Pork Industry Handbook: Building Materials and Equipment for Swine Facilities

Michigan State University
Cooperative Extension Service

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pork industry handbook

COOPERATIVE EXTENSION SERVICE • MICHIGAN STATE UNIVERSITY

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Producers who have invested in new swine facilities are often disappointed by the severe deterioration of their facilities after just a few years. Much of the deterioration could have been prevented if the producer had considered the corrosiveness of the environment within the facility and the pigs' destructive nature. These problems are more pronounced in enclosed facilities but can occur in all types of units. The most rapid deterioration takes place near the floor because of wetness, chemical corrosion, and physical destruction. However, the effects can also be observed in other parts of the building, especially on unprotected metal. Rapid corrosion of metal is characteristic of facilities with a poorly designed ventilation system. See Pork Industry Handbook fact sheet PIH-60, *Mechanical Ventilation of Swine Buildings.*

When planning your building, select materials that are insurable, corrosion-resistant, and durable enough to withstand the rugged pushing, rubbing and chewing activities of the pigs. Materials within the building but outside the pens are not as vulnerable to physical deterioration, but they can have a relatively short life because of corrosion. Materials along alleys will be subjected to physical abuse from the pigs and from moving equipment. Therefore, carefully select equipment and materials regardless of their intended use or location.

Floors

A good, high-quality concrete mix is necessary because manure acids corrode concrete. Solid floors should be made from a mix that will yield a 4,000 psi concrete (maximum of 6 gal. of water per bag of cement). Air entrained concrete should be used for all installations, especially where the concrete will be subjected to freezing temperatures. An alternative is to place a lower strength, less expensive concrete as a base and then add a higher strength concrete over the top as a wear surface. This is accomplished by placing a steel reinforcement mesh over a rough-graded layer of concrete and then adding a finish layer of concrete. The savings in material cost should be evaluated in light of possible inconvenience during the placement of layers of concrete and higher labor costs.

If slats are to be used, they should be designed for corrosion resistance as well as strength. Additional flooring design details can be found in PIH-53, *Flooring for Swine.*

Walls

Concrete and wood-frame are both satisfactory for exterior walls. A choice should be made after considering both construction and maintenance costs. Consider also the work required to provide openings in the wall, such as for ventilation.

Concrete is one of the most durable materials for walls that are subjected to animal and equipment contact. However, concrete has little thermal insulating value. Where warm interior temperatures are to be maintained, as for a farrowing or nursery facility, additional insulation is recommended. In cold climates, insulation is also essential in growing/finishing buildings to prevent condensation and retain animal heat. In very mild climates, concrete walls without insulation are satisfactory for some phases of a hog production facility.

Sandwich panel construction is an effective means of providing a durable interior and exterior surface and at the same time, improving the thermal efficiency of the wall. Sandwich panels are formed by placing a foam board insulation material within the wall during casting of the concrete. This can be done either with cast-in-place walls or precast, tilt-up panels.

An alternative that can be used where animals do not have access to the outside of the building is to erect a concrete wall and apply a spray-on urethane insulation material on the outside. The insulation must be painted or otherwise protected to retard destruction by ultraviolet light from the sun. For added protection, the foam should

be covered with a ¼-in. layer of spray-on plaster or gunite concrete. The result is a durable, thermally efficient, stucco-like wall.

Wood-frame walls may be of conventional stud frame or post frame construction. In either case a wider range of materials is available for enclosing the exterior frame. Among the materials that have been used successfully are ribbed steel or aluminum; composition boards, such as particle board or hardboard; exterior plywood; and boards. As with all wall construction, both initial and maintenance costs, as well as useful life, should be considered before deciding on the material to use.

With either type of wall, stud or post, thermal insulation can be added easily. However, appropriate construction plans must be followed, such as planning stud or girt spacings to accommodate standard widths of insulation materials. The range of insulation materials is broad and includes fiberglass blankets, pour insulation, foam boards and spray-on foams. Regardless of the insulation material chosen, an interior protective covering is necessary.

Where walls are exposed only to personnel and will not be subjected to hog contact or vehicular traffic, the choice of interior covering materials would include the same materials as for exterior surfaces.

The potential for both vehicular traffic and animal contact makes the use of the more durable interior coverings desirable. For occasional contact, such as along alleys used for hog movement, ribbed sheet metals, plywood, wood boards and composition boards are good choices. For continual contact, as in pens, the use of solid coverings — hardwood, steel sheets or panels, or fiberglass-reinforced plastics (FRP) — is recommended. Plastic mouldings used with FRP panels should be located at the pen partitions or fastened very securely so as not to give the pigs a place to start chewing. The FRP material is also available in roll form in long lengths thereby reducing the number of possible joints.

On wall areas above the reach of the animals (usually considered to be about 4 ft.), most common building materials can be used. However, since sanitation is important in swine buildings, these lining materials should be nonporous and durable enough to withstand cleaning with a high-pressure water system.

Ceilings

The main requirements for a ceiling material are cleanability and corrosion resistance. Like wall sections above the hog contact areas, most common building materials can be used.

Since roof trusses are usually spaced 4 ft. on center, the cost of any additional nailers required for installation of a particular ceiling product should also be considered as part of the ceiling cost. Materials such as ribbed metal can be attached directly to truss chords without additional nailers.

Insulation and Vapor Barriers

Where insulation is to be used, consider the purchase price, installation cost, required coverings, and thermal effectiveness. In measuring thermal effectiveness, it is recommended that insulation or "R" values as given by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) be used (Table 1).

The high moisture levels in swine facilities require that appropriate vapor barriers be used. These are needed to reduce the movement of water vapor into a wall or ceiling. Allowing water vapor to move into a wall will cause con-

Table 1. Insulation values.
Most values are from the 1985 ASHRAE *Handbook of Fundamentals.* Values do not include air films unless noted otherwise. All values are approximate.

Item	R-value: Per inch (approximate)	R-value: For thickness listed
Batt and blanket insulation		
Glass or mineral wool, fiberglass	3.00-3.80*	
Fill-type insulation		
Cellulose	3.13-3.70	
Glass or mineral wool	2.50-3.00	
Vermiculite	2.20	
Shavings or sawdust	2.22	
Hay or straw, 20″		30+
Rigid insulation		
Expanded polystyrene		
Extruded, plain	5.00	
Molded beads, 1 lb./cu. ft.	3.85	
Molded beads, over 1 lb./cu. ft.	4.20	
Expanded rubber	4.55	
Expanded polyurethane, aged	6.25	
Glass fiber	4.00	
Wood or cane fiberboard	2.50	
Polyisocyanurate	7.20	
Foamed-in-place insulation		
Polyurethane	6.00	
Building materials		
Concrete, solid	0.08	
Concrete block, 3 hole, 8″		1.11
Lightweight aggregate, 8″		2.00
Lightweight, cores insulated		5.03
Brick, common	0.20	
Metal siding	0.00	
Hollow-backed		0.61
Insulated-backed, ⅜″		1.82
Softwoods, fir and pine	1.25	
Hardwoods, maple and oak	0.91	
Plywood, ⅜″	1.25	0.47
Plywood, ½″	1.25	0.62
Particleboard, medium density	1.06	
Hardboard, tempered, ¼″	1.00	0.25
Insulating sheathing, 25/32″		2.06
Gypsum or plasterboard, ½″		0.45
Wood siding, lapped ½″ x 8″		0.81
Asphalt shingles		0.44
Wood shingles		0.94
Windows (includes air films)		
Single glazed		0.91
with storm windows		2.00
Insulating glass, ¼″ air space		
Double pane		1.69
Triple pane		2.56
Doors (exterior, includes air films)		
Wood, solid core, 1¾″		3.03
Metal, urethane core, 1¾″		2.50
Metal, polystyrene core, 1¾″		2.13
Air space (¾″ to 4″)		0.90
Air films		
Inside surface		0.68
Outside surface		0.17
Floor perimeter (per ft. of exterior wall length)		
Concrete		1.23
Concrete, with 2″ x 24″ rigid insulation around perimeter		2.22

*The R-value of fiberglass varies with batt thickness and manufacturer; check the label.

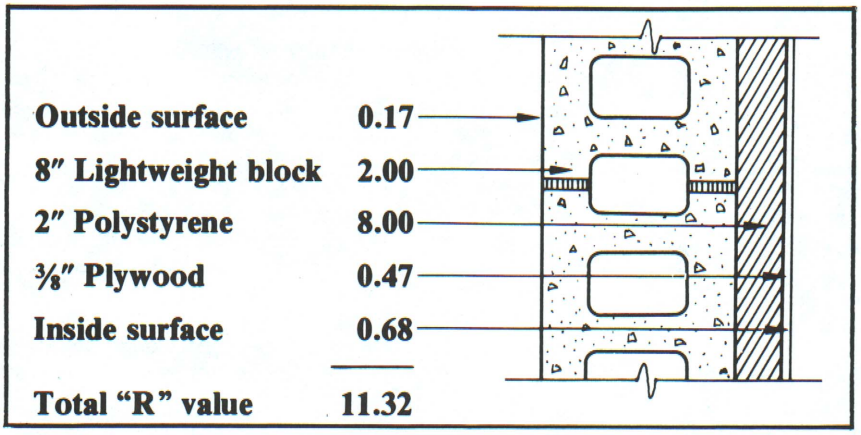

Figure 1. Insulated masonry wall. Omitting polystyrene foam insulation would reduce insulation R value to less than 3. This masonry block wall with only cores filled with vermiculite provides a total R of less than 6.

densation within the wall or ceiling assembly. The condensation will result in a lower R-value and possible destruction of the insulation material. In general, a 4-6 mil plastic (polyethylene) vapor barrier should be used with all insulation materials because, even with vinyl-clad foam boards, it is impossible to maintain all joints in a water vapor-tight condition. In all cases the vapor barrier should be located on the warm side (inside) of the wall or ceiling between the interior covering and the insulation. See PIH-65, *Insulation for Swine Housing*.

Figure 1 illustrates the procedures of determining the R-value for a concrete block wall using the data in Table 1. Figure 2 shows how to calculate the R value of a ceiling. Figure 3 shows winter degree days, and Table 2 recommends minimum insulation levels for swine buildings.

Mice, other rodents, and birds can seriously damage any type of insulation. See PIH-107, *Controlling Rats and Mice in Swine Facilities*. Use physical barriers to keep rodents out of buildings. If ribbed metal is used for inside wall linings, the end openings of the ribs should be closed to prevent the entrance of rodents. A good rodent control program is essential since they seem to find any small openings into the wall cavities. Birds will destroy any exposed insulation. In some cases insulation is consumed

Table 2. Recommended minimum insulation levels for swine buildings. R values are for building sections.

Winter degree days	Recommended minimum R values					
	"Cold"		Modified environment		Supplementally heated	
	Walls	Ceiling	Walls	Ceiling	Walls	Ceiling
2500 or less	—	6	6	14	14	22
2501 to 6000	—	6	6	17	14	25
6001 or more	—	6	12	25	20	33

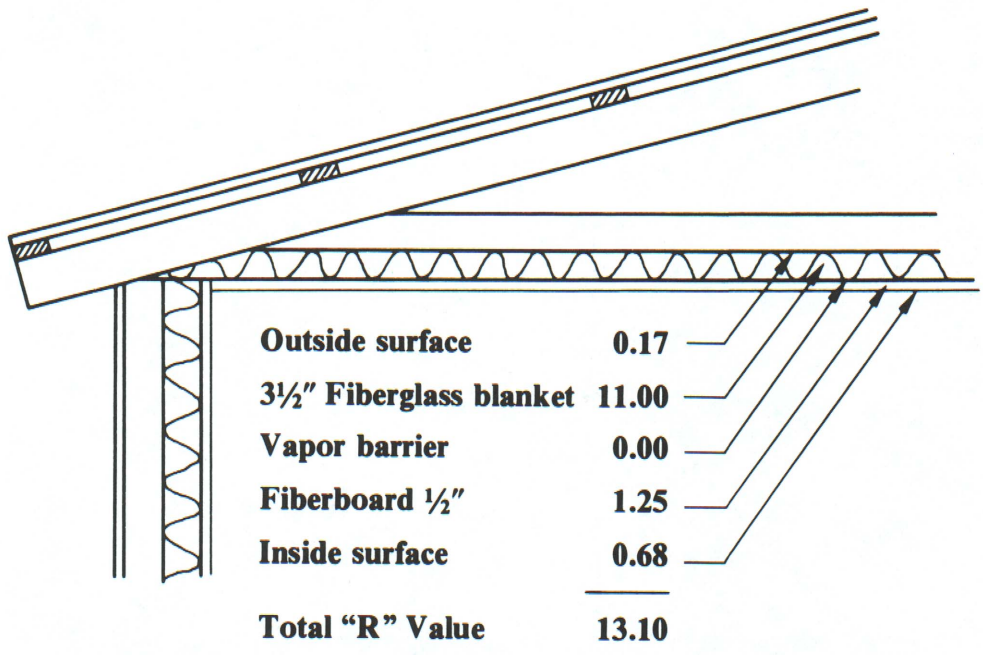

Figure 2. Insulated wood frame ceiling. Reducing the insulation to 1½ in. of fiberglass blanket reduces the ceiling R to 7. Using 6 in. of fiberglass insulation increases the ceiling R to 21.

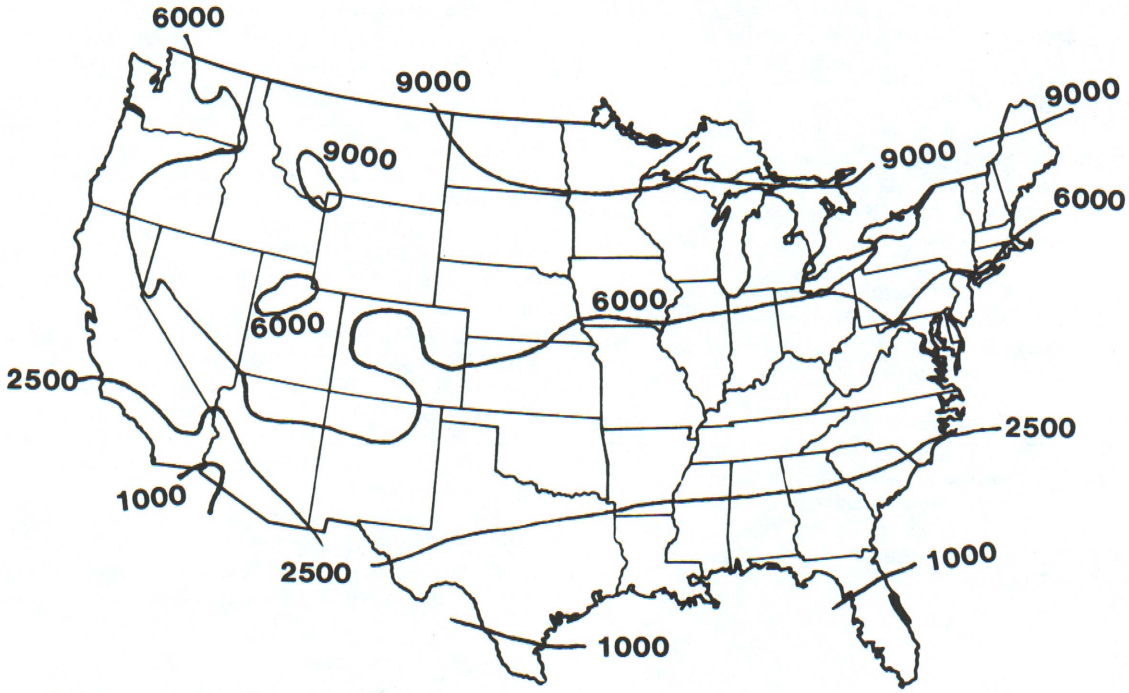

Figure 3. Winter degree days.

directly as food, while in other cases it is used as a nesting location, a material for nest building, or simply something to play with to pass the time. Consequently, cover the insulation and use an effective bird control program.

Pen Partitions

Pen partitions must be durable enough to resist rubbing, chewing and pushing by pigs and, at the same time, resist the corrosion of the environment and manure that comes into contact with them. The choice of materials depends partially on whether open or solid partitions are used and whether the partition is permanent or must be movable. Partitions are generally not insulated.

The durability and general corrosion resistance of concrete makes it an excellent choice for partitions (minimum of 3500 psi; 7 gal. water per bag of cement is recommended). Concrete blocks, cast-in-place concrete, or precast concrete panels can be used (Figure 4). As with exterior walls, steel reinforcing bars or mesh should be a part of all concrete partitions to afford greater strength and to fasten partitions securely to the floor. When anchoring equipment to floors or walls, consider using stainless steel materials.

Woods such as oak and southern yellow pine are fairly durable when used as pen partitions. A key requirement with wood is to restrict pigs from chewing it. Use tongue-and-grooved planks or well-matched planks to reduce access to edges where chewing can start. Softwoods will probably have a useful life of 2 years or less. Hence, their use should be restricted to temporary shelters. As with exterior walls, the life of partitions can be extended by overlaying the basic wood partition with such materials as fiberglass-reinforced plastics, steel sheets, or mesh. Where wood is in contact with the floor, ground or generally wet conditions, the use of pressure preservative-treated lumber is recommended for a longer use life.

Figure 4. Cast-in-place concrete partitions (decorative form shown here) on the solid portion of the floor with vertical bar gates over the slats.

Both solid steel sheets and open welded wire mesh have been used for pen partitions with poor results. The most common steel panels use vertical rods or tubing. The life of these materials depends upon how well they can resist corrosion and flexing because of pushing by the pigs. To maintain partitions and reduce injury to pigs, all joints must be securely welded and protected from corrosion. Plain steel panels can be satisfactory if well protected with a long-lasting coating. The abrasive action of hogs wears away most post-installation coatings such as paint or epoxy. Also, once corrosion starts, it tends to work under the remaining coating and lift it away. Stainless steel is more expensive but might be worth the additional cost in permanent structures subjected to intensive use.

Fiberglass panels with vertical bars are now available and appear durable. Solid plastic planks are available for use where a solid partition is desired or needed.

Farrowing Stalls

Material used for farrowing stalls includes stainless steel, aluminum, fiberglass, or galvanized and painted metal. Any metal near the stall floor is subject to extreme corrosion while parts of the stall's upper metal is subject to wear from the abrasion of sows rubbing. Aluminum stalls require nonmetalic insulating spacers to prevent contact with concrete or dissimilar metals, and galvanic corrosion.

As with pen partitions, rusting will start quickly at unprotected spots on the steel stalls. A heavy galvanized coat helps but galvanizing will wear and corrode off in time.

A quality steel farrowing stall will have all welds cleaned thoroughly, a good prime coat applied and a tough, durable, finish paint coat applied over it.

The life of all metal equipment will be extended with good ventilation to keep air in the hog house drier and lower in corrosive gases and by periodic cleaning and painting at the floor line.

Plastic Pans

When remodeling a farrowing or nursery unit, it is sometimes more practical to use the existing floor as is, and install plastic pans or trays under the slotted floor to contain the manure. Manure may be drained into a pipe that collects from each crate or deck and carries the manure to storage. In some cases a plastic auger can be used to convey the manure to the end of a row of crates or decks and then drain into storage. Some producers have indicated that at times, manure sticks to the plastic and must be cleaned with a high pressure cleaning system at cleanup time. An alternative is to partially fill the pan with water after each drain. This improves cleaning ability but requires handling of greater amounts of liquid manure. Plastic pans should be installed so that access is provided for hand scraping and pressure washing without having to spray through the floor.

Roof Coverings

The most common covering materials are plain or painted ribbed aluminum, galvanized or painted steel sheets, and asphalt shingles. All of these are satisfactory if good quality materials are purchased and properly applied.

With galvanized steel, the use of sheets bearing a Zinc Institute, Inc. grade stamp is recommended. Outdoor exposure studies at The Pennsylvania State University revealed that sheets with a 2-oz. zinc coating and a "Seal of Quality" grade stamp required 15 years of exposure before the first signs of rust. Sheets with a 1¼-oz. zinc coating began to rust after 7 years. Sheets with less zinc per square foot than these industry standards are available at lower cost and will have a correspondingly shorter life before the first signs of rust. It is not possible to determine the amount of zinc coating by visual inspection. Even where factory applied finishes are used, the heavier zinc coatings should be used.

Galvanized and painted steel is sold on the basis of thickness or gage. Gages most commonly available are 28 and 29. Lower gage numbers indicate greater thickness. A choice should include consideration of required roof design loads in the area and the load-carrying capacity of the roofing sheets. Manufacturers' literature and local codes can provide the required information.

In selecting aluminum roofing sheets the ease of installation should be considered. The use of high-strength alloy sheets of less thickness might be a disadvantage since their greater brittleness tends to cause them to split rather than dent if hit too hard or stepped on improperly. Avoid the use of extremely long sheets because of changes in length with variations in temperature. This results in tearing out of nail holes, or bending or extraction of nails or other fasteners. Fewer roof-leakage problems are generally experienced where the length of roofing sheets is kept to 24 ft. or less.

To prevent corrosion of metal roofing through galvanic action, it is imperative that the correct fasteners be used with each kind of metal. Also, galvanized and aluminum sheets should not be placed in contact with each other. Where it is necessary to mix galvanized and aluminum products, they should be separated by a nonmetallic intermediate material.

When installing asphalt shingles, use at least 235-lb. shingles with self-sealing tabs.

Regardless of the roofing material used, the limitations of its use as related to roof slope should be recognized.

Plumbing

PVC or similar plastic pipe is probably the most suitable for a swine building environment. Because of the corrosive atmosphere within swine facilities, metal pipe should be used with caution. Copper pipe usually has a short life when exposed in a swine building. If galvanized or black iron pipe is used, some type of coating should be applied at the threads since this part of the pipe is most subject to deterioration and failure.

In warm facilities, plumbing can be run overhead to reduce contact with animals and manure. Although overhead pipes can be used in cold buildings, such placement requires electrical heat tape and pipe insulation to prevent freezing. Consequently, in cold facilities underground plumbing is recommended. Where pipes are brought to the surface, they can be run through a large-diameter plastic pipe to reduce corrosion and provide easier maintenance.

In cold facilities, built-in heating units are suggested where cup waterers are used. Nipple waterers (Table 3) generally do not require additional freeze protection beyond that provided on the pipe up to the nipple. In all cases, a durable high-strength cover is required over pipe insulation and heat tape to reduce damage by pigs and reduce the potential of electrocution of pigs. Adequate grounding of all electrical equipment is a MUST. Good-quality waterers should be selected to reduce maintenance costs, extend the use life of the waterers, and reduce water

Table 3. Planning guide, nipple waterers.*

Item	Pig weight, lb.					Sow and boar
	< 12	12-30	30-75	75-100	100-240	
Height, in.	4-6	6-12	12-18	18-24	24-30	30-36
Pigs/nipple	litter	10	10	12-15	12-15	12-15
Min. flow rates, quarts per min.	0.2	0.2	0.4	0.5	0.67	1.0

* Install at least two waterers per pen. Locate waterers 14" apart for nursery pigs; 24" for larger pigs. This distance may be reduced some if the nipples are angled away from each other.

usage and manure hauling costs resulting from leaking valves.

Electrical

This may be the most critical component of a swine building since corrosion can create conditions that increase the risk of fire and electrical shock. Electrical materials installed inside a swine building should be designed for damp or wet locations. Thin-wall metal conduit has a short life and should not be used. Fittings, outlet boxes and switches not designed for waterproof locations may create an unsafe condition after several years. If conduit is used, it should be plastic. Type UF cable with waterproof fittings is another option. If at all possible, locate the entrance box in a dry annex of the office room to avoid rapid corrosion. Only surface-mount boxes should be used, especially on outside walls. See PIH-110, *Electrical Wiring for Swine Buildings*. In cold climates, problems can be reduced if all conduit is installed within the warm part of the building. When conduit extends from the warm building up into the cold loft or attic, condensation can occur and the resulting moisture can move back to a fitting and cause corrosion or electrical faults. If a positive pressure ventilation system is used, be sure that no moist, corrosive air can be pushed into electrical boxes.

As noted in the discussion on plumbing, grounding of all electrical equipment is a MUST. This applies to all switches, receptacles and appliances since wet floors increase the continual threat of shock and possible electrocution of both personnel and animals. All electrical equipment and wiring should be installed in accordance with the National Electrical Code. Check with your electrician or power supplier.

Feeders

A low-quality feeder (Table 4) will not last long in a hog house. The increased moisture level near the floor speeds up corrosion. The activity of the pigs causes rapid wear. The upper part of the feeder may last more than 10 years, but this helps little if the bottom has failed.

When purchasing a metal feeder, look for stainless steel or cast iron bottoms. Wood feeders can be improved by covering the wooden trough with a more durable material such as fiberglass or metal. Plastic feeders resist corrosion and appear durable.

As with plumbing and electrical lines, the running of feed conveyance equipment through a ceiling should be minimized to reduce the risk of moisture condensation and the loss of heat.

Ease of adjustment in a feeder is as important as durability. If a feeder cannot be easily adjusted to prevent feed waste, it can easily cost its owner many times its replacement value. Feeders with flat bottoms reduce shelter areas for rodents and are recommended.

Table 4. Feeder space.

Pig weight, lb.	Pigs/feeder space
12-15	2
25-50	3
50-120	4
120-240	4-5

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Reference to products in this publication is not intended to be an endorsement to the exclusion of others that might be similar. Persons using such products assume responsibility for their use in accordance with current label directions of the manufacturer.

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