Dairy Session III

"Bovine Behavior and Cow-Friendly Environments"

Moderator: **Gordon Jones**

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Remodeling Existing Facilities: Changes for the Better

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Introduction

The buildings and equipment which comprise a dairy operation are there to facilitate the job of caring for the animals on the farm. Labor requirements, flow of animals and materials, pollution control, future expansion and management requirements are important considerations in design.

Planning for new construction or remodeling of these dairy facilities must be based on a sound management plan. The plan sets forth all factors related to nutrition health and growth as well as all other activities of the dairy farm operation. The buildings and equipment which comprise dairy facilities are merely tools which allow essential tasks prescribed by the management plan to be carried out on a regular basis. Haphazard planning or impulsive acquisition of buildings or equipment will only lead to facilities which impede implementation of updated management plans and hinder future development and expansion.

Providing environments that meet the needs of the animals being housed is important in design, also. While many of these needs may be obvious, the degree to which they are satisfied may vary widely. This may be due to a lack of understanding as to just what the needs of the animals are when it comes to establishing and maintaining their environment. For example, a warm barn for calves may have excessively high relative humidity due a lack of understanding of both the needs of the calves and the design and operation of the ventilation system. Or, it may result from an improper ordering of the priorities being used for design. For example, the establishment of the environment in a barn may place the needs of people and equipment ahead of the needs of the animals which are to be housed, oftentimes to the detriment of the animals.

A discussion of some of the considerations for meeting the needs of dairy animals follows.

Free Stall Design

Free stalls must provide a clean, comfortable lying space for cows. In addition, free stalls should allow cows to rise and lie down in a natural fashion.

As a cow rises from a lying position in the pasture, she lunges forward, transferring her weight forward to help raise her hindquarters, much like a springboard action. To achieve this natural movement, a cow must have sufficient space to thrust her head forward as shown in Figure 1 (Cermak et al., 1983). If she cannot lunge forward, it is more difficult for her to rise on her hind legs. If restricted too much, she rises front legs first, like a horse.

Free stalls usually do not provide enough rising space. Length is limited to reduce defecations in the rear of the stall, important to good udder health. But the limited length restricts the forward thrust of the head and makes it more difficult for the cow to rise. The lower rail of the stall partition may also injure cows as they lie and rise. Injuries may occur in the hip and pelvic regions as cows strike or rest against lower rails or rear stall supports.

An improved free stall partition (Figure 2) makes it easier for cows to lie and rise and increases the likelihood that cows will use the stalls. The new partition has more space beneath the lower rail at the front of the stall. As a

Figure 1. A cow thrusts her head forward as she lunges during rising.

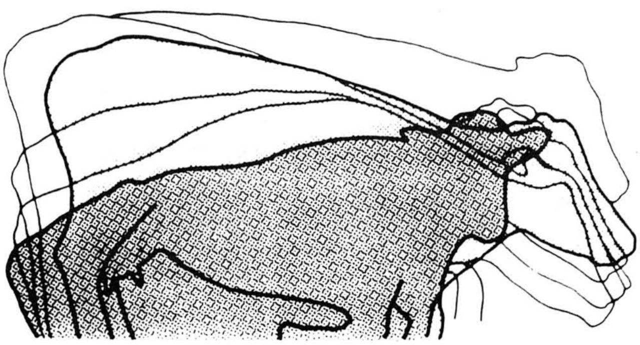
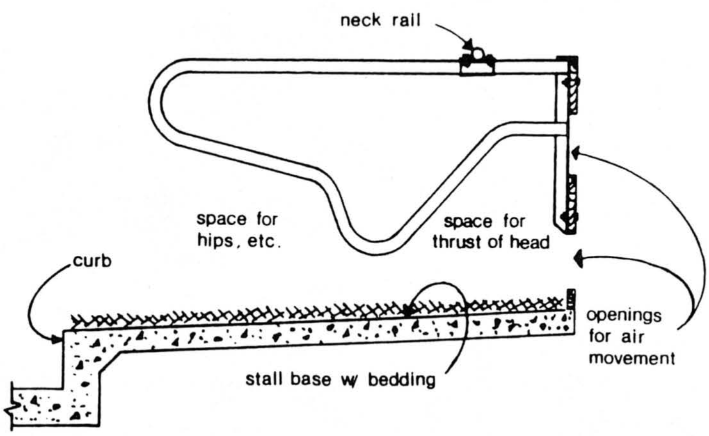


Figure 2. An improved free stall partition.



cow begins to rise, she uses this space as she lunges forward, turning and thrusting her head into the next stall space. The lower rail is also higher at the rear to reduce potential injuries to hips and legs. Reduced stall maintenance is an added benefit as a result of the cow having less interaction with the stall partition.

The stall is supported at the front and has a neck rail which, for typical dairy cows, is positioned 40 inches above the stall base at the front and 18 inches from the stall front for a stall that is seven feet long.

If cows don't use free stalls, there's usually a reason related to stall design, construction or maintenance. Partition design affects the cow's ability to lie and rise and the occurrence of injuries, as has been discussed. Stall length, stall width and the condition of the stall bed are important also.

Stall fronts and partitions should be open sufficiently to allow ventilating air to move through the stall space. Good bedding is always essential, not only to improve comfort but to absorb moisture accumulating on the stall surface as well.

Proper free stall management includes daily inspection and removal of wet bedding and manure, in addition to periodic additions of dry bedding. If free stalls are neglected and contain excessive moisture or accumulations of manure, bacterial populations may exceed critical values, markedly increasing infection rate of the udder.

Ventilation

Ventilation of livestock facilities is essential to maintaining a proper environment for the animals being housed. A complete discussion of environment would include a multitude of related factors that affect animals and their growths; emphasis here is on the need for ventilation as related to the thermal environment, air quality and moisture control. Of course, providing a proper environment is only one component of a successful animal rearing program.

Providing the proper environment for an animal amounts to furnishing conditions that enhance the animal's inherent ability to achieve thermoregulation and using ventilation to provide moisture control and to maintain suitable air quality. Basically, the aim is dry, relatively draft-free surroundings, especially in winter, with increased ventilation for warmer weather. Any attempt to house animals in an enclosed building with inadequate ventilation will result in excessively high humidities that complicate problems of air quality, disease transmission, and condensation; the net result will be generally unhealthy conditions.

Ventilation of livestock buildings in winter is mainly for moisture control; the primary source of moisture being the animals themselves. In summer, temperature control is of principal concern.

From the standpoint of providing for the needs of animals, problems with respect to ventilation usually originate because needs of people and equipment have been placed ahead of the needs of animals. Or, relationships between the needs of animals and the environment are not well understood.

In the first instance, problems are most evident in the winter when cold temperatures contribute to malfunctions of equipment such as mechanical bunk feeders. Or, freezing conditions cause difficulty with scraping manure. To alleviate one or more of these problems, a free stall barn, designed as a cold-enclosed, naturally-ventilated building, may have ventilation openings blocked for the purpose of increasing inside temperatures. Excessively high relative humidities are the usual result of this effort to defeat the function of the ventilation system. On the other hand, dairy animals do well if provided with properly ventilated cold barns and are kept dry and properly fed. Proper equipment selection and management can miminize the inconveniences associated with freezing weather.

In the summer, dairy cows housed in free stall barns show substantial drops in milk production during periods of hot weather. These losses may be expected to increase as even higher milk yields stress animals further. Many farmers accept the lost revenue due to this decreased production as inevitable. But this loss in milk production can be minimized through full wall ventilation, a practice which, in fact, also reduces the cost of new construction.

Cold Housing with Natural Ventilation:

Natural ventilation occurs as air pressure gradients induced by wind forces and density gradients induced by thermal forces produce flow of air through a building. Generally, thermal forces are relied upon for moisture control in winter, wind forces for temperature control in summer.

Temperatures in a cold barn can be expected to be a few degrees warmer than outside air temperature due to the heat being given off by the animals being housed. This warmed air tends to rise. To take advantage of this thermal buoyancy and its ability to move air for ventilation purposes, the ridge and the eaves of the building are left open. The air in the barn, having been heated slightly by the animals, rises, picking up moisture along the way, and leaves the barn through the open ridge. In the process, outside air is drawn in through the open eaves to replace it. This air exchange process is referred to as the stack effect and is the predominant means of providing moisture control in cold enclosed, naturally-ventilated barns.

Provide a ridge opening of 2 inches for every 10 feet of building width; e.g., a 12 inch opening for a building 60 feet wide. This open ridge acts as the air outlet for ventilation due to the stack effect. The eave openings, the air inlets, should provide an overall open area equivalent to that of the open ridge.

Ventilation and moisture problems in cold housing occur primarily because of inadequate openings. Natural ventilation requires openings in the building. The fact that rain and snow may enter these essential openings may lead producers to ignore ventilation needs and close existing openings or to provide inadequate openings in the first place.

Since ventilation in winter is primarily for moisture control, the most obvious indicator of inadequate ventilation is a severe moisture buildup including condensation on the roof and walls. Excessive odors and animal respiratory illness may also result. Due to excessively high relative humidity, the interior of the barn may, in fact feel cold upon entering, in spite of the fact that the inside temperature may be only slightly higher than it should be. Obviously, such a cold, damp condition is to be avoided.

Ventilation should be sufficient to keep inside temperature within 10-15°F of outside temperature in the winter. If this is not the case, check for recommended ridge and eave openings. Make sure that nothing is interfering with the stack effect which is the force for natural ventilation in the winter. A winter ventilation problem can usually be corrected by increasing openings to increase ventilation rates, possibly even taking advantage of winds by opening windows and doors. In any event, install a thermometer in the barn to make sure inside temperatures stay within the acceptable limit given above.

For buildings constructed with an open peak, remove the ridge cap. If the resultant opening is too small, follow the procedure shown in Figure 3 to realize the necessary size.

Figure 3a. A building peak with ridge cap.

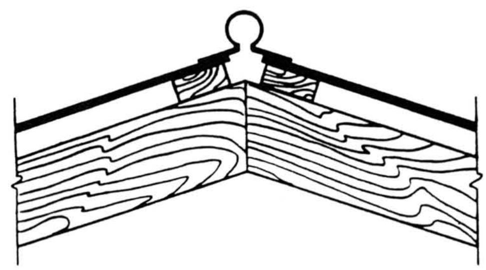


Figure 3b. The ridge is being opened by removing the cap and some roofing.

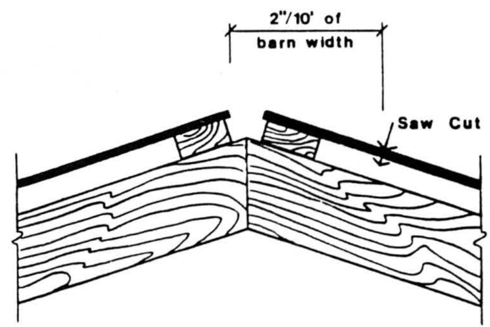
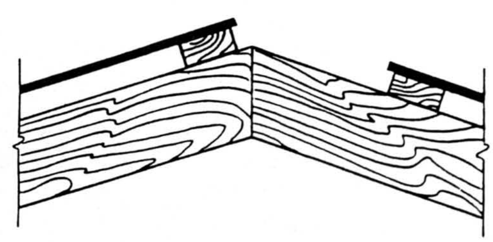


Figure 3c. The exposed purlin has been moved down under the new edge and nailed in place.



Summer ventilation depends on the wind, the main factors affecting ventilation rates due to wind being wind speed, wind direction, area of building openings and local obstructions (hills, vegetation, nearby buildings). To maximize inlet and outlet openings and to site buildings for maximum exposure to existing winds is to maximize air exchange rates due to wind forces.

Current recommendations for constructing naturally-ventilated dairy barns and other livestock buildings for summer ventilation call for large openings, typically 1/2 or more of the sidewall, in both sides of the building. Site selection is deemed important with recommendations calling for situating naturally-ventilated buildings on high ground for better wind exposure and away from other structures or trees.

Far too many naturally-ventilated barns do not meet current recommendations for warm weather ventlitation, not only older facilities but many just completed as well. Even those buildings where recommendations are followed have unnecessarily warm environments in summer. For example, in dairy free stall barns, substantial drops in milk production are noted during periods of hot weather, especially with high producing cows. These losses may be expected to increase as even higher milk yields stress animals further.

Dairy farmers, faced with diminishing profit margins, can no longer accept lost revenue due to decreased milk production in hot weather as inevitable. On the other hand, making a cost benefit analysis, in the usual sense, is difficult since, although the adverse effect of hot weather on milk production is well-known, actual relationships have not been well documented. Instances of cows losing 5 to 12 pounds milk production on days when temperatures exceed 86°F are not uncommon. This loss in production often continues even after the hot period has passed.

Full wall ventilation for naturally-ventilated barns in summer (Figure 4) reduces the potential for heat stress in animals, especially during periods of little wind. Basically, this means having a barn with no sidewall cladding to better utilize winds to improve warm weather environments. Obviously, some sort of cover is essential to accommodate seasonal changes in weather. However, automatic control or even frequent manual adjustment of air inlets is considered unnecessary. The dairy cow can tolerate usual diurnal fluctuations in environment and even fluctuations during the season, especially in summer.

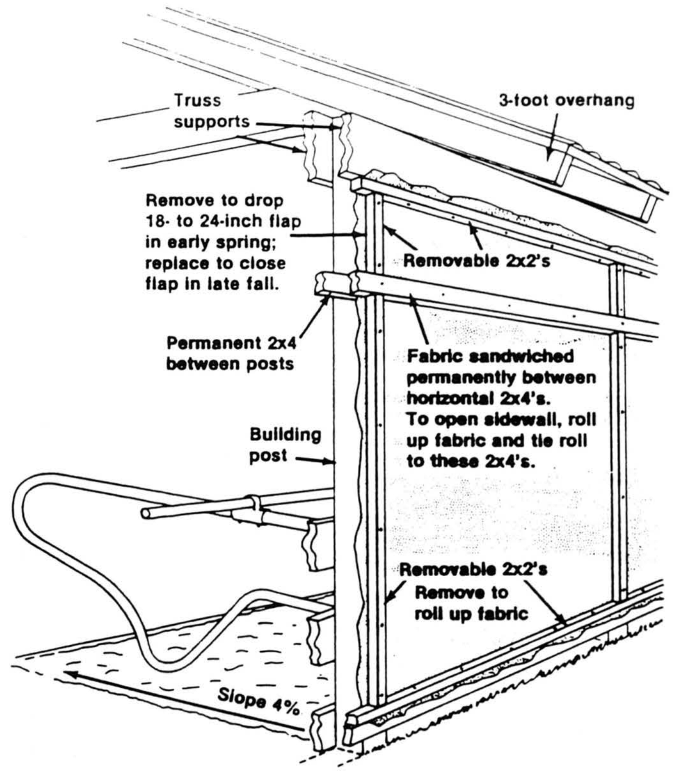
For existing barns, accomplishing full wall ventilation involves removing existing sidewall cladding and other impediments to air movement in the sidewall. In other words, view the barn as a sun shade for summer and open the sidewalls as completely as possible. In new construction, simply stop short of installing a permanent sidewall covering.

Various materials and methods can be used to cover sidewalls for colder weather. But the simplest and cheapest method uses a fabric covering over the full sidewall. For summer, the fabric is manually rolled up as a rug and tied at every post. To close the sidewall, ties are released and the hanging curtain is then fastened in place using a vertical nailing strip at each post and horizontal nailing strips all along the bottom.

Mechanical Ventilation:

Mechanical ventilation systems are usually associated with warm housing where it is desired to maintain a relatively uniform environment throughout the winter. A warm barn is kept at a predetermined temperature in winter by good construction, careful control of the ventilating system and supplemental heat as needed. Such a barn is well insulated and is usually mechanically ventilated. Examples are tie-stall dairy barns and swine farrowing and nursery buildings.

Figure 4. Full wall ventilation; open in summer, covered with fabric or other material in winter.



Three levels of ventilation must be provided to accommodate seasonal changes; three fans can achieve this. The first fan provides a minimum continuous rate to assure that moisture removal takes place even under the coldest conditions. As the weather warms, the outside air picks up less moisture as it moves through the building; more air therefore must be moved to keep the relative humidity down to an acceptable level. The second fan serves this purpose. The third fan is primarily for additional summer ventilation.

Feed Barriers and Mangers

A feed barrier is the divider between the animal and the feed in a manger setting. The primary purpose of this barrier is to restrain the animal while feeding.

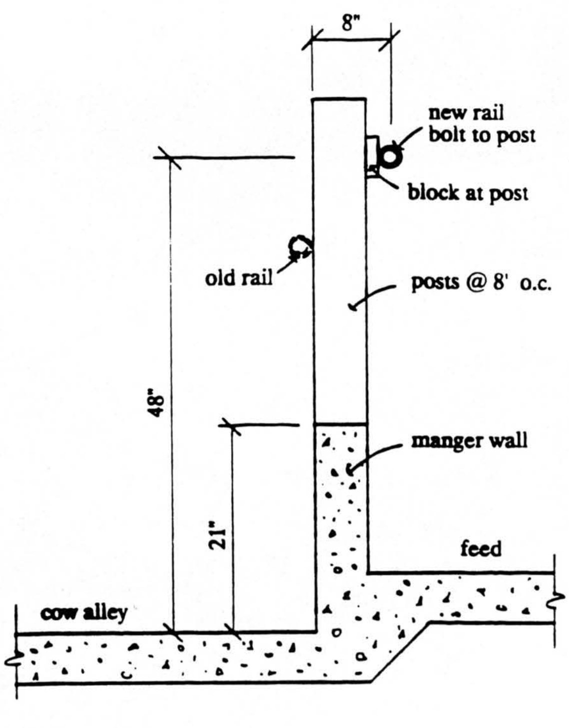
A post and rail barrier is usually used for fence-line feeding, as in a drive-through free stall barn. The animal reaches over a short concrete wall for feed which has been placed on a surface elevated slightly above the floor upon which the animal is standing. The rail, which defines the upper limit of this space, is made up of cable, pipe, or plank and is usually situated directly above the short wall or slightly toward the cow. This design does restrain the animal. But, in doing so, it may unnecessarily restrict the reach of the feeding animal and result in the animal exerting excessive force against the barrier.

Only a slight modification of this design, based on work by Dumelow et al. (1988), greatly improves the feeding situation for the animal (Figure 5). The rail is moved from its usual position upward and away from the animal. This modification, adaptable to existing post and rail installations as well as new construction, allows the animal to reach further while exerting less force on the barrier.

The feed surface may be elevated 2-6 inches above the cow alley in the fenceline barrier in Figure 5. Minimizing this elevation maximizes the height of the manger wall against which the cows' ration is piled. This maximizes the amount of material that can be deposited in a given feeding. Also, as discussed by Albright (1983), cows prefer mangers that offer the opportunity to eat in this natural grazing-like position as compared to eating from elevated bunks. Furthermore, behavorial activities contributing to feed wastage, such as rooting feed out of shallow, elevated bunks and feed tossing are virtually eliminated.

Eating surfaces must be smooth, clean and free from leftover feed and other debris in order to encourage feed intake and aid in the control of disease. In new construction, use high-strength concrete to prolong the condition of the manger surface used for feeding silages and other feed which tend to etch the concrete. Or, line the manger with a resistant material such as ceramic tile. Inspect existing manger surfaces for etched conditions and exposed aggregate or worn and splintered wood and take measures to correct these conditions if they exist.

Figure 5. A post and rail feeding barrier.



Waterers

Recommendations for waterers, including location, size, height and number, seem to have evolved over the course of time. When considering that water is an essential nutritional ingredient and that nutrition is of utmost concern with respect ot satisfying the needs of the high-producing cow, it is surprising that more research-based design data are not available and even more amazing that design guidelines for watering systems for cows rarely, if ever, include even a mention of the necessary water supply rate based on the drinking rate of a cow.

Nonetheless, minimum design guidelines at this time seem to be to provide at least one watering space or two feet of tank perimeter for every 15-20 cows. At least two waterer locations are needed for each group of cows. Provide more space and more locations if two-year-olds are housed with older cows. Limit water depth to 6-8 inches for fresher water and less debris accummulation.

Access to adequate fresh water becomes even more important in summer as consumption per cow increases. Consider locating extra water tanks in the barn for use during hot weather. In fact, design space for such tanks in new barns. Heaters will not be required as these tanks will be removed for cold weather.

Floors

Concrete floors must have adequate texture for good footing. Not only does a properly textured floor help eliminate injuries that may result from cows slipping and falling, but the improved footing has other benefits as well. Cows having sure footing are more likely to go to feed and water and to seek out free stalls for lying down. Also heat detection will be improved.

The exact form of the textured surface for best footing has not been established. However, it appears desirable that the cow's hoof contact some part of the groove or other pattern each time it is set down. The texture very likely serves to interrupt an impending skid.

In new construction, grooves or other patterns should be cut or floated into fresh concrete. Existing floors which have been worn smooth should be grooved or otherwise roughened to reduce slipping. With saw cutting, aim for grooves cut 1/2 to 3/4 inch wide, 3/4 inch deep and 3-1/2 to 4 inches on center. An alternate treatment is done with a machine called a scabbler. A series of hammers pound the surface, providing a roughened effect. More than likely, sawed grooves are a more long-term soution than the shallower treatment of the scabbler.

Summary

Design of cost efficient livestock facilities must take into account the needs of the people who will be using these facilities and their ability to implement management programs. As well, the design of these facilities must meet the needs of the animals being housed in order to maximize productivity, health and welfare. Sometimes, providing for these needs may add to the cost of the facility with no prospect of increased return. Or, provisions may be an improvement for the animal but may not cost more than the the usual way of doing things; e.g., free stall partitions that allow the cow to rise easily usually cost no more than more conventional loop-style partitions. In certain cases, making things better for the animal may, in fact, increase returns, not only through increased productivity, but decreased cost as well. For example, barns designed for full wall ventilation can be built at less cost than conventional designs. Moreover, full wall ventilation minimizes the slump in milk production typically associated with hot weather. Existing design guidelines must be continually reevaluated and updated as we learn more about the relationships between facilities and the animals that use them.

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