ENVIRONMENTAL QUALITY

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Manure Management in Hoop Structures

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Hoop structures for raising swine offer an alternative to managing manure in the traditional liquid form (Figures 1 and 2). Some producers are willing to provide the increased labor and management required for a hoop structure so that manure can be handled as a solid. Advantages of handling manure as a solid include the following:

- Bedding availability on the farm
- Less odor than with liquid manure systems
- Less risk of runoff or "spills" than with liquid manure systems

Disadvantages of handling manure as a solid include the following:

- Large amounts of bedding required
- Labor required to handle bedding and manure
- Bedding costs, if bedding must be purchased

Figures 1 and 2. Hoop structures are lower-cost facilities that require bedding and handling of manure as a solid.

Bedding considerations

Bedding is a key item in the successful operation and management of swine hoop structures, especially during the winter. Enough bedding should be used to keep the bedding pack relatively dry. Pigs will usually establish a dunging area in a portion of the structure, and extra bedding may be required in this area to keep it from becoming excessively wet and sloppy. It is recommended that accumulated manure and bedding be removed from the hoop structure after each group of finishing swine. Typical practices are to place about 15 percent of the total bedding used for each group of pigs into the structure when the group is started. About 5–6 percent of the total is then added weekly (for about 15 weeks) to maintain dry bedding.

Bedding materials and amounts

Almost any dry organic material that is capable of absorbing moisture can be used as bedding in hoop structures. Typical bedding materials include cornstalks, straw, fescue hay, sawdust and wood shavings. Bedding originating from wood product residue (sawdust, shavings) should be used with caution due to the possibility of transmitting avian tuberculosis from bedding to pigs. The avian tuberculosis organism accumulates in the bark and wood, through contact with birds, during the life of the tree and persists through processing of the wood to sawdust or shavings. Hence, these wood products should go through a heat process (as with kiln-dried lumber), or be aged a minimum of two years to reduce the risk of avian tuberculosis. The use of "green" sawdust or shavings from fresh-cut trees should be avoided.

The amount of bedding needed depends on such factors as season of the year, management characteristics and climatic conditions. Bedding required during the summer is typically one-half to two-thirds of that required during the winter. Table 1 suggests bedding use rates for hoop structures.

Large round bales of poor-quality hay or stalks are often used for bedding. If bales weigh about 1,000 lb, then about one-fifth of a bale will be needed for every pig marketed (assuming 200 lb bedding per pig), or about one bale for every five pigs marketed. More may be used in winter and less in the summer. At this rate, a 200-head hoop structure for finishing swine (turning 2.7 groups of pigs per year) would require about 100 to 110 bales of bedding annually. It is important to ensure availability of sufficient bedding material when using hoop structures to grow swine.

Table 1. Bedding use rates for hoop structures (pounds bedding per pig marketed).

Material	Amount of bedding used		
	Average	Summer	Winter
Shredded corn stalks	200	125-150	200-250
Corn cobs	240	150-180	240-300
Barley straw	240	150-180	240-300
Oat straw	180	110-135	180-225
Wheat straw	225	140-170	225-285
Sawdust (hardwood)	335	210-250	335-415
Sawdust (pine)	200	125-150	200-250
Wood shavings (hardwood)	335	210-250	335-415
Wood shavings (pine)	250	155-190	250-315

Note: Adapted from MWPS AED 41, *Hoop Structures for Grow-Finish Swine.*

Bedding management

Typical bedding management recommendations suggest placing five to eight large bales of bedding material in the hoop structure when beginning a new group of pigs (180 to 200 head). Additional bedding is added at the rate of about two bales per week, or as needed to keep the bedded pack at the desired moisture content. Bales should be unrolled for the initial bedding application to acquaint the pigs with the bedding material and provide an even distribution of bedding within the structure. In subsequent additions, the bales may not need to be unrolled, but are simply placed in the areas where bedding additions are needed. The general activity of the pigs is then sufficient to spread the bales as bedding. Strings must be removed from the bales to prevent ingesting or entanglement by the animals. Although poor-quality hay or stalks can be used as bedding, care should be taken to maintain the dry matter and absorbency characteristics of the material. Bales stored outside for long periods of time, especially over the summer, tend to lose dry matter and "bedding quality" and become less suitable for use in hoop structures.

Manure and bedding

The amount of manure and bedding that will accumulate in a hoop structure is an important consideration. Equipment requirements, time and labor requirements, and ultimate disposition of the manure/bedding mixture depend on the amount generated. The accumulation of manure and bedding in a hoop structure depends on a number of factors. Under certain conditions, some composting may take place in the manure/bedding mixture, and this process tends to reduce the volume of manure and bedding. In cold or wet weather, more bedding is used and the volume increases at a faster rate.

In Iowa studies, the average accumulation of manure and bedding in hoop structures was about 0.3 ton per pig during the summer, and 0.6 ton per pig in the winter. Hence, a hoop structure housing 200 pigs might be expected to contain about 60 tons of manure and bedding at the end of a summer grow out period, and 120 tons at the end of a winter grow out period. Average moisture content of the manure/bedding mixture in the studies was about 60 percent. With an assumed bulk density of 50 lb per cubic foot for the manure and bedding, a volume of 2,400 cubic feet might be expected in the structure for a summer grow out period, and 4,800 cubic feet for a winter period. If a manure spreader with 200 bushels capacity were used to haul manure from the structure, about 10 trips would be required for the summer period, and 20 trips for the winter period. Successful operation and management of hoop structures requires that appropriate equipment and sufficient labor be available to handle these amounts of manure. Table 2 summarizes these estimates for manure and bedding.

Table 2. Estimated manure and bedding generated by one group of pigs in a 200-head hoop structure.

	Summer	Winter
Tons of manure/bedding	60	120
Cubic feet of manure/bedding	2,400	4,800
Loads with 200 bu manure spreader	10	20

Management and handling of the manure/bedding mixture at cleanout are additional important considerations. To minimize the risk of disease, prevent excessive accumulation of manure/bedding, and enhance overall sanitation, hoop structures should be cleaned after each group of finishing pigs is moved out. Ideally, the manure should be spread on appropriate fields during the cleanout process. However, since cleanout may be performed two or more times per year, and at varying times during the year, some cleanout events may be performed when land spreading is not possible. Conditions that would prevent immediate land spreading include inclement weather, saturated or frozen ground), and unfavorable crop status on fields designated to receive manure.

When manure cannot be spread immediately during cleanout, stockpiling is necessary. When manure is stockpiled, care should be taken to locate the pile on a well-drained site that is separated from sensitive areas or features such as lakes, streams, wells, sinkholes and property lines. Rain-induced runoff will occur around "open" manure stockpiles. This runoff will contain contaminants that can impair water quality and create pollution issues. Thus, it is important to locate a stockpile where runoff is not likely to adversely affect water quality, and also to minimize the length of time the stockpile exists. If long-term stockpiling is anticipated, covering the pile may be necessary to minimize contaminated runoff. Some producers consider the use of "stackhouses" or sheds in which manure is stockpiled. This practice eliminates pollution concerns from runoff and gives the operator more flexibility in timing spreading operations.

Equipment and labor

Managing manure and bedding in hoop structures requires different equipment and labor inputs than those used for more conventional swine facilities. If large round bales are used for bedding, a tractor of sufficient size (60 hp or larger recommended), or large skid-steer loader is needed to handle the bales. A three-point hitch bale spear or cradle on the rear of the tractor may be sufficient, however, a similar attachment on a front-end loader facilitates placing the bales in the hoop structure.

Cleanout of a hoop structure requires use of loading equipment appropriate for the manure and bedding. Front-end loaders on tractors, or skid-steer loaders are commonly used. When long hay, straw, or stalks are used as bedding, a grapple fork or tines on the loader bucket may be necessary to break up and remove the bedded pack (Figure 3). Care should be taken not to "dig out" the earthen floor of the facility. Manure from hoop structures is usually hauled and spread with conventional beater-type manure spreaders. Long fibers in the bedding may tend to accumulate and wrap around the beaters on the manure spreader. A spreader design with the ability to cut or shred long fibers will reduce this tendency (Figure 4). For a given number and size of hoop structures, spreader size determines the number of loads or trips necessary to clean out a facility. Available time for cleanout and hauling manure should be considered in selecting the size of spreader to be used.

Figure 3. Front-end or skid steer loaders are necessary for handling bedding and manure in hoop structures.

Figure 4. Manure spreaders should be able to handle stringy, fibrous mixtures of manure and bedding from hoop structures.

Hoop structures may require more labor on a "per-pig" basis than more conventional confinement facilities. Survey studies in Iowa suggest that labor requirements for hoop structures are in the range of 0.2 to 0.3 hour per pig. About half of this time is associated with bedding and cleaning out the facility. Using these figures, a producer might expect to provide 20 to 30 hours of labor per turn of pigs in a 200-head hoop structure for bedding and cleanout activities. This estimate does not include time spent baling bedding material or time spent hauling manure away from the facility.

Nutrient considerations

When manure is cleaned from a hoop structure it should be spread on land in such a manner that crops can use the nutrients and the potential for adverse environmental effects is minimized. As with other manure, the fertilizer nutrients of primary interest are nitrogen, phosphorus and potassium. The concentration of manure nutrients in a hoop structure is usually highly variable and depends on such factors as amount of bedding used and dunging patterns within the building. Mixing the manure in a stockpiling or composting operation would reduce this variability and make nutrient concentrations more uniform. Since relatively large amounts of bedding are used in hoop structures, the resulting manure has a high carbon/nitrogen ratio. This condition can lead to nitrogen immobilization and crop stress if the manure is spread during or immediately before the growing season. Again, stockpiling or composting the manure before field spreading will reduce these effects.

Manure nitrogen excreted in a hoop structure is subject to some volatilization and loss to the atmosphere. Phosphorus and potassium are not subject to volatilization, and most of that excreted will be present in the manure cleaned from the facility. When large amounts of bedding are used, and dunging patterns are not evenly distributed, the amount of manure nutrients is highly variable within the structure. Table 3 shows estimates of the manure nutrients produced by one turn of pigs in a 200-head hoop structure. Nutrients contributed by the bedding are small in comparison to nutrients contributed by manure, but are included in the estimates.

Table 3. Estimated manure nutrients produced by one group of pigs in a 200-head hoop structure.

	Nitrogen	P_2O_5	K_2O
Amount, lb	2,100	1,200	1,400
Estimated concentration, lb/ton	18-35	10-20	12-23

Note: Manure nutrient data taken from MWPS-18 Section 1, Manure Characteristics.

No nutrient losses were assumed in the estimated values in Table 3, and thus the values may be considered an upper bound for nutrients available at cleanout. Nitrogen is subject to volatilization and loss in the hoop structure as well as loss in subsequent stockpiling, composting and field spreading. These losses depend on many factors and are difficult to predict. Laboratory tests of manure nutrients should be obtained so that more accurate information is available.

Example

A hoop structure complex of four buildings housing 200 finishing pigs each is planned. Average weight per pig in the structures is 150 lb, and each structure will turn 2.5 groups of pigs per year. A 200-bushel manure spreader will be used to haul manure and bedding from the structures, and round-trip time for loading, travel and unloading the spreader is estimated at 45 minutes. Use the information in this publication to estimate the following.

1. Amount of bedding needed annually. Assume large round bales (cornstalks) of 1000 lb average weight will be used.
   From Table 1, average bedding use is 200 lb per pig marketed.
   200 pigs/turn-building x 4 buildings x 2.5 turns/yr x 200 lb/pig x 1 bale/1000 lb = 400 large round bales of cornstalks
2. Weight of manure and bedding produced annually.
   From Table 2, assume that average manure/bedding produced in the hoop structures will be about 90 tons per group of pigs.
   4 buildings x 2.5 turns/building x 90 tons/turn = 900 tons of manure/bedding
3. Volume of manure and bedding produced annually.
   From Table 2, assume average manure/bedding volume produced by each group of pigs is 3,600 cubic feet.
   4 buildings x 2.5 turns/building x 3,600 cu ft/turn = 36,000 cubic feet of manure/bedding
4. Number of spreader loads required to clean buildings annually.
   36,000 cu ft x 0.8 bu/cu ft x 1 load/200 bu = 144 loads
5. Time required to clean, haul, and spread manure/bedding annually.
   144 loads x 0.75 hr/load = 108 hrs = about fourteen 8-hour days
6. Number of acres required for land spreading if manure is spread at the rate of 150 lb nitrogen per acre.
   From Table 3, estimated nitrogen produced is 2,100 lb per group of pigs.
   4 buildings x 2.5 turns/building x 2,100 lb N/turn x 1 acre/150 lb N = 140 acres
   Note: This calculation assumes no loss of nitrogen. If 50 percent of the excreted nitrogen were lost or unavailable to plants, then only 70 acres would be required.
7. Number of acres required for land spreading if manure is spread at the rate of 50 lb P_2O_5 per acre.
   From Table 3, estimated P_2O_5 produced is 1,200 lb per group of pigs.
   4 buildings x 2.5 turns/building x 1,200 lb P_2O_5/turn x 1 acre/50 lb P_2O_5 = 240 acres

For further information

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