + Irrigation	Waste Storage Structure + Injection
Sow	Sow	1.4	1.0	29	23	4.4	12
Sow + Onsite Nursery	Sow	2.1	1.5	43	36	6.5	17
Offsite Nursery	Pig	0.42	0.31	7.7	7.3	1.2	3.1
Finisher	Hog	0.90*	0.70*	18	16	2.7	7.3
Farrow to Finish	Sow	7.1	5.3	150	130	22	58

* These are average values for a farm containing a mixture of different aged hogs. Many company farms use "all in-all out" finishing. Under "all in-all out" conditions, volume increases from a minimum of 0.5 gal/unit-day when hogs arrive at 50 lbs. to a maximum of 1.2 gal/unit-day when reach 220 lbs. Similarly, organic matter increases from 0.36 lbs. VS/unit-day to 0.9 lbs. VS/unit-day as the hogs mature.

Salt

Another ration component to watch closely is salt. Salt is a major factor in the amount and quality of urine produced. Salt should not be fed in excess of the pig's dietary requirement. Any attempt to manage salt intake will benefit the waste handling system through improved treatment performance and better quality manure for land application.

Manure Characteristics from a Farm Scale Perspective

Hog farms are made up of a combination of all different types of animals. Table 2 gives total farm manure characteristics for farms commonly found in Oklahoma. Values are given on the basis of the animal number that distinguishes

the farm unit. For instance, a 600-sow farrowing and gestation farm contains 11 boars, 500 gestating sows, and 100 lactating sows with litters. The distinguishing animals on the farm are the 600 sows. To find the daily volume of manure produced, multiply 1.4 gallons/day times 600 for an 840 gallons/day farm total.

Conclusion

The values in this fact sheet are only an example of how a certain ration affects the production and characteristics of swine manure. Keep accurate records of water and manure use on your own farm. Get in the practice of testing waste materials at different points in the manure handling process. A little time spent becoming familiar with manure production on your farm will save feed, labor, and money in the long run.

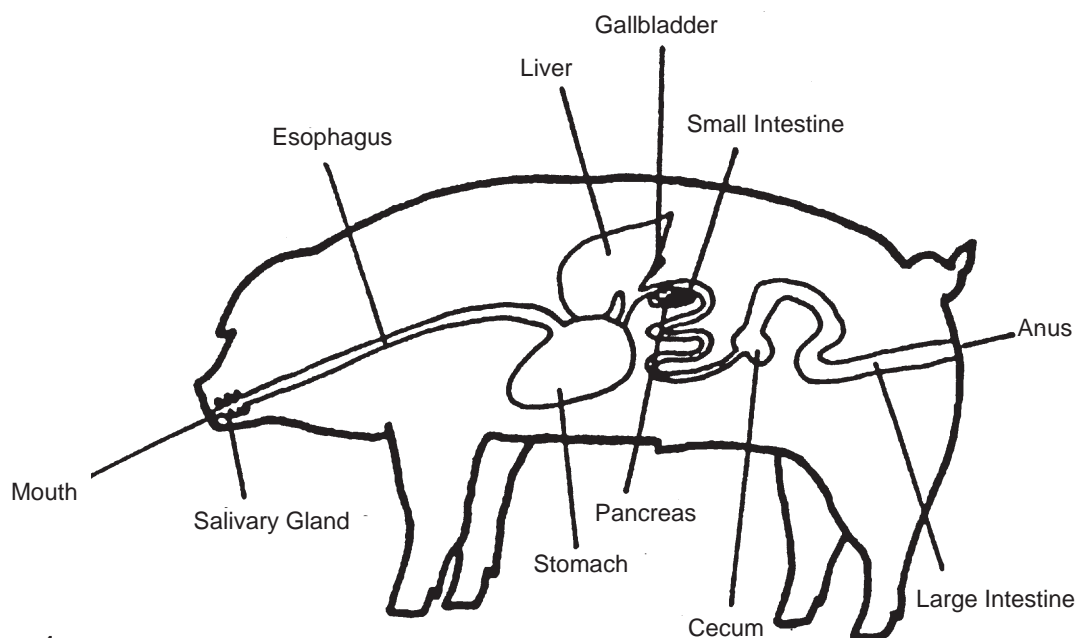


Figure 1.

Definition of Manure Production Terms

Quantity

Quantity terms define the amount of manure produced. Manure quantity determines storage and equipment sizes and plays a great role in the time and labor required to handle manure.

Weight: The daily mass of feces and urine excreted by the animal.

Volume: The space taken up by the daily production of manure.

Total Solids (TS): The daily mass of manure — minus water.

% Total Solids The mass percentage of feces and urine taken up by solids. This value determines the consistency of manure. When it is excreted at 9 to 10 percent total solids, swine manure is a thick slurry. Dried to 30 percent, manure acts more like a solid. Diluted to less than one percent, manure becomes a liquid.

Organic Matter

Organic matter determines how we handle manure to reduce odors and nuisance conditions. Undigested feed energy shows up in manure as organic matter. Because of these factors, we use organic matter content to design waste treatment systems.

Volatile Solids (VS): The mass of solids that will ignite when heated to 550° C. Approximately 85 to 90 percent of fresh manure solids are volatile; therefore, nearly 90 percent of all manure solids are organic matter.

Chemical Oxygen Demand (COD) A measure of the pollutant strength of manure. This is the mass of oxygen required to break down the organic matter in manure. It is measured by digesting a manure sample with a strong chemical oxidant.

C:N Ratio The ratio of carbon to nitrogen in manure. It is a rough measure of the biological stability of organic matter. Stability is defined two ways. Unstable organic matter has a high energy content as denoted by large amounts of carbon. When dried to an optimum moisture content for bacterial growth, high C:N materials give off heat. Organic matter with C:N above 30 removes nitrogen from the environment; whereas, materials with C:N less than 20 release nitrogen to the environment.

Plant Nutrients

The values given in Tables 1 and 2 are the masses of total nutrients excreted by the animal. These values determine area required to spread material when it is applied to cropland and pasture. Nutrient content changes greatly as manure moves through the handling system.

“As Excreted” versus “As Used”

The values given in Tables 1 and 2 are excreted values. Once manure is excreted from the animal, it undergoes a multitude of changes. For example, water is added to flush material out of buildings, and volatile solids are digested in lagoons. Waste production and characteristics for your farm is unique to your system. Keep accurate records of farm water and manure use. Get in the practice of testing waste materials at different points in the manure handling system. A little time spent becoming familiar with manure production on your farm will save lots of feed, labor, and money in the long run.

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