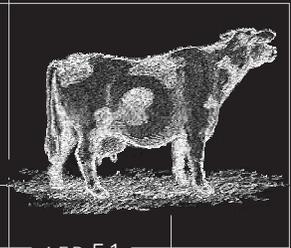


Hoop Barns for Dairy Cattle



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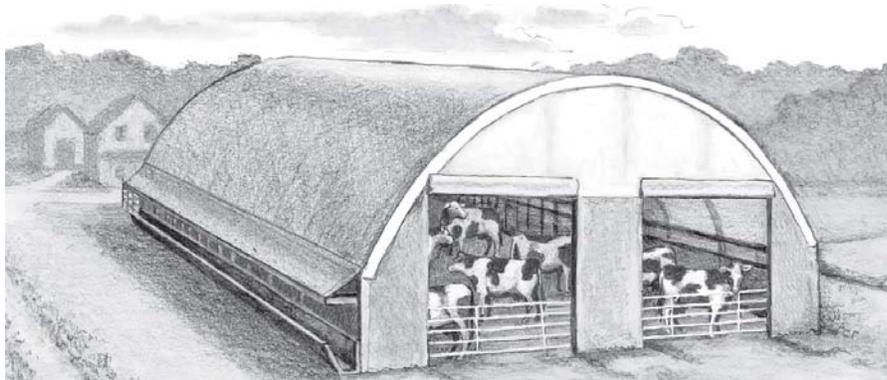
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Overview

Hoop barns offer an alternative roof and shelter system to dairy producers for a variety of uses including calf, heifer, and cow housing. When compared on an equal basis, they are not necessarily less expensive than other options such as post or steel frame structures. One possible reason that hoop barns can keep the capital cost lower than the alternatives is the fact that these types of structures can be erected by the producer, which helps to reduce construction labor cost. A producer may not have the skills necessary to construct a post or steel frame building so the opportunity to save on labor costs is not available. In a similar frame, a producer may not have the skills to build some of the wider hoop barns used for dairy applications. Depending on location and dealer availability, hoop barns are competitively priced with post or steel frame buildings.



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A hoop barn is a Quonset™-shaped structure with sidewalls 4 to 10 feet high made of treated wood posts and wood sides. Posts are typically 6- × 6-inch or 8- × 8-inch treated wood spaced 6 to 12 feet on center. For building widths less than 30 feet, tubular steel arches fastened to the tops or sides of the posts form a hooped roof. Hoop barns wider than 30 feet often use a tubular truss frame, providing an integral sidewall and roof system with clear spans up to 140 feet. The hoop or arch is covered with ultraviolet (UV)-resistant, polyvinyl tarp. In many dairy applications, a translucent covering is used as an alternative to the opaque fabric to provide additional natural light. In bedded-pen housing designs, the bedded resting area can be earthen or concrete. Walk alleys and feeding platforms are typically constructed with concrete alleys to allow daily collection of manure.



Figure 1. Typical hoop barn.

Figure 1 shows a hoop barn, and Figure 2 shows the common components of a hoop barn.

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. A designed ridge opening in the cover and adjustable sidewall curtains provide for natural ventilation in heavily populated barns.

Many hoop barns are associated with a deep-bedded housing system, which is a lower cost system design compared to a freestall barn. In many dairy designs, the layout of the barn would not change just because a hoop barn is used to cover the footprint. A hoop barn is a viable alternative shelter for covering specific dairy layouts.

When to Consider Hoop Barns

Hoop barns appear to be most beneficial when producers have one or more of the following goals:

- Want to provide roofed weather protection
- Desire to relocate the building in the near future
- Want to utilize a bedded-pen housing system
- Want to eliminate outdoor lots and runoff concerns
- Want to reduce cash cost by providing labor in the construction process

Hoop barns provide an alternative shelter system from post frame and steel frame buildings. Hoop buildings may provide needed, short-term

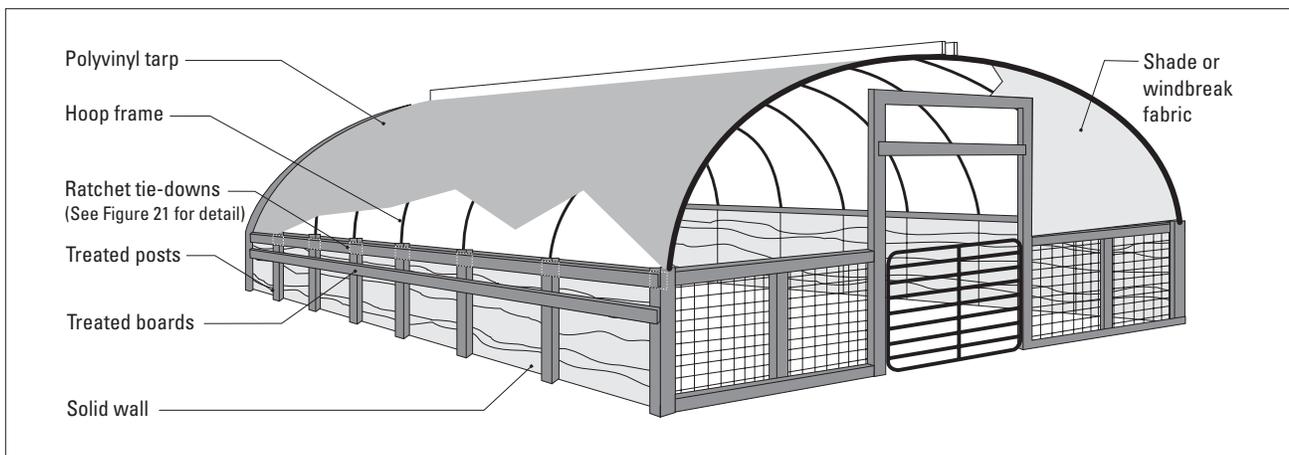


Figure 2. Basic components of a hoop barn for calves.

Sidewall heights for calf barns range from 4 to 8 feet. Sidewall heights for cow barns range from 8 to 14 feet and have open or curtained sidewalls. Wire panels or fencing must be used to protect curtains or prevent cows from exiting the barn through the sidewalls.

weather protection for cattle in outside lots or pasture. Producers who want seasonal protection for cattle along with winter storage for hay may find hoop buildings advantageous. Producers wanting to eliminate the liability and environmental risk from open lot runoff may find total confinement in hoop buildings to be a cost-effective alternative. Confinement operators may choose hoop buildings for a solid manure alternative to liquid manure in pits or lagoons.

If the producer is seeking a facility that has alternative uses, investing in a hoop building becomes even more attractive. The high ceiling, low cost, and quick construction make hoop buildings a logical choice for a number of uses including livestock housing, hay storage, machine storage, feed storage, and working facilities' protection.

Hoop Barn Management

Equipment selection, material handling, and animal-handling techniques are important factors that affect both the longevity of the structure and animal comfort.

Structure management issues include:

- Managing the structure as a cold, naturally ventilated barn.
- Providing frost-free or no-freeze waterers.
- Handling rainfall runoff in an environmentally satisfactory way.
- Providing lighting.
- Providing adequate watering space.
- Developing a maintenance schedule that includes checking the entire structure every 12 months, and checking the tarp for tears and tautness every 6 months.
- Laying the floor plan out in a way that makes manure collection and cleaning easy.

Cattle management is defined as a management plan that is dependent and appropriate to the type of animal housed. A management plan typically includes:

- Developing management groups of cattle according to the management plan.
- Providing comfortable environments for resting, eating, and drinking.
- Enabling individual animals to be easily restrained for treatment.
- Providing easy observation.

Using Hoop Barns for Dairy Operations

Applications of hoop barns for dairy operations include:

- Calf housing in individual pens and bedded group pens.
- Heifer housing in bedded group pens.
- Cow housing in freestall or bedded pens.

Depending on the type of animal housed, a hoop frame structure can be used for dairy applications in a variety of ways. Generally the type of housing system (individual pens, group bedded pens, or freestall platforms) will determine the hoop frame width that would be adapted to a particular system design and layout. Also remember to account for the hoop truss frame width in determining the total width of the building. The frame may intrude on the space required for clearance of the equipment used. Table 1 shows the different building widths that would work for various barn plans for dairy applications.

Some common features or options in many dairy hoop designs are:

- **High sidewalls.** Sidewall height is dependent on the size of the animal in the structure. The sidewall height for a structure with only young calves is typically 4 to 6 feet high, while a structure for mature cows is 8 to 10 feet high.
- **Sidewall lining.** Animals in the bedded-pack areas of transition calf and heifer barns can damage posts. Lining the interior with treated tongue and groove lumber or rough 2-inch oak planks 2 to 4 feet high can lengthen the lifespan of the structure.
- **Adjustable curtains.** Natural ventilation sidewall curtains that can be adjusted up or down are a common feature for all types of dairy housing.
- **Pen dividers.** Tubular swing gates make a strong and lightweight divider that can be easily moved when needed.
- **Swing gate location.** Locating swing gates so they can be swung to lock calves into an alley or section of a pen can help make manure cleaning easier.
- **Bedded-area floors.** Floors for the bedded areas can be earthen or concrete.
- **Outside feed platform.** Some hoop designs that house older animals have outside

| Dairy Housing Use | Width (feet) | |
|---|--------------|---------|
| | Recommended | Minimum |
| Dairy Cows | | |
| • Two (2) freestall rows and one (1) alley (no feeding) | 26 | 24 |
| • Two (2) freestall rows and two (2) alleys (drive-by feed platform) | 38 | 34 |
| • Two (2) freestall rows and two (2) alleys (drive-through feed platform) | 52 | 48 |
| • Three (3) freestall rows and two (2) alleys (drive-by feed platform) | 48 | 43 |
| • Three (3) freestall rows and two (2) alleys (drive-through feed platform) | 62 | 57 |
| • Four (4) freestall rows and two (2) alleys (no feeding) | 52 | 47 |
| • Four (4) freestall rows and four (4) alleys (drive-through feed platform) | 100 | 86 |
| • Six (6) freestall rows and four (4) alleys (drive-through feed platform) | 118 | 104 |
| • Bedded pen and one (1) alley (drive-by feed platform) | 48 | 43 |
| • Bedded pen and one (1) alley (drive-through feed platform) | 62 | 57 |
| Heifers | | |
| • Bedded pen and one (1) alley (drive-by feed platform) | 40 | 32 |
| • Bedded pen and one (1) alley (drive-through feed platform) | 54 | 46 |
| • Self-cleaning pen and one (1) alley (drive-by feed platform) | 28 | 24 |
| • Self-cleaning pen and one (1) alley (drive-through feed platform) | 42 | 38 |
| Calves | | |
| • Two (2) rows of individual pens and one (1) alley | 24 | 22 |
| • Bedded pen and one (1) alley (drive-by feed platform) | 24 | 22 |
| • Bedded pen and one (1) alley (drive-through feed platform) | 38 | 34 |

feeding platforms in which feed is dropped onto an uncovered concrete pad area and the sidewall on the feed alley side is left open.

In this design a curtain can be hung from the eave, allowing an opening at the cattle level for accessing feed.

- **Feed platform awning.** An awning can be used to protect the feed platforms from rain and snow, and to provide shade when the sun is shining. The eave height of the awning should be checked carefully to make sure that feeding equipment can clear the eave.
- **Curtain protection.** Curtains need to be protected from contact and possible damage by animals. Wire panels, bird netting, or closely spaced high-tensile wire fence can all be used to protect the curtains.
- **Ridge opening.** An open ridge is highly recommended in almost all structures because it helps facilitate air movement by allowing moisture-laden air to be exhausted from the structure. If left unexhausted, moisture-laden air can accumulate at the peak of the hoop, which can lead to metal and tarp deterioration.

- **Interior and exterior lights.** Having adequate lighting can aid in nighttime observation.

- **Clear span truss frame.** As barn widths increase, some manufacturers combine wall and roof systems into a clear span truss frame supported on a concrete foundation. The concrete foundation can either be a frost footer or a post-and-beam concrete foundation. A hoop barn 50 feet or wider may have this framing system.

Calf barns

A 26- to 30-foot wide hoop building with a 4- to 6-foot high post frame wall can be used for a simple shelter to protect individual calf hutches or pens for raising calves (Figure 3). Two rows of pens are placed on the exterior walls with a center work alley between the rows of pens (Figure 4). The center alley should be wide enough to allow utility vehicle traffic and access to the area with a skid steer for cleaning pens. Pens are stocked on one side until the row of pens is full. When calves are removed, the pens are moved out of the way to allow skid steer cleaning of the accumulated bedding and manure. The opposite row is stocked while cleaning this row of pens. To aid in moisture control, a 6-inch ridge opening is a good option for this building.



Figure 3. Calf hoop barn.

Transition calf barns

A 30-foot wide hoop building with a 4- to 8-foot high solid post frame wall can be used to shelter a series of bedded pens for weaned calves coming out of individual pens. Figure 5 shows a barn designed for small groups of calves up to 6 months of age. As calves grow and get older, two small groups can be combined into a larger group by doubling the pen size. A scrape alley is used adjacent to the feeding platform, but this area also can be bedded. A 6-inch wide ridge opening can be installed to aid in moisture control. A cart can be used to feed calves in the 6-foot wide feed platform. An alternative to using a feed cart is to use an open sidewall between support posts next to the feed platform side to allow access from the side of the barn to the feed platform with a skid steer loader.

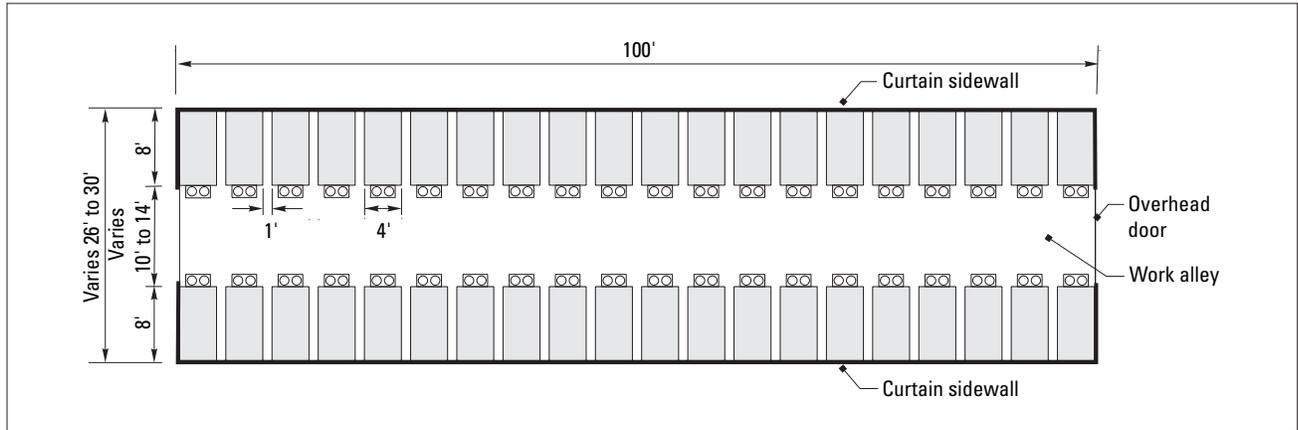


Figure 4. Layout for a 40 individual pen calf hoop barn.

Use individual removable pens for easier cleaning. A 6-inch ridge opening can be used to aid in moisture control.

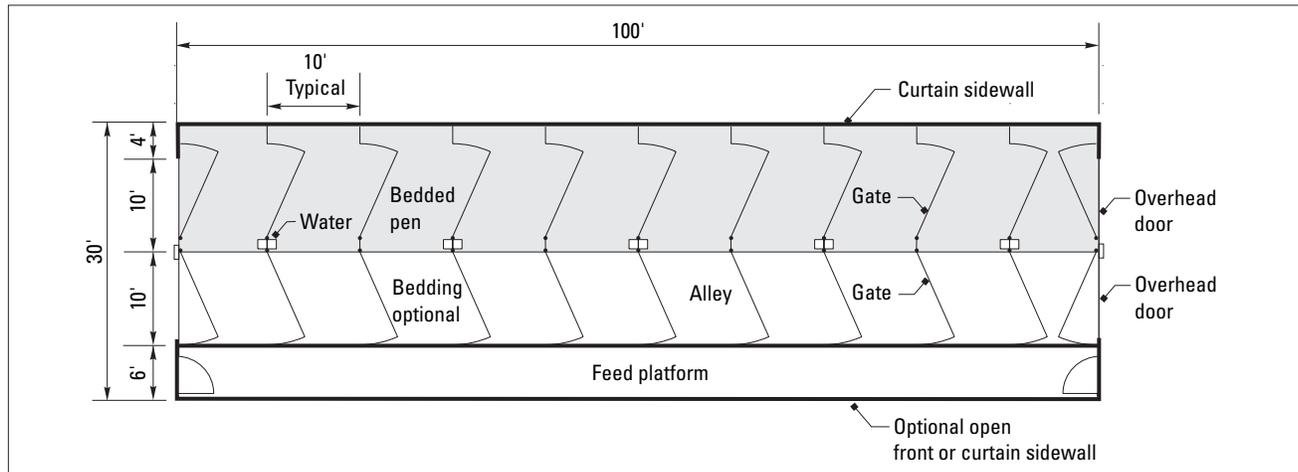


Figure 5. Layout for a 50-calf, bedded-pen hoop barn.

Bedded-group pens are designed with swing gate partitions. Pens are sized for five calves, which provide about 28 square feet of bedded area per calf. Protect sidewall curtain from calves with a wire panel. A 6-inch ridge opening can be used to aid in winter ventilation moisture control.

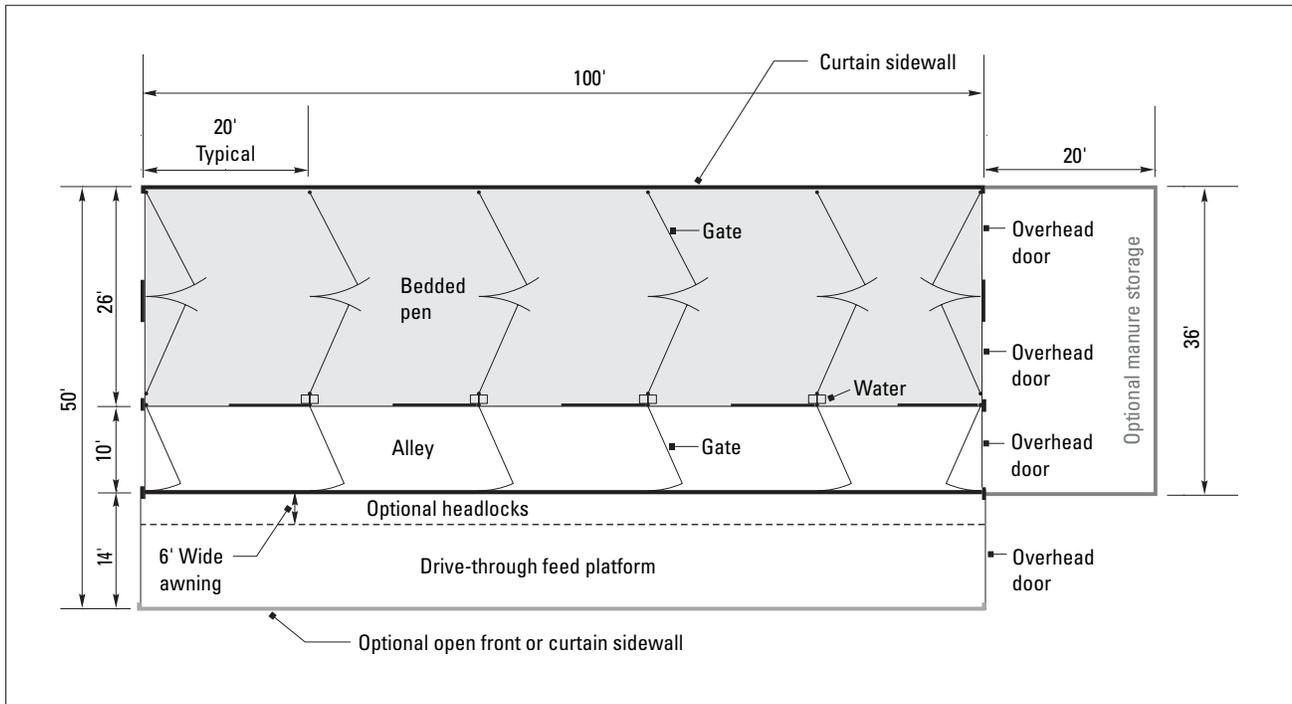


Figure 6. Layout for an 80-heifer hoop barn.

The drive-through feed platform can be either under roof (50-foot width) or outside the hoop (36-foot width) with or without a 6-foot wide awning. Bedded-group pen is sized for 16 heifers, which provides about 32 square feet of bedded area per heifer. Protect sidewall curtain from heifers with a wire panel. A 10-inch ridge opening is recommended to increase airflow for winter ventilation moisture control.

Heifer barns

A 50-foot wide hoop building with 8- to 10-foot high post frame wall can be used to shelter a series of bedded pens with feeding under roof for heifers (Figure 6). An alternate design would be to use a 36-foot wide hoop building with 10-foot post frame wall and optional awning on one side of the building over the outside feed platform. In this case the eave height of the awning should be checked carefully to make sure that feeding equipment can clear the eave. The barn space is designed to allow for groups of heifers to be housed in pens with a drive-by feeding platform. A scrape alley is used adjacent to the feeding platform to ease daily scraping of manure. A 10-inch ridge opening is recommended for moisture control. The feed platform is 14 feet wide to allow a tractor and mixer to drive-through and lay the feed along the feed fence (Figure 7).

Freestall barns for cows (2 rows)

A 30-foot wide hoop building with 8- to 10-foot high post frame wall can be used to shelter two rows of freestall platforms and a center manure alley. Fig-



Figure 7. Inside feeding alley for a heifer hoop barn.

Drive-through feed platform and headlocks. Note ridge opening for winter ventilation moisture control.

ure 8 shows the layout for the freestall barn under a hoop structure with an outside drive-by feed platform. Adjustable curtains are used on both sidewalls for natural ventilation. End wall ventilation is provided with an 80% closed shade or windbreak fabric (Figure 9). A

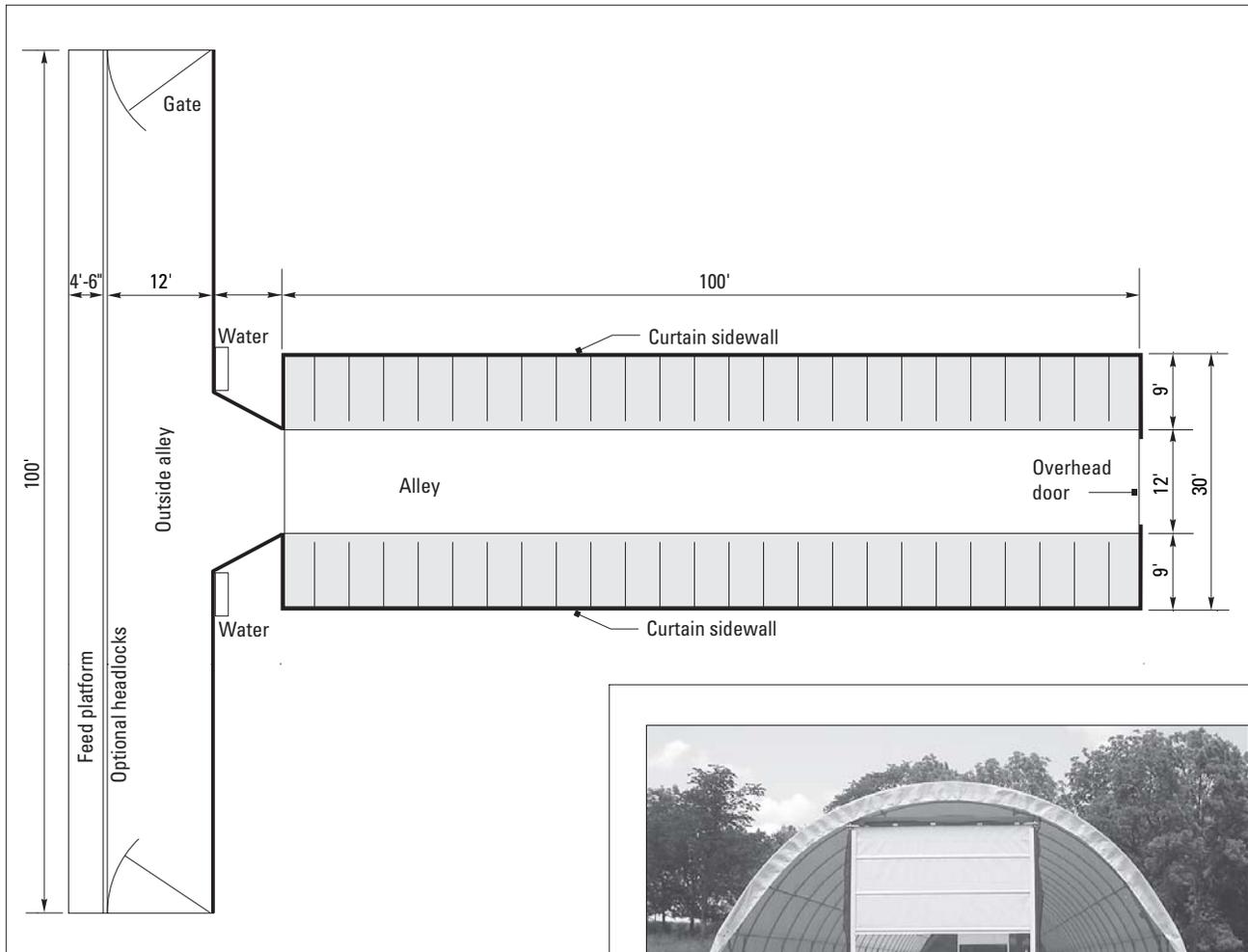


Figure 8. Layout for a 50 freestall, two-row hoop barn. Two rows of freestall platforms and center concrete alley. Freestalls are spaced at 48 inches on center. A 6-inch wide ridge opening is recommended to help facilitate air movement for moisture control. Note outside alley and feed platform.

6-inch wide ridge opening is recommended for moisture control. Cows exit the end of the barn through rollup doors into the outside alley adjacent to a feeding platform. The alleys are scraped daily to a collection area or temporary manure storage. Figure 10 shows the outside feed platform for Figures 8 and 9.

Bedded-pen barns for cows

A hoop building with 8- to 10-foot high post frame wall can be used to shelter a bedded pen, alley, and feed platform. Figure 11 shows a plan for several milk cow groups including dry cows and optional maternity



Figure 9. Outside of a two-row hoop freestall barn. Photo shows the feed platform side of the structure for the layout in Figure 8. Note wind shade cloth end wall ventilation and roll-up door for cow and equipment access.

pens for calving for a herd size of approximately 100 cows.

Figure 12 shows a cross-sectional view of how the space is developed for both a 50- and 64-foot wide barn with a bedded-pen resting area, an adjacent alley where cows stand to eat, and the feed platform.

The feed platform is 14 feet wide to allow a tractor and mixer to drive-through and lay the feed along the feeding fence. In the 50-foot wide barn, the feed platform is placed outside the frame along the post frame wall supporting the hoop frames. In the 64-foot



Figure 10. Outside feed platform for a two-row hoop freestall.

Drive-by feed platform and headlocks in foreground. The poles in the photo are for lighting that allows for cattle viewing.

wide barn, the feed platform is inside (Figure 13). The alley is scraped daily to a collection area or temporary manure storage.

Freestall barns (2 to 3 rows)

A 50- to 64-foot wide hoop building with 8- to 10-foot high post frame wall can be used to shelter 2 to 3 rows of freestall platforms, alleys, and a feed platform. Figure 14 shows a layout for a three-row barn for two milk cow groups, with pens for dry cows, close-up cows, and maternity pens for a herd of approximately 120 cows. Note that this layout has a higher stocking capacity than a bedded-pen barn (Figure 11), which has the same footprint. An alternate design layout for a 3-row barn would be to use a 50-ft wide hoop building with an awning (Figure 15) or the barn can be 64 feet wide with the barn covering the feed platform.

A 12-inch wide ridge opening is recommended to help facilitate air movement for moisture control. The feed platform is 14 feet wide to allow a tractor and mixer to drive-through and drop the feed along the feeding fence. In the 50-foot wide barn, the feed platform is placed along the post frame wall supporting the hoop frames. The alleys are scraped

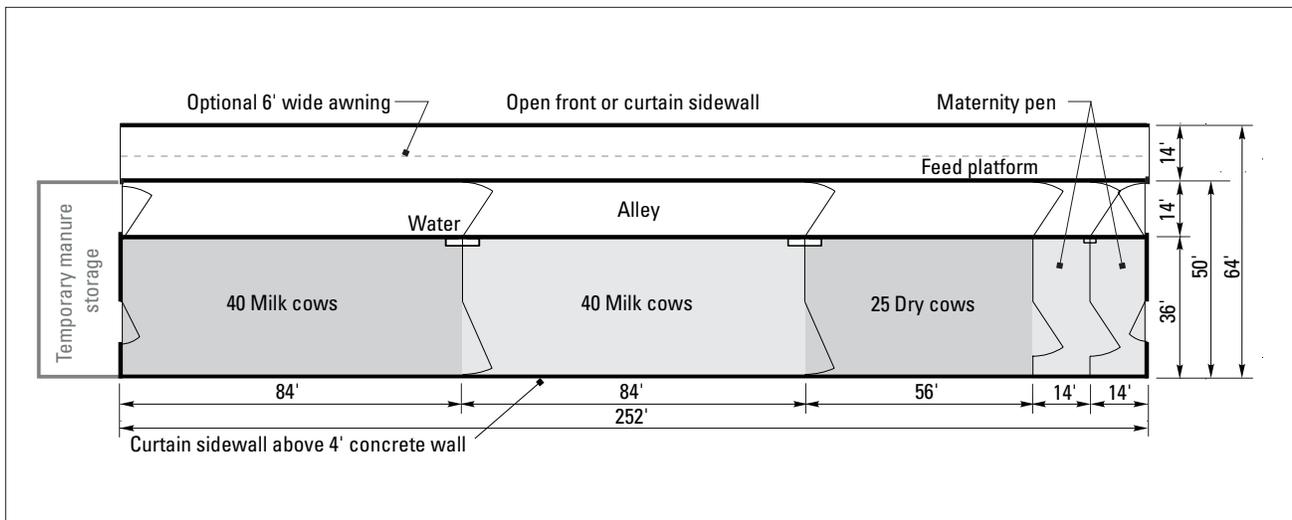
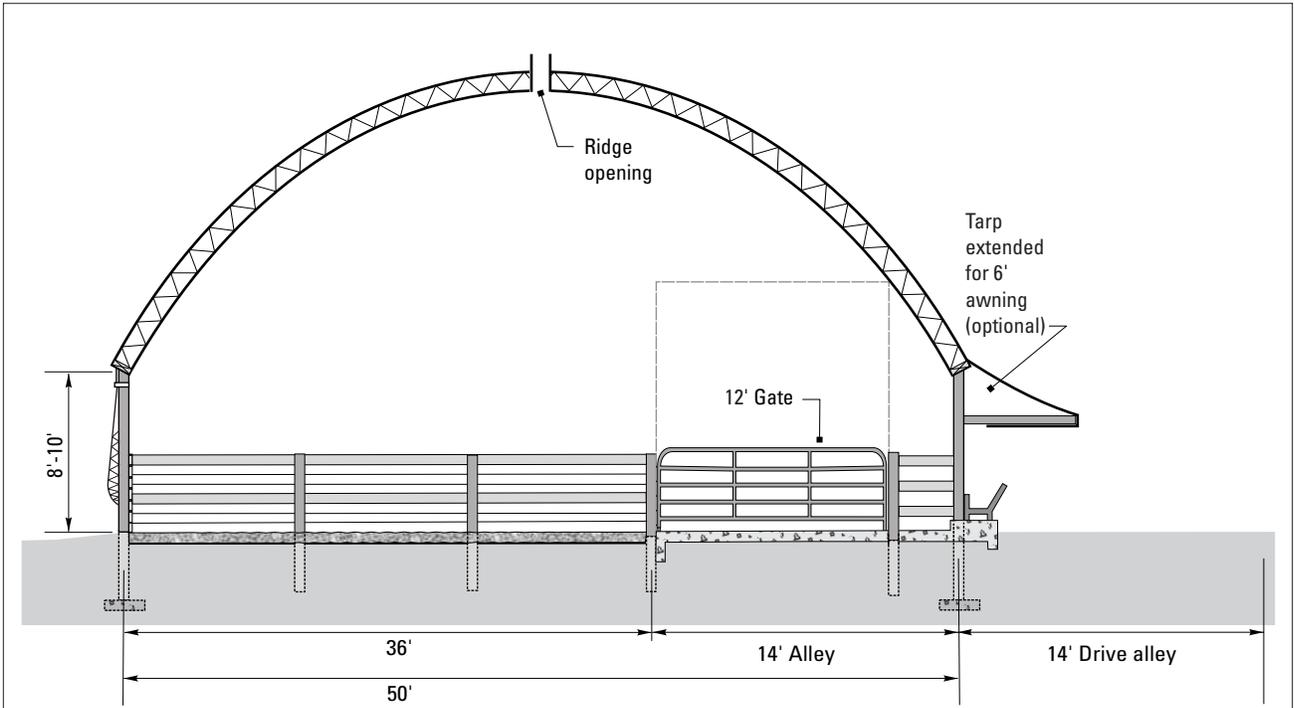


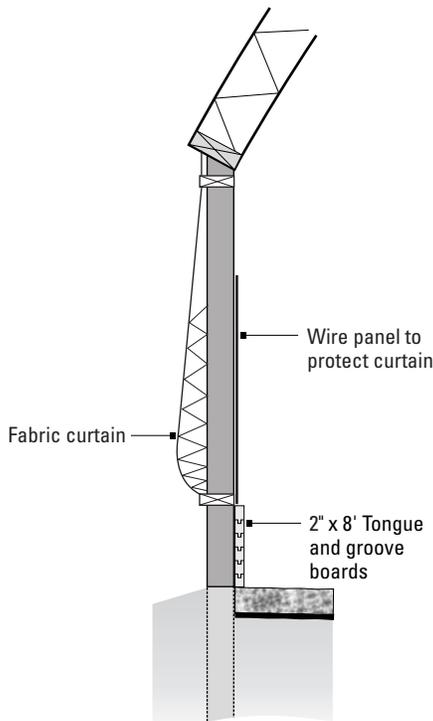
Figure 11. Layout for a 105-cow hoop barn.

Three bedded pens for milk and dry cows, and two maternity pens. Each large pen provides about 75 square feet of space per cow. Each maternity pen is sized for three cows and newborn calves. Note drive-through feed platform or optional drive-by feed platform. Bedded area may be concrete or earth. A 12-inch wide ridge opening is recommended to help facilitate air movement for moisture control. The minimum hoop width is 50 feet. A 6-foot wide awning can be located over the feed platform with this design. Another option would be to use a 64-foot wide hoop that covers the drive-through feed alley. A curtained sidewall could be used with this option.



A. Cross-section for 50' barn with awning.

A 64-foot wide hoop barn without an awning covering the drive alley is another option with this design.



B. Frame post detail.

Figure 12. Cross-section of a bedded-pen hoop barn for cows.



Figure 13. Outside view of a bedded-pen hoop barn for cows.

Hoop extends over the drive-through feed alley.

daily to a collection area or temporary manure storage. A white translucent fabric is used to provide additional natural light.

Freestall barns (4 or 6 rows)

A 100- to 120-foot wide hoop building can be used to shelter 4 or 6 rows of freestall platforms, alleys, and feed platform(s). Figure 16 shows an alternate arrangement with the feed platforms on the outside

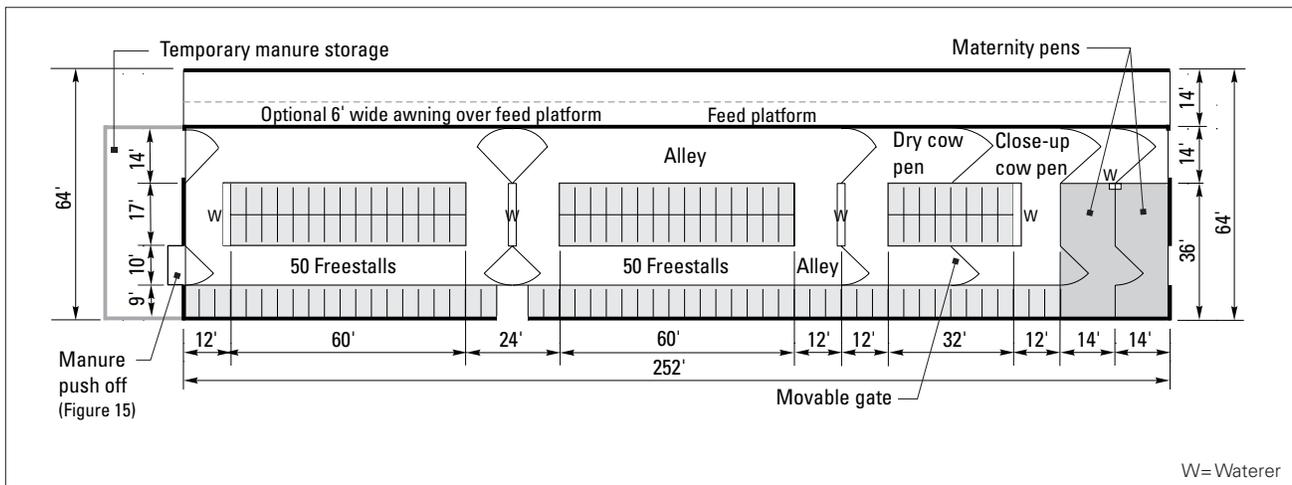


Figure 14. Layout for a three-row, 130-freestall hoop barn.

Freestall areas for 100 milk cows, and 30 dry and close-up cows. Freestalls are spaced at 48 inches on center. Two maternity pens are available with each pen sized for three cows and newborn calves. Note drive-through feed platform or optional drive-by feed platform. A 12-inch wide ridge opening is recommended to help facilitate air movement for moisture control. The minimum hoop width is 50 feet. A 6-foot wide awning can be located over the feed platform with this design. Another option would be to use a 64-foot wide hoop with a curtained sidewall that covers the drive-through feed alley.



Figure 15. Inside of a freestall barn with covered drive-through alley.

Note full curtain sidewall and headlocks. Ridge opening to help facilitate air movement for moisture control.



Figure 16. Inside of a four-row freestall barn with an interior feed platform.

Drive-through feed platform under roof. A 24-inch wide ridge opening is recommended to help facilitate air movement for moisture control. Note full curtain sidewall and optional headlocks.

walls of the hoop barn. A 24-inch ridge opening is recommended for moisture control. Cows are fed in alleys adjacent to the feeding platform. The feed platform is 20 feet wide to allow a tractor and mixer to drive-through and lay the feed along both feeding fences. The feed platform is usually 14 feet wide when feed is placed on only one side of the feed platform as shown in Figure 16. A white translucent fabric is used to provide additional natural light.

Other uses

Hoop barns are versatile structures and can be used for a variety of purposes on a dairy operation. Hoop barns with open sides can be set up as cattle shades in pastures or lots. Hoop barns can also be used as shelter for cattle-handling facilities such as crowding tubs, alleys, chutes, etc. Hoop barns can also be used for storage of hay, compost, feed, grain, forage, bulk commodities, or machinery.

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 animals. 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 have been used in the swine industry for many years in the United States and Canada, using hoop barns for dairy housing is relatively new. Many hoop 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 building 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. The 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. As the building widths increase for use in dairy applications, the resulting loads can be significant.

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 animals. In an engineered building, the foundation has been specified to withstand the loads transferred from the wall, and the structure has been designed to meet snow and wind loads for the geographic area in which it is to be erected. An important point for producers to consider is that engineered structures are more easily insured because they 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 building:

- 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

Deep-bedded resting area designs can have either a dirt or concrete floor, with many producers preferring concrete for ease of cleanout. In some states, regulations require concrete floors to prevent nutrients from leaching into the underlying soil and groundwater. Thicken the edges of the slab, particularly at the end where vehicles will drive into the bedding area for cleaning.

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 animal housing.

Sidewall and endwall construction

Both wood and concrete sidewalls are relatively common. Generally, pressure-treated, 6- × 6-inch or 8- × 8-inch posts are used. Pressure-treated tongue and groove 2- × 6-inch lumber is used on the animal side of the posts to form the sidewalls to contain the bedding and manure when using a bedded-pack system. Curtains are used on the sidewalls to provide natural ventilation openings. Concrete sidewall foundations are more durable than wood. Typically the sidewalls are at least 6 feet high for narrow barns and increase to 8 or 10 foot high for wider barns. High sidewalls are recommended for providing large, natural ventilation openings, especially for heavily stocked confinement barns. Prevent animals from damaging the tarp or curtains with wire panels, bird netting, or closely spaced high-tensile wire fencing.

Endwall construction should include posts and headers to support rough openings for doors or gates to allow access for cattle, 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 which may damage the tarp material. In some dairy applications an endwall tarp (Figure 17) or shade cloth (Figure 9) is used. In wide hoop barns the end wall is also framed with steel trusses. Adequate endwall and cross bracing is provided with cable and steel tube cross bracing (Figure 17).

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 building 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

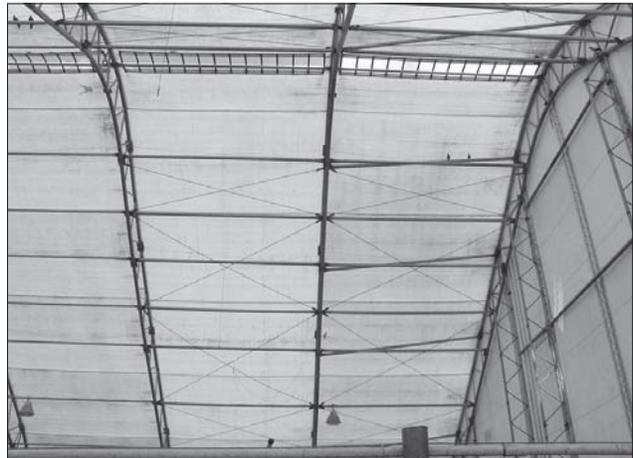


Figure 17. Endwall tarp.

Endwall steel frame with tarp covering. Note ridge opening, steel cable cross bracing, and steel tube endwall bracing.

then construct a 4- to 10-foot high wall along the sides of the frame. The pipe frame is attached to the tops or sides of the posts as shown in Figure 18. 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. Concrete foundations may be required on wider buildings. Figure 19 shows a hoop truss frame to concrete foundation connection. Always follow engineered foundation designs from the hoop barn supplier. The frames must be supported concrete walls high enough to prevent manure from accumulating around the hoop frame to concrete connection or be placed where the connection is not accessible to the animals. If precast walls are used, they must be designed to accommodate the fastening requirements of the selected brand of hoop barn.

Frames

Hoop frames are constructed primarily from 2- to 3-inch O.D. (Outside Diameter) round tubular steel. These frames support the roof and sidewall construction of the building. 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 building. Steel purlins connect the trusses to each other to act as a unit (Figure 19). The thickness



Figure 18. Hoop frame connection to post frame wall.

Note curtain sidewall.

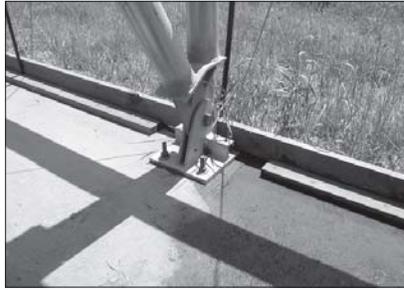


Figure 19. Hoop frame connection to concrete foundation.

Hoop truss frame has a 120-foot clear span. Note full curtain sidewall.

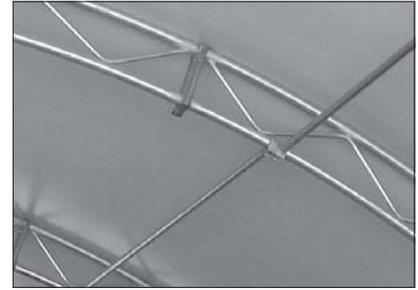


Figure 20. An engineered truss arch.

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. Frames are spaced at a variety of widths from 4 to 12 feet on center. Some narrower hoop barns use a single tube only, without forming a truss. While widths for single-tube frames usually range from 18 to 36 feet, many hoop barns spanning 40 feet or more use an engineered truss frame arch. Some manufacturers span 150 feet or more with engineered truss arches such as the one shown in Figure 20. Truss arches also are used when high snow or wind loads are a concern or when a lower roof height is desired.

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 UV stabilizers and a fire-resistant substance to provide safety and longevity. Producers should consult their insurance company about which treatments are required for insurability.

Tarps generally come in different weights, such as 10.0-, 12.5-, and 14.9-ounce fabric. Many colors are available, including clear, translucent, and opaque fabric. Fabrics that are translucent allow some natural light through and tend to make a building brighter and the animals easier to see

(Figure 16). Clear fabrics, such as the one shown in Figure 16, are not a good choice because they allow a high degree of solar penetration, which may overheat animals. In that case shade cloth may be necessary to limit the solar gain on the cattle. 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. See Figure 21 for an illustration of how the tarp is fastened to the sidewall and frame.

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.

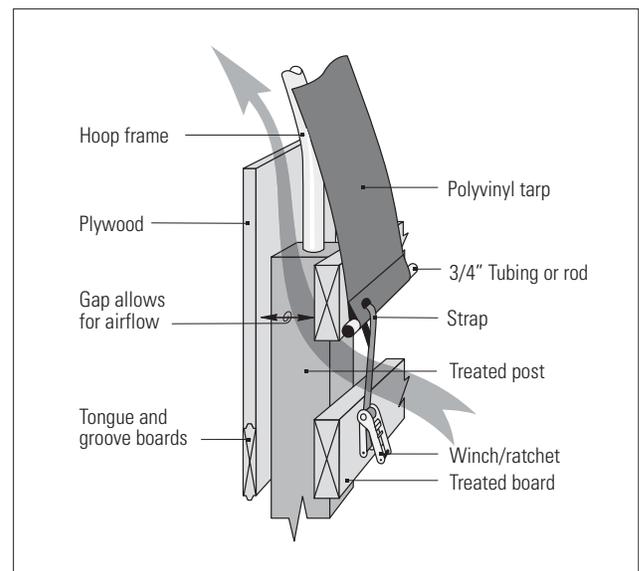


Figure 21. Tarp properly fastened to frame and sidewall.

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 it 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. Diagonal bracing of the sidewalls from the endwalls and along the roofline should be incorporated. 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

Hoop barns are naturally ventilated and should be 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. If ridge openings are not used, then the building should be sited so that prevailing summer winds blow into the end of the building. In many dairy applications, the buildings are usually stocked heavily, producing large amounts of moisture. End wall openings may not be adequate in ventilating the moisture out of the building, especially when the wind is not blowing in the end wall. Open ridge openings are available in the fabric covers from some manufacturers and should be considered, especially as the building width and length increases.

When building multiple hoop barns, provide adequate space between buildings for natural ventilation as shown in Figure 22. This will allow space for equipment to travel between buildings and allow for snow removal and moisture drainage.

Perhaps the top priorities for hoop barns used as dairy 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 unheated barns and should be managed as such. Although bedded-manure pack generates considerable heat and enhances animal

comfort for animals in the winter, hoops require special design and management for hot weather comfort.

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 a dry bedded resting area provides a suitable and comfortable environment.

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 is often within 5°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 winds through the sidewalls. 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 is 75 feet.

Ridge outlet openings

Natural ventilation uses openings at different heights to achieve ventilation in the winter. Building a structure with an open ridge, as shown in Figure 23, 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, some hoop barns used for dairy housing do not have ridge openings. For example, calf barns sometimes do not use ridge openings. Air exchange, and therefore air quality, will likely be poorer for structures without ridge vents, especially as the building width and length increase.

Endwall openings

In some dairy applications of hoop barns with small animals and low animal density, endwall ventilation openings may be adequate for moisture control. The ends above the sidewall are covered in a windbreak cloth (80% to 90% closed) to cut drafts but still allow some air movement through the cloth



Figure 22. Provide adequate space between naturally ventilated buildings.

The spacing between the two, 30-foot wide buildings is 75 feet.



Figure 23. Ridge outlet opening in tarp.

Note the straps holding separate pieces of tarp connected at the ridge opening. Note steel purlins and cross bracing cables supporting frames.



Figure 24. Hoop frame connected to endwall.

A gap at the top serves as a continuous air opening for ventilation.

opening (Figure 9). Hoop barns without ridge vents are difficult to ventilate naturally if they are too long (more than 100 feet) or too wide (more than 30 feet). Typically, a hoop barn longer than 75 feet, without ridge vents, and filled with animals will present ventilation challenges.

Figure 24 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. These gaps in the end are very important when no ridge is present, because it is the only high opening with which to remove moisture. The south end, or end away from the predominant winter winds, should remain open during cold weather. 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.

Sidewall eave openings

Ventilation air enters through an open sidewall or a continuous space along the sidewall eave where the tarp is attached. Air exits through the ends of the hoop or the ridge outlet. Figure 21 shows a 3- to 6-inch gap between the top of the wall and where the tarp overlays the wall, a common design for calf barns. This gap serves as a continuous air opening for ventilation. When ventilation 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 and moisture occur most often when hoop barns are closed too tightly.

Sidewall curtains

Hoop barns may be constructed with sidewall curtains to promote cross-ventilation during summer. This is essential in barns positioned perpendicular to predominate summer winds. Curtains should be the full wall height if possible, with a minimum of 4 feet typical for calf barns and 8 feet for larger animals. Take care to ensure animals cannot damage the curtain.

Manure Handling

Before considering a hoop barn, producers must carefully plan how to handle the manure. Dairy manure is usually handled as a slurry. The use of bedding will increase the solids content of the manure and can change the method in which manure is collected and transferred. If direct application to a field is not possible, then space to stockpile the manure must be available. Knowing the nutrient content of manure is essential for those who have developed a manure management plan for their fields.

The *Dairy Freestall Housing and Equipment Handbook* (MWPS-7) has a more detailed discussion on manure handling and bedding.

Bedding

Bedding is used in some type of systems, especially in the winter. If bedding is used, then enough bedding must be provided to keep the soil under the bedding pack relatively dry if it is not completely concreted.

Several materials have been used successfully for dairy bedding. Organic bedding materials such as straw and sawdust can be used. However, a deep bedding on a dirt surface can encourage coliform mastitis.

If sawdust is used as a bedding material, then use the sawdust generated from kiln-dried lumber. Avoid using woodchips when other choices are available. Green sawdust can harbor organisms that cause *Klebsiella mastitis*, so age green sawdust before using it as a bedding.

Removing manure

Management of the manure in the hoop can either be done by selectively cleaning portions of the barn or by allowing the bedding pack to build up, hauling it after cattle are removed. If selective cleaning is done throughout the hoop barn or exterior feedlot, you must have a place to stockpile if it will not be spread immediately. This location must be free of runoff and have an all-weather surface.

Tractor scraping using a tractor-mounted blade or bucket, or a skid loader is one of the most common methods of manure collection used in dairy hoops. When concrete floors are used, many producers will use a rubber scraper fabricated from half of a large tire. The tire is bolted to a metal frame that can be mounted to the front of a tractor or a skid loader. The curved shape of the tire also results in less manure flowing out along the edges. The manure/bedding mixture removed from the hoop barn is either directly spread on fields or stored for later use.

Storing manure

If manure is applied directly to the fields, storage requirements are minimal. If manure is not applied directly to a field after cleaning, then designing a storage area to safely stockpile the manure is necessary. To properly design the storage area, the amount of manure to be stockpiled must be determined.

Slurry manure can be stored in a formed earthen or man-made storage. The storage must be sized to contain the amount of manure for a maximum length of time between emptying events. Some states require a minimum number of days of storage. Contact the

local extension service for assistance in designing an earthen or man-made manure storage structure.

Manure from a bedded hoop barn may have a high degree of variability, which makes it difficult to predict manure nutrient contributions to crop fertilization needs. Unless it is too wet, composting is likely to occur if the manure is solid and is stored for any length of time. The composting will provide volume reduction of one-third to one-half and nutrient stabilization prior to field application. Such composting will occur with minimal management if the material is piled in windrows about 6 feet high and 12 feet wide.

Some concern exists about nitrogen leaching from solid manure storage, especially during high rainfall. Most states require that environmental control agencies are concerned about runoff and will inspect areas of stockpiled manure. They also require storing solid manure on a concrete pad and the use of a runoff control structure. Contact state environmental control agencies to determine proper procedures and requirements for stockpiling manure.

References and Resources

Available from MPWS, 122 Davidson Hall,
Iowa State University, Ames Iowa 50011-3080
or Fax: 515-294-9589 or www.mwps.org:

- *Dairy Freestall Housing and Equipment*, MWPS-7
- *Raising Dairy Replacements*, RDR-Book and RDR-CD
- *Dairy Reference Manual*, NRAES-63
- *Guideline for Dairy Odor Management*, NRAES-146
- *Penn State Freestall and Heifer Housing Plans*, NRAES-85
- *Penn State Housing Plans for Milking and Special-Needs Cows*, NRAES-200
- *Natural Ventilation for Dairy Tie Stall Barns*, NRAES-119

An Economic Comparison of Soft Covered Barns Vis-a-vis Post-Frame Steel Clad Barns For Lactating Dairy Cows in Ontario. Fisher, J.W., P.H. Sharp. 2001. Kemptville College. Box 2003.830 Prescott Street. Kemptville, ON K0G 1J0. 613 258 8336.



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