Hoop Barns for Grow-Finish Swine

Swine producers in the United States who are looking for lower cost structures in which to raise pigs have increasingly turned to so-called hoop barns or hooped shelters as facilities in which to house grow-finish swine. Hoop barns have been rapidly adopted. For example, by 2001, Iowa farmers had erected more than 2,100 hoop barns for finishing pigs. Hoop barns can be used successfully to finish pigs, but producers need to be aware of the advantages and disadvantages of this type of housing.

To help producers and designers resolve some of the issues involved in using a hoop barn, this publication summarizes information about designing and using hoop barns. It discusses some of the management techniques that hoop barns require, and it presents economic factors that can be used to analyze design layouts and construction alternatives. The publication contains a sample budget comparing the costs of hoop barns to the costs of more traditional confinement housing.
Overview

A hoop barn is a Quonset™-shaped structure with sidewalls 4 to 6 feet high made of treated wood posts and wood sides or concrete. Tubular steel arches fastened to the tops or sides of the posts form a hooped roof, which is covered with UV-resistant, polyvinyl tarp. When used as swine housing, hoop barns have concrete or earthen floors. Buildings with earthen floors have a concrete slab for a feeding and watering area. The floor, except for the feeding and watering area, is deep bedded and cleaned after each group of pigs is marketed.

Figure 1 shows a typical installation of a hoop barn. Figure 2 shows the common components of hoop barns.

Hoop barns are naturally ventilated and are sited to take advantage of prevailing winds. In the Midwest, most buildings are oriented in a north-south direction.

Basic Questions

Most of the previously available information about using hoop barns for swine housing came from farmer experiences and comparisons in magazines and news articles. Recent research performed in Canada and at Iowa State University has added to what is known about using hoop barns for swine housing. Producers thinking about building any type of swine housing need to answer questions like the following to determine if building the hoop barn is right for their situation.

1. Does the building's design make the use of optimal or preferred management practices possible and convenient?
2. Is the design conducive to providing for the animals’ needs during all seasons?
3. Is the design structurally sound and does it meet common tests of reliability, longevity, and insurability?
4. Is the design cost effective?
5. How will the structure fit in with my overall production goals?
6. Do I have the necessary site and equipment to operate the building?
7. Are environmental permits necessary?

When to Consider Hoop Barns

Hoop barns appear to be most beneficial for producers who have one or more of the following needs:

- Want facilities to match a rapidly changing swine industry.
- Need a short-term structure that can be removed after use or that can be adapted for other uses.
- Want to keep fixed costs low.
- Have limited capital.
- Need facilities for groups of 150 to 200+ pigs, which could be impractical for other housing types.
- Are not interested in accepting the financial risk associated with a large capital investment.
- Prefer to handle solid manure and have the capability to do so.
- Have the equipment and land resources to harvest crop residue for bedding.
- Prefer a system of production that is less automated and requires different husbandry skills than those needed in confinement buildings.
- Believe pigs should be reared in an environment with bedding.
- Need a structure built quickly.
- May want to qualify for some niche market requirements and premium prices.

Along with the benefits, hoop barns have some disadvantages:

- Observing animals in large groups is more difficult.
- Hoop-housed pigs may use feed less efficiently during cold periods.
- During inclement weather, the labor environment is less favorable in hoops than in confinement buildings.
- Hoop-raised pigs may be slightly less lean than confinement-raised pigs.
- More labor may be needed for hoops than for confinement buildings.
- Hoops require large amounts of bedding, and labor needs for harvesting bedding may conflict with the labor needs for harvesting grain.
- Raccoons and other animals that can foster farm-to-farm disease transmission may use the bedding storage area for nests.
- Excluding birds and other pests that may carry diseases is difficult.

An example of a producer who should consider using hoop barns is a farrow-finish producer with a moderate size sow herd who weans 150 or more pigs.
at one time and who currently uses a variety of outside lots for grow-finish. Problems with pig comfort and performance in cold weather coupled with environmental concerns about current manure storage and runoff control systems might lead this producer to consider a hoop barn as a housing alternative.

If the producer is seeking a facility that has other options for use if the swine enterprise is discontinued, investing in hoop barns becomes more reasonable. If this producer’s goals in pork production include the use of a production system that requires a lower capital investment or a system that requires bedding use to qualify for a niche market, the case for using hoops becomes stronger. Finally, if equipment for harvesting crop residue and for handling solid manure is already available, the logic of investing in a hoop barn is even more compelling.

From another perspective, many large producers are considering building one or more hoop barns as a way of dealing with fluctuations in pig flow numbers. These producers consider a lower-cost building for excess pigs to be beneficial so more expensive facilities always can be stocked at an economic optimum.

Table 1 shows a comparison of various swine finishing facilities. Hoop barns are a good alternative for producers who are unwilling or unable to invest in confinement facilities but want to move pigs from outside lots or Cargill-type floor units to a facility that has a more manageable thermal environment, that provides better runoff control, and that allows better feed usage.
Designing and Erecting Hoop Barns

Producers who decide to build a hoop barn need to treat the construction project as they would any construction project involving a new structure. Aspects to consider include what type of structure to build; site selection; and proper access to the building for moving feed, bedding, and pigs. Producers thinking about building a hoop barn also should consider the building's usefulness within an existing operation, its proximity to neighbors, the availability of services and utilities, and the possibility of using the structure in conjunction with existing buildings.

Using engineered or non-engineered hoop barns

Although hoop barns do not have an extensive history in the United States, Canadian farms have been using hoops for several years. In both the U.S. and Canada, many models have proven to last 10 years or more if they are well maintained. Factors influencing the life include the use of strong, tear-resistant tarps, corrosion resistant structural members, and sidewalls that are well maintained and not abused.

One factor producers should consider is whether to purchase an engineered or a non-engineered structure. When a hoop barn is engineered, a qualified designer (typically a registered engineer) has analyzed how each component of the structure will interact with the other components of the structure. A qualified designer has analyzed how the loads applied to the roof (or tarp) will affect the design of the tubular frame and how the tubular frame will transfer forces vertically and horizontally to the sidewall frame.

In addition, the designer has considered the forces the animals themselves will exert against the sidewalls and has designed the sidewalls to withstand the outward push of the frame and pigs. In an engineered building, the foundation has been specified to withstand the loads transferred from the wall. Structures that are engineered have been designed to meet snow and wind loads for the geographic area in which they are to be erected. An important point for producers to consider is that engineered structures are more easily insured because they are assured to meet weather design conditions. Insurance agents should be consulted about insurability issues before any building is purchased and constructed.

An engineered structure typically will include the frame, tarp, sidewall materials, and materials to anchor the building to the foundation. Warranties for engineered structures range from 10 to 15 years on materials and workmanship. Engineered structures often are more insurable than non-engineered structures, and engineered structures often cost less to insure.

Some hoop barns on the market have not been engineered. Hoop barn dealers often sell a roofing system instead of a complete structure. Included in most packages are the tubular frame, tarp, and material to attach the tarp to the sidewalls. The buyer must purchase the wood posts and tongue and groove boards to construct the sidewalls. Many times, non-engineered structures will have less than a three-year warranty on products and workmanship. Non-engineered structures may have little if any resale value after five years.

Producers must ask themselves questions like the following when considering the purchase of a hoop barn:

- How long do I want the structure to last?
- Do I want to have the opportunity to resell the structure in the future?
- Will the extra cost of buying an engineered structure outweigh the savings of buying a less expensive, non-engineered structure?
- How does having an engineered structure affect my ability to get insurance on the structure?
**Design and construction details**

Hoop barns are naturally ventilated and are sited to take advantage of the summer prevailing winds. For much of the Midwest, the building is oriented in a north-south direction to take advantage of the summer prevailing winds from the south. Prevailing summer winds should blow into the end of the building at which the feeders and waters are located and should blow out the end at which the bedding is located.

In a grow-finish hoop barn, an area approximately one-quarter to one-third the length of the structure is provided for feeders and waterers. The feeding and watering slab should be planned to allow the animals to move about the slab without disturbing animals that are eating. For instance, circular feeders should have at least 5 feet of open space completely around them to account for the space pigs require while eating. In a north-south oriented structure, this slab area should be located at the south end and extend the entire width of the structure. In such a location, the feeding pad is sloped 1 to 2% (1/8 to 1/4 inch drop per foot of length) to the south, or away from the bedded area. The remaining deep-bedded area of the structure can have either an earthen or concrete floor, with many producers preferring concrete for ease of cleanout. A complete concrete floor will make cleaning much easier because it prevents the problem of pigs digging into the underlying soil. A concrete floor also tends to reduce bedding usage in summer because pigs cannot dig to reach cooler soil. In some states, regulations require concrete floors to prevent nutrients from leaching into the underlying soil and groundwater.

If the bedding area is to be concreted, the soil should be compacted to prevent differential settling. A five-inch slab with woven wire, placed in the center (vertically) of the slab should be sufficient for most applications. The concrete floor should have a strength of 4,000 psi. Thicken the edges of the slab, particularly at the end where vehicles will drive into the bedding area for cleaning. Place the concrete flat.

When building multiple hoop barns, provide at least 10 feet of space between buildings. This will allow space for equipment to travel between buildings and allow for snow removal and moisture drainage.

A typical hoop barn is 30 by 72 feet and holds approximately 195 head of finishing pigs in one large group. Table 2 shows the typical space distribution in a hoop barn used for housing grow-finish pigs. Optimum stocking density usually is about 11 square feet per pig. Figure 3 shows a common layout for a grow-finish hoop barn.

<table>
<thead>
<tr>
<th>Table 2. Space distribution in a hoop barn used for grow-finish housing.</th>
<th>Optimum</th>
<th>Range</th>
</tr>
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<tr>
<td>Bedded Area, sq ft per pig</td>
<td>8</td>
<td>5.8–12.7</td>
</tr>
<tr>
<td>Concrete Area, sq ft per pig</td>
<td>3</td>
<td>2.3–4.2</td>
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<tr>
<td>Total Area, sq ft per pig</td>
<td>11</td>
<td>10.0–15.0</td>
</tr>
<tr>
<td>Feeder Space, Pigs per space</td>
<td>10</td>
<td>5–10</td>
</tr>
<tr>
<td>Drinking Spaces, Total</td>
<td>4</td>
<td>4–6</td>
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</tbody>
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![Figure 3. Typical layout for a grow-finish hoop barn.](image-url)
Wood sidewalls and concrete are both relatively common, with increasing interest in using concrete. For wood sidewalls, the steel frames are fastened to the tops or sides of the posts that support the outside wall. Commonly, pressure treated 6 x 6’s are used as posts. Pressure treated tongue and groove 2 x 6’s are used on the animal side of the posts to form the sidewalks of the animal space.

Either poured or precast concrete walls can be used for hoop barns. Either must be designed to support the design loads caused by the hoops. Properly engineered hoop frames connected to precast concrete walls, similar to those used in bunker silos, can be a good choice in that the structures can be moved if necessary. Concrete for the sidewalls is more durable than wood but may be more expensive, and may be colder for the animals to lie against. Pouring concrete sidewalls would make the hoop barn a more permanent structure. If concrete sidewalls are used, they must be designed to accommodate the fastening requirements of the selected brand of hoop barn.

Typically the sidewalls are 4 to 6 feet high. Six-foot sidewalls are recommended to prevent pigs from damaging the tarp when a great deal of bedding has accumulated. Figure 4 shows the inside details of a typical hoop barn.

Livestock panels or gates form the north and south endwalls at animal level. In the winter, these gates are covered with sheets of galvanized steel, recycled plastic, or plywood to reduce drafts. In all instances, the north wall can be closed relatively tightly to reduce winter winds using commercially available tarp kits, especially in northern climates of the United States. In the summer, both the north and south ends are totally open, with the steel, plastic, or plywood panels removed from the end gating to increase air flow in the pig zone.

Endwall construction should include posts that will be close enough to fasten the end gates adequately, but far enough apart to allow room for feeding and manure handling equipment. If the posts extend to the height of the hoops, do not fasten the posts to the end hoop. Hoops can deform during winds and will rub against the posts. Rubbing against the posts may damage the tarp material. Commercially available end tarps will reduce the potential for damage. Figures 5, 6, and 7 show typical endwall configurations for various weather conditions.

Figure 4. Inside view of a typical hoop barn.
Plywood has been added above the structural wall to prevent the pigs from damaging the tarp and to direct cold incoming air upwards.

Figure 5. End open during mild weather.
In the Midwest, both ends would most likely be open in mild weather. The prevailing summer wind should enter the structure through the feeding end.

Figure 6. End closed during cold weather.
This is a typical configuration for the north end of a hoop structure in the Midwest during harsh winter weather.
Foundations

The foundations of hoop frames must be able to transfer the loads applied to the frame to the earth. Wind applies horizontal and uplift loads to the sidewall frame, while snow, rain, and the weight of the frame apply vertical loads downward to the sidewalls. The foundation anchors the barn to the earth and must resist corrosion from contact with manure, moisture, and the soil.

The most common method of anchoring the frame to the foundation is to build a post frame wall with the posts extended below the frost level and then construct a 4- to 6-foot high wall along the sides of the frame. The pipe frame is attached to the tops or sides of the posts. Figure 8 shows the construction details of the frame and walls. Posts must be set properly. If posts are set improperly, they can move out of plumb and affect the structural integrity of the building. Posts should be set below the frost line and on top of concrete footings. The soil around the posts must be tamped properly. Do not set posts in areas that have a high water table. Precast concrete sidewalls can be placed on a crushed rock layer or on concrete. The weight must be adequate for the hoop barn to resist wind uplift forces. Follow engineered designs from the hoop barn supplier.

Frames

Hoop frames are constructed primarily from 2- to 3-inch O.D. (Outside Diameter) round tubular steel to form a roof truss system. Steel purlins connect the trusses to each other to act as a unit. (See Figure 9.) The thickness of the tubing used in frames ranges from 16 to 12 gauge. (The lower the gauge number, the thicker the tubing.) Frame sizes depend on building width and frame spacing. Some narrower hoops use tubing only, without forming a truss.

Frames are spaced from 6 to 16 feet apart. These frames support the roof and sidewall construction of the building. See Figure 10 for an illustration of how the tarp is fastened to the sidewall and frame. Galvanized steel tubing 1-3/8 inch O.D. is used for purlins and bracing to span and brace between the frames along the length of the barn. Frame widths for single span structures usually range from 18 to 36 feet.

Some manufacturers span from 40 feet to well over 100 feet with engineered truss arches such as the one shown in Figure 9. Truss arches also are used when high snow or wind loads are a concern, or if a lower roof height is desired.

Because of the corrosive nature of an animal housing environment, high quality galvanizing is...
crucial. Some manufacturers use hot dipped galvanizing, which produces excellent results. Other types of galvanizing, however, may not be suitable for use in animal environments. Check the quality and amount of galvanizing in the frame tubing and determine what type of warranty is available from the supplier. Aluminum frames are an option with some suppliers. Aluminum frames used with the appropriate fasteners should experience less corrosion than steel in the conditions that exist in typical swine housing.

Covers

Tarp coverings for hoop barns come with various options, but evaluating what type of tarp to get should be an integral part of the overall design and decision-making process. Generally, tarps are made of woven polyethylene fabric that is produced from low-density polyethylene extruded over high-density woven polyethylene. Due to the woven nature of the tarps, punctures do not tend to run. When punctures occur, they may be patched with a kit the company provides. The better tarps are those that have been treated with Ultra-Violet (UV) stabilizers and a fire resistant substance to provide safety and longevity. Producers should consult their insurance company on which treatments are required for insurability.

Tarps generally come in different weights, which may include 10.0-, 12.5-, and 14.9-ounce fabric. Many colors are available, including clear and opaque fabric. Fabrics that have a white underside or are white and allow some light through tend to make a barn brighter and make the animals easier to see. Clear fabrics are not a good choice because they allow a high degree of solar penetration, which may overheat animals. Pro-rated warranties for tarps are generally 10 to 15 years. Rub points, such as purlin connections and end wall connections, tend to wear first. It is best to minimize such rub points.

Snow and wind loading

In general, the structure must be able to meet snow and wind load requirements. Structures that do not meet snow and wind load requirements risk failure and may not be insurable.

The snow load design should be similar to what other agricultural building loads are for the area in which the building is being constructed. The effect of snow on the structure can vary. Snow may slide off the roof, or the snow may accumulate and put additional weight on the tarp and hoops. Generally, snow loads are not seen as a big concern because the curvature of the structure minimizes snow buildup.

Wind loads also should be calculated as they would be for other agricultural structures in the area. Additionally, uplift of the frame under wind loads needs to be considered in the design of the frame and the foundation anchoring. In some designs, diagonal bracing of the sidewalls from the endwalls and along the roof line should be incorporated. Outside guy wires can be important to keep the frame from racking or deforming out of plumb. Frames that have shifted off center are likely to be loaded unevenly and are subject to failure. Some reports of wind damage have indicated that hoops sometimes deform without failing.

Environment and Ventilation

Perhaps the top priorities for hoop barns used as swine housing are the issue of animal environment and the related issue of proper ventilation. Realistic expectations for these structures are that they reduce exposure to wind and snow in winter and sun and rain in summer. Hoop barns are cold structures and should be managed as such. Although the bedded-manure pack generates considerable heat and enhances animal comfort for grow-finish pigs in the winter, hoops require special design and management for year-round farrowing or nursery operations.

The primary goal of hoop barns is to protect the animals from the weather. In the summer, the building should provide shade and allow cross ventilation by wind pressure. In the winter, the housing should allow for moisture removal and draft control. In the winter, a cold barn with dry bedding allows the pigs to create a suitable, comfortable microenvironment in the bedding.

A natural tendency of producers using hoop barns is to restrict ventilation to keep warmed air inside the structure. However, when the hoop barn is being used to house animals, restricting ventilation traps the moisture the animals produce along with the warm air. This creates a situation that can be damaging to the pigs’ health.

At night a hoop barn loses heat to the cold surroundings and the cold, clear, black sky. This cools the air in the structure, lowering its moisture-holding capacity substantially and causing relative humidity to rise. The result is cold, damp air and, most likely, excessive condensation on the underside of the tarp. If ventilation is inadequate, animals will be subjected to wide day-to-night variations in air
temperature and humidity, which could adversely affect animal health.

To reduce risks to animal health from poor air quality, hoop barns must be well ventilated, and the ventilation must be well managed. A hoop barn must be managed just as any cold, naturally ventilated structure. Do not close the structure too tightly. Do not attempt to manage the structure as a warm barn; it is primarily a shelter. Properly managed, air temperature in the hoop barn 4- to 6-feet above the bedding pack is often within 10°F of the outside air temperature.

Because wind is a major force in ventilating any naturally ventilated structure, orient hoop barns to intercept the prevailing summer wind through the feeder-end opening. Do not construct hoop barns where buildings, trees, or other large obstructions block the prevailing summer winds. For most structures, the minimum separation distance from obstructions to the end of the barn is 75 feet.

**Ventilation openings**

Natural ventilation uses openings at different heights to achieve ventilation in the winter. Building a structure with an open ridge will allow the moist air that builds up to escape through the opening at the top of the structure. Ideally, a ridge opening would be provided. However, many hoop barns used for swine housing do not have ridge openings. In these buildings, ventilation air enters through a continuous space along the sidewall where the tarp is attached and exits through the ends of the hoop, depending on wind direction. Figure 10 shows a 3- to 6-inch gap between the top of the wall and where the tarp overlays the wall; this gap serves as a continuous air opening for ventilation.

Because openings are not adjusted, the hoop acts mostly as a wind and snow shelter and does not maintain a set temperature. Problems with air quality occur most often when hoop barns are closed too tightly.

**Endwall ventilation**

Hoop barns without ridge vents are difficult to ventilate naturally if they are too long. Typically, a hoop barn longer than 75 feet, without ridge vents, and filled with animals will present ventilation problems. Hoop barns up to 100 feet long can be used in high wind areas. In all areas, hoop barns rely on endwall openings to aid airflow through the structure. The ends are open most of the year. Figure 11 shows an example of how the gap between the top of the endwall and the frame and tarp acts to aid natural ventilation when the ends are closed.

Where such devices as hovers or wind baffles on gating are used to reduce drafts, the draft prevention devices must still allow ventilation and moisture removal to occur.
Cooling

In hoop housing, as in most swine housing systems, heat stress can be an issue for pigs, especially as they near market weight. Use of a sprinkling system will help maintain feed intake and growth rates during hot periods.

In confinement facilities with liquid manure systems, cooling can be accomplished using a thermostat and cycle timer with a sprinkler system to wet the pigs and then allow them to dry. Allowing the water to evaporate between cycles draws heat from the pigs' bodies as the water evaporates off their skin. This evaporation helps to cool the pigs. Any excess water ends up in the manure collection system.

With hoop barns, a similar system can work, but there are a few obstacles. Hoop barns are not always equipped with electricity so the use of a thermostat and cycle timer may not be practical. Excess water will go into the bedding rather than into a manure collection system thereby causing a wet place for the pigs to lie, even when temperatures cool off in the evening.

Work in Australia with bedded finishing systems has shown that it is best to wet most of the pigs at the same time. This spreads the water across a large area, including the bedded area, and helps to avoid excessive water on the bedding. Sprinklers can be attached to the roof trusses to cover a portion of the barn. With this type of arrangement, leave some areas of the hoop barn, including the feeding area, un-wetted to give animals a choice of environments. Pigs may have a tendency to lie on bare concrete to remain cool, but wetting the concrete feeding area will encourage the pigs to lie in the feeding area more, making it difficult for the animals to have access to feed. Allow 5 to 6 square feet per pig when determining the area to be sprinkled.

Wetting of the pigs should be done using a cycle timer to allow evaporation of water from the pig's surface to enhance the cooling effect. Sprinklers should put out large droplets instead of a mist. Large droplets are designed to cool the pigs; misters are designed to cool the air immediately above the pig. Nozzles that emit large droplets are preferred because the pig can select its rate of cooling by posture and location. Also, misters depend in part on airflow and lose some effectiveness when the relative humidity in the pig zone where the misters are spraying is at or above 75%.

Timers should be set to operate anytime the temperature exceeds 80-84°F, and they should turn sprinklers on for 1 or 2 minutes out of a 10- to 20-minute period. Specific settings will vary with climate, pig size, humidity, temperature, wind, and water pressure, but the critical issue is wetting the pigs and then allowing them to dry and cool as the water evaporates. Producers will have to experiment with several settings to find the right one for a specific location. The goal is to wet all the pigs in 1 to 2 minutes and then allow them to dry. Just as they become dry, the water should turn on again.

If electricity is not available, sprinklers will have to be managed manually, or there may be options using solar or battery-operated controllers. In either case, the producer must observe the pigs frequently, adjust the system accordingly, and avoid allowing puddles to form in the bedding. Careful management is necessary to prevent problems with wet bedding and inadequate drying time, but pigs digging holes in the bedding pack has not been a problem when wetting devices are managed properly.

Feeders and Waterers

Hoop barns usually use self-feeders like the ones depicted in Figure 12, and feeders are often used as feed storage devices as well. In a grow-finish operation, provide a feeder space for every five to ten pigs. Some producers have used less feeding space (more pigs per hole) with success, but other producers have reported problems. The quality, or width and depth of the eating space, defines the number of pigs per space. If large feeder spaces (more than 12 inches wide) are provided, more pigs can use that space. However, if the feeder spaces

![Figure 12. Use self-feeders in a grow-finish hoop barn.](image-url)
are smaller and restrict access due to width (a typical 270-pound pig is 13 inches wide at the shoulder) or restrict head movement during the ingestion process, more eating spaces need to be provided.

Providing sufficient feeder space is relatively inexpensive and will be cost effective in the long term. A typical 180- to 200-head hoop barn has two or three large self-feeders and one, four-hole, no-freeze waterer. In the summer, additional watering space is necessary, and this is typically provided by one or more nipple waterers.

**Animal Management**

One major way in which the management of hoop barns differs from the management of confinement facilities is the use of large amounts of bedding. This difference necessitates acquiring the bedding, putting it in the structure, and hauling the used bedding away.

Because the pigs are in a large group in a bedded setting, they may be hard to locate. The producer must actually enter the bedding area at least daily and check all the pigs; checking the pigs by simply looking into the structure is inadequate.

Other management strategies are the following:

- Because the pigs are in one large pen, hoop barns must be managed as all-in-all-out units. They cannot be operated as continuous flow units.
- After the structure is cleaned during the winter, the floor must be heavily bedded immediately to prevent the ground from freezing.
- In addition to initial application of bedding, bedding must be added regularly to maintain a dry environment.
- Freeze proof waterers are necessary.
- Lights may need to be added for observing animals after dark.

**Pig Performance**

With all housing systems, haphazard or careless management will usually lead to poor pig performance, but because management needs are different in hoop barns than in confinement facilities, performance and management may be more closely linked in hoop systems than in confinement systems.

While the hoop barn provides a dry and draft-free environment and the bedding aids the pig in creating a desirable microenvironment, there may be seasonal differences in pig performance, particularly in northern climates.

Producers report that behavioral vices are occasionally present in hoop-raised pigs. These vices include ear necrosis, tail biting, and naval sucking in small pigs. Experience suggests that these vices are usually a signal that additional, high quality, dry bedding is needed.

**Growth**

In the Midwest, feed intake is often greater in hoop barns than in confinement barns, particularly in the winter. The amount of additional winter feed varies between farms, climate, and seasonal extremes. Research at Iowa State University resulted in winter feed intake that was almost 10% more in hoop barns than in confinement facilities. Typically, for the first one or two uses of a hoop barn, the producer provides the same diet as for pigs in confinement barns until a clear pattern of elevated feed intake emerges. Some producers are beginning to adjust diets for nutrient density with an expectation of elevated feed intake.

During the winter in the Midwest, a good estimate is that 0.3 pound more feed will be needed per pound of live weight gain, or about 10% more feed compared to the amount of feed needed in confinement barns. During the summer in the Midwest, a good estimate is that there will be no difference. For a yearly estimate in the Midwestern United States, use 0.15 pound more feed per pound of gain in hoop barns. Based on ISU research results and on producer experiences in both winter and summer, backfat is estimated to average 0.05- to .10-inch more at the tenth rib for pigs raised in hoop barns compared to pigs raised in confinement.

Average daily gain for hoop-housed pigs is similar to the rate of gain of confinement pigs and may be as much as 4% more during the summer if adequate cooling is lacking in confinement facilities.

A majority of producers report a three-week marketing range if the pigs grouped in a hoop are within one week of age. That is, the time from the sale of the first pig to the removal of the last pig is about three weeks. For 195 pigs, this usually means that approximately three to five pigs do not reach minimum market weight. These results are similar to those obtained in confinement operations.

The percentage of pigs that die or are euthanized (mortalities), that are marketed alternatively because of a detrimental condition (culls), or that are marketed to the packer but are less than an
acceptable weight (lights) does not differ between hoop barns and confinement buildings.

Research at ISU has been conducted related to optimum stocking density of finishing pigs in bedded hoop barns. In a study comparing 9, 10.5, and 12 square feet per pig, the pigs with 9 square feet grew slightly slower (about 2-3%) and ate less feed (about 4%) than pigs with 10.5 or 12 square feet in bedded barns. Results from the study suggest that 9 square feet per pig in bedded barns results in poorer pig performance and economic returns and that allocating 11 square feet per pig may be the best combination of pig performance and economics. As the stocking density increases, that is as pigs are more crowded, the research also observed more dunging on the feeding platform.

Meat quality
Pigs from hoop barns typically have a lower dressing percentage or yield (approximately 1%) less than that of confinement-fed pigs. This may be due to slightly greater feed intake, consumption of some bedding, or larger meals because of the larger group size. Some data suggests that pigs raised in cold climates also have larger internal organ size, which also contributes to a reduced dressing percentage. Hoop-reared pigs, therefore, will need to be marketed at slightly heavier live weights (about 2 or 3 pounds) to achieve the same carcass weight as pigs raised in confinement.

The quality of fresh pork dictates the suitability of pork for use as a fresh product and further processing. Pork color, water-holding capacity and texture are among the important characteristics that domestic and international customers use to define pork value. These traits are under the influence of the response of muscle during the early postmortem period (0-24 hours). During this period, glycogen is converted to lactic acid in muscle and a concomitant increase in the acidity of the product (measured as a decrease in pH) is observed. A rapid decline of pH during the first few hours after slaughter is especially detrimental to proteins that determine the color and water holding capacity of pork. Because there is a direct relationship between ultimate pH and pork water-holding capacity, the extent of pH decline also has the potential to influence pork quality.

Enriching the production environment can alter animal and tissue response to stress of handling and transport. Decreasing pen density and providing bedding can enrich production environments and can alter the amount of pen-mate directed behavior. A change in the behavior has the potential to alter the pigs’ response to the period before slaughter and thus pork quality. Previous reports have shown that environmental enrichment can improve pork water-holding capacity and tenderness. The precise explanation for this improvement is not currently known. The influence of hoop systems on ultimate pork quality is currently under investigation.

Health
The health of pigs in hoop barns appears to be very good. Studies report that death loss has been minimal in hoop barns. Respiratory problems have been minimal. To date, experiences have shown that a wide variety of pig genetics are adaptable to hoop barns. With repeated use of the structure, pathogens may build up in the soil under the bedded pack, or on a concrete floor if it has not been cleaned thoroughly. Roundworms can be an additional long-term health management concern if the pigs are not wormed or parasite free before entering the facility. Concrete floors can be pressure-washed between groups, although not all producers may find this necessary. A routine monitoring program for internal parasites is essential, and a monitoring program for external parasites also is recommended.

Animal Handling
To facilitate animal handling, a hoop barn needs to have a good gating system with some type of sorting area. The gating system must make possible the following activities:
- Sorting animals for market.
- Holding back smaller animals not going to market.
- Separating sick animals from the larger group.

When handling large groups of finishing pigs it is important to remember several behavioral principles. Pigs are social animals, and therefore prefer to be around other pigs. With these behaviors in mind, design a handling facility so that pigs always can see other pigs, which promotes movement of pigs through the handling facility. Pigs will synchronize their behavior such as walking, running, and lying down and will follow the leader of the social grouping. When stock people are moving pigs, it is essential that they keep this in mind.

Pigs can be moved out of a hoop barn using a wide plastic tarp (approximately 30 feet long and 3
feet wide). One stock person holds each end, and they use the tarp like a moving fence.

An alleyway across the front of a series of hoops to a holding pen also is very useful for sorting and handling pigs. Figure 13 shows a typical arrangement of barns and holding and loadout areas. Sometimes working chutes, like the example outlined in Figure 14, are added to help with routine management and sorting.

A working chute should curve to promote pig movement, as pigs can always see other pigs ahead, and there are no sharp angles. Single and double wide chutes are suitable.

The holding pen holds approximately 195 market pigs, which is the usual number of pigs kept within a single 30 x 72 hoop barn. A common practice when handling the pigs is to sort the pigs in groups

Figure 13. A common concrete area with proper gating can allow easy sorting.

Figure 14. A working chute, such as this, allows pigs to be loaded with minimal stress to pigs and less effort by the stock person.
of approximately 20, and then reload the sorting pen with another group of pigs. Moving small groups of pigs at a time appears to promote pig flow.

Portable loading chutes are effective for loading market animals if one to three hoop barns are being used. If an operation has more than three hoop barns, a permanent loading facility is more efficient.

To promote pig movement during loading, the loading ramp should be designed so that the pigs move in single file or side by side, so they can't turn around. In addition, the ramp has stair steps to minimize slipping, and is free of sharp edges to avoid bruising.

Because of the layout of hoop barns and large group sizes, identifying, removing, and/or treating sick animals can be difficult.

**Bedding**

Bedding management and the labor involved are two factors that are important in making hoop barns operate efficiently. Lack of sufficient bedding can cause stress in the pigs, and bedding is one of the biggest keys to the success of winter production in hoop barns. Trials in Iowa showed that summer groups required about one-third less labor per pig than the winter group because of less bedding (about one-third less bedding in summer) and less manure to haul.

However, the bedding creates distinct labor demands in a hoop barn. Because of the bedding, more time is spent checking pigs, that is, walking through the bedded area. More time also is involved in carefully locating and observing sick animals because sick pigs tend to stay burrowed in the bedding. Time is also spent moving bedding material and loading and hauling solid manure.

Provide enough bedding to keep the floor under the bedding pack relatively dry. Pigs will establish certain dunging areas throughout the structure. Many times, winter groups will sleep in the far back and along the sidewalls and dung in the space between the bedding area and the concrete slab used for feeding and watering, although sometimes the dunging area is concentrated along the cool northern walls.

Wherever it occurs, additional bedding will be required to prevent the dunging area from becoming sloppy. If the dunging area becomes too wet, pigs may not be as willing to go to the feeder. Excess moisture, whether from dunging, leaky waterers, or heavy sprinkling for summer cooling, can leach nutrients out of the bedded pack. Such leaching will lead to elevated levels of N and K in the soil and groundwater beneath earthen-floored structures, another reason to ensure adequate bedding and to consider an impermeable concrete floor. The manure and bedding mixture will accumulate to a depth of three to four feet in portions of the structure during winter groups.

The combination of moisture and additional nutrients from urine and dunging stimulates microbial decomposition of the bedded pack. In the wet dunging areas, this decomposition is anaerobic. In unsaturated areas of the bedded pack, aerobic decomposition also will occur, which reduces odors and methane emissions and generates heat. This heat production increases temperatures in drier areas of the bedded pack during summer and winter conditions, respectively.

Cooling sprinklers and reduced bedding rates can help keep the bedded pack from overheating in summer conditions. Somewhat higher bedding rates and lower humidity during the winter result in increased heat production, allowing the pigs to find warm areas to rest on and burrow into on cold winter nights. The comfort the pigs receive from the bedding amounts to an effective temperature increase of approximately seven degrees over the actual air temperature. However, because of the heating of the composting bedding pack and the effect of huddling, the actual effective temperature may be as high as 25°F or more over the air temperature. This depends upon the bedding condition and the ability of the pig to burrow into loose bedding.

Several materials have been used successfully for bedding, including baled corn stalks and wheat straw. Bedding use is seasonal with the largest share used in cold weather, but on an annual basis, most producers use about 195 pounds of baled stalks per pig marketed to maintain dry bedding. Producers in warmer regions report using sand for bedding. Table 3 lists other products that could be used, along with the approximate amount of bedding needed.

While the selection of bedding is based mostly on what is readily available, many other concerns should enter into the decision. These concerns vary from region to region and include the following:

**Soil conservation:** In some places in the Midwest, much of the agricultural land base is classified as highly erodible. Many producers have signed an agreement as part of their conservation plan with the federal government that they will maintain a certain residue level after planting. Use of large amounts of residue in a bedded livestock
system such as hoops has raised the following concerns:

• From how many acres do I need to harvest residue? Corn stover residue weight is approximately equivalent to grain weight, so a 150-bushel/acre cornfield will generate about 4 tons of stover per acre. Similar estimates can be made for other crop residues, based on yield and the harvest index (the grain to residue ratio varies for different crops). Harvest losses and conservation constraints can reduce this potential by 30 to 50% or more.

• How much residue can I remove per acre and still comply with my conservation plan? This depends on site-specific calculations, and will be strongly influenced by tillage, slope, and crop rotation. Higher removal rates are possible with no-till on relatively flat fields, and are increased if rotations include perennial crops or forages.

• If I intend to plant using no-till, will I be able to land-apply the residue in a thin enough and uniform enough pattern with existing manure spreaders so as to minimize planting problems?

• What is the fertilizer value of the manure and residue mixture?

• Substantial organic matter will be returned to the crop land, but will a high carbon-to-nitrogen (C:N) ratio prevent the nitrogen from being fully available for crop use the first year following land application?

• Is sufficient space available to store the manure safely and legally when land is unavailable for spreading?

### Custom baling: Custom baling of residue stalks may be expensive, costing between $7 and $15 per bale. Additional costs are incurred in transporting bales. On-farm baling, while requiring less out-of-pocket expense, is not a low-cost option. Additionally, stalk baling results in more wear on round balers than does normal hay baling.

### Bedding availability: During years in which a wet fall or early snow prevents stalks from being baled in a timely manner, they may become less available and more costly. A situation of this type could require a shift in priorities from doing all of the grain harvesting first to a system of harvesting and baling stalks. An alternative is to plant a portion of the field crop acreage with a crop such as barley, wheat or oats that produces a summer residue.

### Bedding storage: In regions with cold and relatively dry winters, bedding baled in the fall and used before the spring generally does not deteriorate if stored outside. However, if stored under warm and damp conditions, bedding must be protected to prevent reduction in its quality. In the Midwestern United States, bales that will be used during spring and summer should be stored under cover on a well drained area. Bales stored outdoors will lose bedding quality, thereby increasing costs.

Producers are reporting that winter use requires 30 to 40 big round bales (1,200-pound bales) of shredded corn stalks per group of 195 pigs. The typical method of employing bedding is to begin a set of pigs with eight bales of bedding already in the structure, and then to add an average of two bales per week in winter. Summer use will be less. Table 3 shows estimates of the amounts of various bedding types needed at different times of the year. The biggest key to success appears to be using lots of high quality bedding. The major reports of behavioral problems come from producers who have restricted bedding additions.

The cost of bedding will vary by region, but producers should expect that the cost of bedding will be $1.50 or more per pig for winter use. Besides shredded corn stalks, some producers have used soybean stubble bales successfully. Other producers have used barley straw, wheat straw, oat straw, prairie hay, and spent turkey litter as bedding.

<table>
<thead>
<tr>
<th>Material Used</th>
<th>Average Amount of Yearly Bedding, lb per pig</th>
<th>Average Amount of Summer Bedding, lb per pig</th>
<th>Average Amount of Winter Bedding, lb per pig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shredded corn stalks</td>
<td>195</td>
<td>125–150</td>
<td>200–250</td>
</tr>
<tr>
<td>Corn cobs</td>
<td>240</td>
<td>150–180</td>
<td>240–300</td>
</tr>
<tr>
<td>Barley straw (long)</td>
<td>240</td>
<td>150–180</td>
<td>240–300</td>
</tr>
<tr>
<td>Oat straw (long)</td>
<td>180</td>
<td>110–135</td>
<td>180–225</td>
</tr>
<tr>
<td>Wheat straw (long)</td>
<td>225</td>
<td>140–170</td>
<td>225–285</td>
</tr>
<tr>
<td>Sawdust (hardwood)</td>
<td>335</td>
<td>210–250</td>
<td>335–415</td>
</tr>
<tr>
<td>Sawdust (pine)</td>
<td>200</td>
<td>125–150</td>
<td>200–250</td>
</tr>
<tr>
<td>Wood shavings (hardwood)</td>
<td>335</td>
<td>210–250</td>
<td>335–415</td>
</tr>
<tr>
<td>Wood shavings (pine)</td>
<td>250</td>
<td>155–190</td>
<td>250–315</td>
</tr>
</tbody>
</table>
sources. Wood product residue should be used with caution. Shavings and sawdust need to go through a heat cycle to avoid the transmission of avian tuberculosis to the pigs. Unless wood product residue has gone through a heating process, there is a risk of carcass condemnation at slaughter.

Producers who use big round bales as bedding report they use a spear point on a hydraulic loader. They lift the bale through the rear opening, cut the strings, lower the bale, and unroll the bale down the middle of the bedding pack. (See Figure 14). This takes 10-20 minutes per bale. As the pigs get older, many producers simply set bales on end and let the pigs unravel the bales. In all cases, strings must be removed from the bales so pigs will not ingest them or become entangled in them.

In hoop barns, prevent the bedded pack from expanding into the feeding and watering area by elevating the feeding and watering area 12 to 18 inches above the bedded area. Figure 15 illustrates this concept. Early in a cycle, smaller pigs may have difficulty going from the feeding-watering area to the bedded area; if they do, most producers just stack small bales or mound the bedding thickly enough for pigs to access the feeding area.

**Manure Handling**

Each time a group of pigs is finished, all of the bedding and manure must be removed. Reusing the bedding may reduce the sanitation in the structure and carry over some pathogens from previous groups. Letting the building surfaces thoroughly dry out between groups can help reduce the potential for pathogen carry-over.

In the winter it is important to apply new bedding shortly after cleaning, before the floor of the hoop barn can freeze. Frozen ground or cold concrete will chill the next group of pigs by rapidly drawing the heat from the pigs' bodies. A fresh layer of bedding can insulate an earthen or a concrete floor for several days or even weeks (depending on temperatures) until the next group of pigs arrives.

The best equipment to remove the bedding pack is a mechanical, front-wheel assist tractor with a grapple fork attachment on the front end loader. A tractor-loader with manure tines on the bucket generally will work; although, it can take some effort to break apart the bedded pack, and a standard skid-steer loader may not be sufficient. One producer reports using a chisel plow to disrupt the bedding pack before clean out. Most producers agree on 10 to 15 hours of total labor to clean the hoop barn and spread the material on nearby crop land. Below is a list of some of the challenges that may exist with manure handling:

- Fewer custom solid manure haulers are available in some parts of the Midwest. This may require that a manure spreader, loader, and tractor will need to be available for on-farm usage.
- The properties of the manure vary greatly throughout the structure. Because of this, the fertilizer value of the manure is difficult to estimate accurately and properly credit for nutrient content in a manure management plan. Mixing loads to balance material from dunging and resting areas can partially alleviate this concern, as can composting.
• Depending on the time of year, space may be needed to store the manure safely and legally until land is available for spreading. Storage and composting sites should be designed to minimize runoff and associated water quality concerns. A roof shelter and impermeable surface are ideal, while runoff collection ponds and/or vegetative filter strips may be required in some situations.

• Used corn stalk bedding is not easily handled due to the potential for wrapping on manure spreader beaters. This can exacerbate problems with spreader uniformity, and be frustrating to clear and clean.

• Minimum tillage cropping systems may have difficulty with irregular manure distribution following land application of the manure, especially if the manure has not been thoroughly mixed following removal from the hoop or if the residue used as bedding has not been chopped to reduce straw or stubble length prior to placement in the hoop. This can be a particular challenge for no-till planters when manure is applied in the spring.

• Substantial organic matter will be returned to the crop land, but unstabilized carbon in bedding can reduce nitrogen availability during the first year after application, and in extreme cases cause net N immobilization, which can actually reduce crop yields. This problem most often arises with heavily bedded manures applied in the spring.

Composting manure

Several of these challenges, including lack of manure uniformity, interference with minimum till planters, and the risk of N immobilization, can be greatly reduced by composting the bedded pack prior to spreading. Bedded hoop manure is easy to compost. Unlike many manures, the bedded pack from hoop barns typically has appropriate moisture and adequate porosity to be composted without any additional bulking material. Simple windrow piles, about 5 to 7 feet high and 10 to 15 feet wide, will compost with minimal management.

Turning is not necessary, although it will enhance weed seed and pathogen destruction and provide a more uniform product. Within two to three months the volume of the manure will be reduced by 50 to 60%, with similar weight losses unless precipitation is high. These reductions in weight and volume reduce hauling requirements considerably, which helps compensate for the additional handling and management.

Manure composting windrows also can be used for mortality disposal, as long as the carcasses are well buffered on all sides. About 18 inches of compost on the bottom, sides, and top of the mortalities are usually sufficient to eliminate odors and attraction of varmints. Piles with mortalities should not be turned until the carcasses degrade, which usually takes several weeks. Some states have specific rules or guidelines for manure or mortality composting, so it is important to check for regulatory compliance.

The typical bedded pack in a hoop barn used for finishing pigs is higher in nitrogen than is normally recommended for composting, with a C:N ratio averaging between 11:1 and 16:1 as opposed to the 25:1 or 30:1 that is considered ideal. This relatively low C:N ratio reflects 1) the relatively high N content of swine manure, and 2) the biodegradation that has already occurred in place within the bedded pack, which includes losses of both C and N. This low C:N ratio results in significant N losses during composting (about 20% of excreted N), although this is less than has already occurred within the bedded pack (about 55% of excreted N).

Manure characteristics

Cumulative losses of hoop manure nitrogen, about 75% of the excreted N, are high relative to slurry manure storages and slightly less than occur from anaerobic lagoons. Most of these losses are volatile N compounds, including ammonia and nitrous oxide, although leaky waterers within the structure or rainfall on composting piles can result in runoff and leaching losses of ammonium and nitrate. The other macronutrients P and K are better conserved, although cumulative losses of these elements can reach 20 to 40% in outdoor composting systems if runoff and leaching are allowed to occur.

Because of differences in bedding type and management, the nutrient content of the bedded pack and subsequent compost can vary widely. Table 4 illustrates mean values and ranges for dry matter content and N, P, and K for fresh hoop manure at the time of cleanout and after several months of composting. Values are presented in lbs/ton (to help calculate application rates) as well as percentage of dry matter.

The first four columns of data are summarized from several hundred samples from hoops, a
demonstration farm, and eight different commercial farms. The wide range reflects both seasonal differences in bedding rates as well as different management styles. The final column, which shows means and standard deviations in pounds per pig, can help project manure weights and nutrient quantities based on pig production. This column is more consistent, because reporting on a lb/pig basis to some extent normalizes for different bedding rates. Adding more or less bedding has a strong effect on nutrient concentrations (reflected in lbs/ton and % dry matter), but the low nutrient content of the bedding has less effect on the overall nutrient amount (lbs/pig).

Because application rates are dependent on the more variable concentration data, it is important to get a site specific manure analysis for an accurate manure management plan. Given the variability in the bedded pack, composite samples that include subsamples from different depths and regions in the bedded pack are particularly important when sampling hoop manure for analysis.

The values in Table 4 reflect total nutrient content, and, as with other organic amendments, not all of these nutrients will be available in the first growing season. P and K availability has not been studied for hoop manure or the resulting compost, but based on results for similar organic amendments 60 to 80% availability is likely in the initial year. Nitrogen availability has been investigated, and results indicate about 25 to 30% of the nitrogen will typically be available in the first year. Although the N availability was similar for both fresh and composted hoop manure applied in the fall, the previously mentioned immobilization problem can reduce or eliminate short term N availability for fresh hoop manure applied before planting in the spring. Composting will eliminate the risk of N immobilization, and thus is recommended when hoops are cleaned out in the spring. However, the additional losses during composting do reduce the total nutrients available, so in areas with adequate cropland available, hoop manure from fall cleanouts probably is best applied fresh.

Comparisons

To get a better sense of how hoop barns compare to confinement buildings, many aspects such as labor requirements, pig performance, building life, and bedding costs need to be examined. Carcass quality also can affect the packer’s offered price. Knowledge of these items will enable producers to compare hoop barns to other options.

Labor requirements

Labor requirements are a highly variable input to swine production systems. Labor varies from farm to farm depending on the layout, level of automation, age and condition of facilities, and other factors. Table 5 shows some estimated amounts for general labor and manure handling.

Studies of labor needs for hoop barns show slightly more labor needed than needed for confinement systems. Labor needs are slightly higher primarily because large bales of bedding must be hauled and placed into the hoop barn. The total difference is estimated at about 0.05 hour/pig, or approximately 4 minutes more per pig.

The type of labor, however, is quite different for hoop barns compared to the labor needs associated

<table>
<thead>
<tr>
<th>Table 4. Characteristics of fresh and composted bedded manure from swine finishing hoops.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Note that all nutrients are on an elemental basis (N, P, and K; not P₂O₅ or K₂O).</td>
</tr>
<tr>
<td>Mean Range</td>
</tr>
<tr>
<td>-------------</td>
</tr>
<tr>
<td>lbs/ton % (dry basis¹) lbs/pig</td>
</tr>
<tr>
<td><strong>Fresh hoop manure</strong></td>
</tr>
<tr>
<td>Dry matter</td>
</tr>
<tr>
<td>Nitrogen</td>
</tr>
<tr>
<td>Phosphorous</td>
</tr>
<tr>
<td>Potassium</td>
</tr>
<tr>
<td><strong>Compost</strong></td>
</tr>
<tr>
<td>Dry matter</td>
</tr>
<tr>
<td>Nitrogen</td>
</tr>
<tr>
<td>Phosphorous</td>
</tr>
<tr>
<td>Potassium</td>
</tr>
</tbody>
</table>

¹Values are reported on a dry basis, except dry matter content which is reported on a wet basis.
with typical confinement facilities. It includes bedding the pigs, checking the pigs, and cleaning out the bedding pack. Walking the bedding area twice daily to check pigs is crucial; with large groups of deep-bedded pigs, consistent observation of pigs is critical for success.

**Cost analysis**

Table 6 shows a cost analysis comparing confinement and hoop barns. Costs vary depending on location and availability of materials, so you are encouraged to prepare your own budget in the “Your Estimate” column of Table 7 with values that reflect your operation. Use Tables 5 and 6 to help estimate your costs.

The comparisons in Table 6 use a cost of $180 per pig space for a confinement system compared to $62 per pig space for a hoop barn. The confinement system is 7.5 square feet per pig while the hoop system is 11 square feet per pig. Investment in manure and feed handling equipment is the same for each system. Again, depending upon alterations in system design, location, or other individual characteristics, these values may differ for your operation. The average daily gain will be the same for both systems: 1.7 pounds per day. The budget is calculated based on pigs being placed in the facility at 50 pounds and fed to 265 pounds or 215 pounds of gain. Thus, on average, pigs are marketed in 126 days. However, this means that 50% of the pigs are marketed in the 10 day period prior to the 126-day average and the other 50% are marketed in the 10 day period after the 126-day average. Add a 7-day clean out period between groups of pigs, and the total time per group of pigs is 143 days (126 + 10 + 7). This equates to 2.55 turns per year with each system.

Fixed costs are calculated at 12.2% of investment for a confinement facility and 15.2% for the hoop facility. The interest rate is 8% on average investment (4% on initial investment), with insurance and taxes

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### Table 5. Estimated amount of labor requirements.

<table>
<thead>
<tr>
<th></th>
<th>Labor Requirements</th>
<th>Labor Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average, hr per pig</td>
<td>Range, hr per pig</td>
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<tr>
<td><strong>Confinement</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General labor</td>
<td>0.20</td>
<td>0.14–0.25</td>
</tr>
<tr>
<td>Manure handling</td>
<td>0.04</td>
<td>—</td>
</tr>
<tr>
<td><strong>Hoop barn</strong></td>
<td>0.24</td>
<td>0.18–0.30</td>
</tr>
<tr>
<td>General labor</td>
<td>0.24</td>
<td>—</td>
</tr>
<tr>
<td>Manure handling</td>
<td>0.05</td>
<td>0.09</td>
</tr>
</tbody>
</table>

### Table 6. Estimated costs.

<table>
<thead>
<tr>
<th>Facility Investment (FI)</th>
<th>Average</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Building cost</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Confinement (per pig space)</td>
<td>$180</td>
<td>$160–$200</td>
</tr>
<tr>
<td>Hoop structure (per pig space)</td>
<td>$62</td>
<td>$60–$65</td>
</tr>
<tr>
<td>Feed and Manure Handling Equip. (per pig space)</td>
<td>$36</td>
<td>—</td>
</tr>
<tr>
<td><strong>Fixed Cost</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depreciation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Confinement and Engineered Hoop Building (of Fixed Investment)</td>
<td>6.7%</td>
<td>—</td>
</tr>
<tr>
<td>Non-Engineered Hoop Building (of Fixed Investment)</td>
<td>10.0%</td>
<td>—</td>
</tr>
<tr>
<td>Interest (of Fixed Investment)</td>
<td>4.0%</td>
<td>—</td>
</tr>
<tr>
<td>Insurance and Taxes</td>
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</tr>
<tr>
<td>(of Fixed Investment)</td>
<td>1.5%</td>
<td>—</td>
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<tr>
<td><strong>Total Fixed Cost</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Confinement and Engineered Hoop Building (of Fixed Investment)</td>
<td>12.2%</td>
<td>—</td>
</tr>
<tr>
<td>Non-Engineered Hoop Building (of Fixed Investment)</td>
<td>15.5%</td>
<td>—</td>
</tr>
<tr>
<td><strong>Operating Cost</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuel, Repairs, Utilities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Confinement (per pig marketed)</td>
<td>$1.39</td>
<td>—</td>
</tr>
<tr>
<td>Hoop structure (per pig marketed)</td>
<td>$1.04</td>
<td>—</td>
</tr>
<tr>
<td>Bedding (per pig marketed)</td>
<td>$2.44</td>
<td>$2.20–$2.70</td>
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<tr>
<td><strong>Feed Efficiency (FE)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Confinement</td>
<td>2.9</td>
<td>2.80–3.0</td>
</tr>
<tr>
<td>Hoops</td>
<td>3.05</td>
<td>2.9–3.2</td>
</tr>
<tr>
<td><strong>Feed Cost (per lb. of feed)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Confinement</td>
<td>$0.06</td>
<td>$0.05–$0.07</td>
</tr>
<tr>
<td>Hoop structure</td>
<td>$1.56</td>
<td>$1.25–$2.00</td>
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<tr>
<td>Marketing/Misc. (per pig marketed)</td>
<td>$1.53</td>
<td>$1.00–$2.00</td>
</tr>
<tr>
<td><strong>Miscellaneous</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moving round bales (per bale)</td>
<td>$2.00</td>
<td>$1.00–$3.00</td>
</tr>
<tr>
<td>Grinding, mixing feed (per ton)</td>
<td>$6.20</td>
<td>$3.50–$10.00</td>
</tr>
<tr>
<td>Surface spreading liquid manure (per hr)</td>
<td>$33.75</td>
<td>$30.00–$45.00</td>
</tr>
<tr>
<td>Hauling and injection (per gal.)</td>
<td>$0.0088</td>
<td>$0.0050–$0.012</td>
</tr>
<tr>
<td>Hauling and surface broadcast (per gal.)</td>
<td>$0.0079</td>
<td>$0.0050–$0.010</td>
</tr>
<tr>
<td>Irrigation (per gal.)</td>
<td>$0.0057</td>
<td>$0.0040–$0.008</td>
</tr>
<tr>
<td>Umbilical (per gal.)</td>
<td>$0.0070</td>
<td>$0.0060–$0.010</td>
</tr>
<tr>
<td>Loading solid manure (per hr)</td>
<td>$31.35</td>
<td>$25.00–$35.00</td>
</tr>
<tr>
<td>Loading, spreading solid manure (per hr)</td>
<td>$42.45</td>
<td>$40.00–$50.00</td>
</tr>
<tr>
<td>Farm labor (per hr)</td>
<td>$10.00</td>
<td>$7.50–$12.50</td>
</tr>
</tbody>
</table>
Pigs raised in hoop facilities ate 4.5% more feed than did the confinement-raised pigs. Again, location can affect these values, as feed efficiency tends to be affected the most during the winter months in the northern climates. Labor requirements, including manure removal, are 14 minutes (.24 hour) per pig for confinement and 17 minutes (.29 hour) per pig for the hoop barn.

The confinement pigs had a greater lean premium. It was $.45 per pig or $.18 per cwt live weight. This may be affected by the type of genetics used in hoop or confinement facilities.

As this comparison shows, total costs per pig are quite similar between the two systems. Management is important for both systems. Differences between producers in management preferences and/or capabilities may tip the scales toward one system.
or the other. Increases in confinement facility or investment costs would favor a hoop barn system. Similarly, increases in fuel, utilities, or repair costs would favor the hoop barn. Hoop barns also have an advantage when feed costs are low, confinement building prices are high, initial capital is limited, and bedding is cheap.

In other cases, confinement buildings may be a better economic alternative. Increases in prices for bedding, feed, or labor would create an advantage for a confinement system.

Niche markets that require specific housing systems are also a possibility. When evaluating systems it is necessary to evaluate specific opportunities and potential premiums that may be possible with the system. It is necessary to evaluate both the cost structure and the premium structure.

Note that an engineered hoop barn will have a longer life and a lower fixed cost percentage than a non-engineered hoop barn. Depending on the initial cost, an engineered hoop barn could have an economic advantage over both a confinement building and a non-engineered hoop barn.

Financial analysis

Table 7 provides a comparison of a hoop facility with a confinement facility. The comparison provides mixed results. Hoop facilities provide a superior rate of return on initial investment, internal rate of return, and modified internal rate of return, along with a shorter payback period. These advantages can be attributed largely to the hoops’ lower initial investment. The confinement facility has the advantage of a longer service life as well as higher net profits per pig per year. The confinement facility has an advantage of a higher net present value. This means that hoop operations will have to invest in more pig spaces in order to return the same net present value.

Evaluating the systems based on their sensitivity to market conditions and productivity also yields mixed results. Due to its lower investment, shorter service life, and lower net profit per year, the hoop facility is more sensitive to changes in hog prices, facility costs, and production costs. However, the confinement facility is more sensitive to changes in the cost of capital due to its longer service life and higher initial investment.

An evaluation of the effect of a change in the feed ration price on return on investment shows that the hoop system is more sensitive to changes in ration costs. This is expected given that more feed is needed for pigs in hoop systems due to their poorer feed efficiency. Rate of return on investment is equal between the hoop and confinement facility at a ration cost of about $.08 per pound.

Market hog carcass price also affects rate of return on investment. Return on investment for the hoop system is more sensitive to market hog prices than it is for confinement systems. At a carcass price of about $54.00 per hundredweight, the return on investment is equal between the two systems. At lower carcass prices, the rate of return on investment is higher for confinement systems. For carcass prices above $54, the rate of return on investment is higher for hoop systems.

This makes the question of which system is a better financial investment dependent on several issues. The producer must consider the available amounts of initial capital, operating capital, land for manure application, labor available, and pig flow in order to decide which is the better investment. The operator also must consider the cost of capital, value of alternative capital uses, market specifics, and risk aversion, as well as the intrinsic value that the alternatives have.

Other considerations

For diversified, moderate-sized swine producers, hoop barns offer some additional considerations. Hoop barns create opportunities for producers to participate in certain niche markets, which pay a premium over the commodity price level. Producers using hoop barns need to check all the specifications for a particular market, but niche markets such as organic, natural, humanely reared, reared with bedding, reared on family farms, or combinations of these attributes appear to offer additional marketing outlets for hoop-raised pigs. Many of these markets require specific housing systems such as hoops in order to participate in the market.

The structures themselves are versatile and could be used for alternative purposes, such as storing hay, machinery, or grain. The hoop barns may be constructed with on-farm labor. The versatility, production flexibility, and low capital costs may result in reduced financial risk. The quality of the work environment is generally good, with no liquid manure and a large volume of naturally ventilated air inside the barn. Manure can be stockpiled for spreading at other times.

The bedded-pack requires solid manure handling equipment, which some producers prefer but others do not. Because of the added bedding and high solids content, manure can easily be stockpiled
or composted for spreading at other times. However, the added bedding increases the volume of solid manure, which can increase hauling costs. Some bedding may need to be protected from adverse weather for use later in the year. Low cost, high quality bedding must be a high priority for the system. Also, it is unclear whether pathogens will build up under the bedding pack over long periods of use.

Following is a summary of the concerns and possible limitations to be examined when considering hoop barns.

- How often does the tarp need to be replaced?
- Can I insure this building against wind and hail damage?
- What types of bedding can be used?
- Will storage be needed for bedding?
- What provisions are needed to prevent leaching and runoff from stored or composted manure from polluting ground or surface water?
- Will there be pathogen buildup under the deep-bedded area?
- Will heat from the decomposing manure pack cause problems for the pigs in hot humid weather?
- Will manure spreading and residue harvesting equipment need to be purchased as an added expense?
- How much decrease in lean premium will result due to the hoop-reared pigs being fatter at market?
- Are niche markets available as alternative marketing outlets?
- Will diets need to be tailored for cold or hot environments?
- Do all genetics of pigs work equally well?

**Wean-to-finish**

Hoop barns can be successfully used for wean-to-finish pig production. The slower turnover rate of wean-to-finish production is a good fit with the lower fixed costs of hoop barns. However, special attention needs to be given to the needs of the weaned pigs in the hoop barn. During the summer in the Midwest, early-weaned pigs can be placed directly in bedded hoop barns. However, during fall, winter, and spring the early-weaned pigs need the protection of hovers and may need supplemental heat for the first few weeks post-weaning. A variety of materials can be used to build hovers: plywood, plastic, or straw bales with tarps. Special care must be taken when using supplemental heat to minimize the risk of fire because of the bedding. Supplemental heat sources can be heat lamps, brooders, or radiant heaters.

Because large groups are common in hoop barns, the newly-weaned pigs should be carefully checked 3 to 4 times per day. The large area in the hoop barn can be partially blocked off in the back of the hoop with bales of bedding to make checking the pigs easier. Offer fresh feed 3 or 4 times per day on the feeding platform. Some producers use feeding mats or boards to allow all pigs to eat simultaneously. Fresh water is critical. Provide temporary portable water troughs for the pigs for the first 1 to 2 weeks. Make sure that each pig eats and drinks several times daily for the first 2 weeks. Gradually the pigs can be shifted to self-feeders and automatic waterers. Although wean-to-finish has been successfully accomplished in hoop barns on a year-round basis, piglet growth for the first 2 weeks postweaning during the colder months may be slower than in a hot nursery. Also finer bedding (for example, small grain straw or shredded cornstalks) may be preferable for the small pigs. Some producers use ramps, bales, or mounded bedding to help the small pigs get onto the feeding platform. Once the pigs are established and the bedding pack begins to compost giving off heat, the special measures can be withdrawn.

When hoops are used in wean-to-finish operations, producers will need to deal with issues related to feeders and waterers.

Feeder design may be an issue for hoops when used for wean-to-finish. Many feeders used in hoops for grow-finish pigs are not suitable for newly weaned pigs. Issues include pigs getting trapped in feeder troughs, inability of small pigs to operate feed delivery or agitation devices and height of the feeder lip (4-6 inches recommended for newly weaned pigs). If feeders have lids, these need to be secured open until the pigs are big enough to access the regular drinkers.

Automatic water access may need to include the provision of a step or platform to reach the drinking trough or water delivery mechanism. Low energy or no-energy freeze-proof drinkers typical of many hoops used for grow-finish may not be suitable for newly weaned pigs due to the difficulties in operating the lid and/or ball device in the drinking trough. In addition, the small pigs may not consume sufficient water to keep the device ice-free. Thus, an electric or propane-fired heated drinker with a low-access height is recommended until the pigs are big enough to access the regular drinkers.
Summary

The full impact of new swine housing alternatives such as hoop barns needs to be evaluated for short- and long-term effects. Producers considering a hoop barn need to evaluate initial costs and operating costs for each alternative. They also need to gather as much information as possible about animal performance in different types of housing.

Among the major issues that a producer thinking about building a hoop barn must consider are the following:

• Managing winter ventilation is a crucial factor in making a hoop barn successful. Hoop barns should not be closed so tightly that moisture and warm air are trapped inside the structure.
• Hoop barns have lower fixed costs and higher operating costs (for example: bedding, labor, animal efficiency) than confinement facilities.
• Hoop barns are versatile and can be used for other applications, such as machinery storage, if not used to house pigs.
• If the tarp covering needs to be replaced before 10 years, tarp replacement costs must be added to cost calculations.
• Because hoop barns have a lower initial cost, producers can test their capability in swine production without a large investment.
• Producers who want to erect multiple hoop barns for a swine operation may find that the volume of bedding will become a limiting factor. The amount of bedding that accumulates with more than four hoop barns in one operation is substantial.

The example budget presented in Table 7 of this publication suggests that a hoop barn can be a competitive alternative building for pork production. However, producers should analyze their costs and compare alternatives. Given similar costs, other factors may tip the building decision to a hoop barn or a confinement building.

Personal preference and perceived benefits of one style over another may sway a producer to choose which housing type is more appropriate for a specific situation. For example, a producer who wants to expand quickly may find a hoop barn to be the best alternative, while another producer might conclude that the longer history and known attributes of a confinement building are more appealing. Additionally, a fixed level of investment capital can be spread over more pigs with the lower cost hoop barn. This would allow for the return on a given level of investment to be higher for the hoop barn.

References and Resources

Those interested in additional information about the topics discussed in this publication should consult the following sources:


Swine mortality composting website: http://www.abe.iastate.edu/PigsGone/index.htm

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