Opportunities for Improved Cow Comfort through Freestall Barn Renovations

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The environment in which lactating dairy cows spend the majority of their time has considerable influence on productivity, health, milk quality, reproduction, animal well-being, and farm profitability. When discussing this environment, we often talk about maximizing cow comfort. Cow comfort generally refers to minimizing animal stress in efforts to maximize milk production and animal well-being. Many dairy producers provide shelter for dairy animals within a freestall barn. A properly managed and designed freestall barn can support high levels of milk production and animal well-being. On the other hand, mismanaged or poorly designed freestalls can contribute to mastitis, lameness, hock abrasions, and injuries. Through years of experience observing and studying cow behavior in freestall barns, farmers, researchers, and engineers have refined recommendations for freestall design and management. Additionally, as cow size has increased so has the amount of resting space required within a freestall, effectively changing the recommendations for freestall dimensions. Today's freestall barns provide a more desirable environment for dairy cows than those that were constructed 20, 30, or 40 years ago. Dairy producers still housing their cows in these older facilities could observe dramatic improvements in cow comfort by making some minor, relatively simple changes to existing freestalls. The economic assessment renovations in facilities is difficult because of wide variation in herd responses to modifications. However, the potential economic impacts of increased production, reduced lameness, improved milk quality, reduce culling rates, and increased longevity are immense. Further, just as important, as public concern for animal well-being increases, freestall barn renovations may help minimize the impact of future concerns, policies, or third-party audit programs.

Freestalls and Lying Behavior

The purpose of a freestall is to provide a cow with a comfortable, clean, dry resting area. A good freestall allows the cow to enter and exit the stall with a natural reclining, resting, and rising motion without striking the stall structure. These freestalls present minimal opportunity for injury, pain or frustration. Some freestall design considerations involve trade-offs between optimal stall usage and cow cleanliness. Providing the largest cows in the herd with maximum resting space may mean that even slightly smaller cows may have more opportunity to soil the rear of the stall with manure and urine. For example, research has shown that cows spend more time lying in wider freestalls; however, these same stalls were not as clean as the narrower stalls. Thus, the maintenance requirements for stalls that provide better conditions for cows to lie may increase.

Lying behavior plays a critical role in the production, profitability, and well-being of dairy cattle. The amount of time a cow spends lying is influenced by many factors including facilities, management, and the physiological status (i.e. days in milk, milk yield, pregnancy status) of the animal. Grant (2007) proposed that the requirement for lying may be as high as 14 hours per day, based upon lying behavior observed in high producing cows. Production benefits of increased lying time have been reported to be as much as 2.0-3.5 lbs of milk per day for each extra hour of lying time (Grant, 2007). Increasing lying time may increase rumination, improve immune status, increase blood flow to the mammary system, reduce stress on the hoof, and

reduce the incidence of lameness in a herd. Research has demonstrated that depriving cows of adequate lying time may result in physiological and behavioral stress, increased lameness, altered feeding behavior, and reduced milk yield. Cows strive to attain a fixed amount of lying time even at the expense of feeding time. Lying time has higher priority than eating time and social contact in both early and late lactation cows (Munksgaard et al., 2005). In managing dairy cows, we need to do everything we can to ensure that cows have the opportunity to fulfill their lying time requirements. Additionally, a good freestall helps keep the cow clean and minimizes the chances of injury to the cow while moving in and out of the stall.

Behavior Observations

Often, dairy producers wonder why their cows do not spend as much time lying in their freestalls as they should. This situation is particularly problematic when cows choose to lie in manure-covered alleys rather than in the freestalls (Figure 1). The most effective way to determine if your freestall barn is meeting your cows' needs is to simply watch the cows. In comfortable, well-designed freestalls, cows will spend most of their time lying or standing straight (parallel to the length of the stall) in the stall (Figure 2). Approximately 2 hours after milking, about 90% of the stalls should be occupied (McFarland, 2007). Continuous monitoring of stall use and cow behavior while getting into and out of stalls is essential for assessing cow comfort. By understanding what behaviors to look for, you can learn what minor adjustments need to be made to the standard recommendations to best fit the needs of your cows in your facilities.

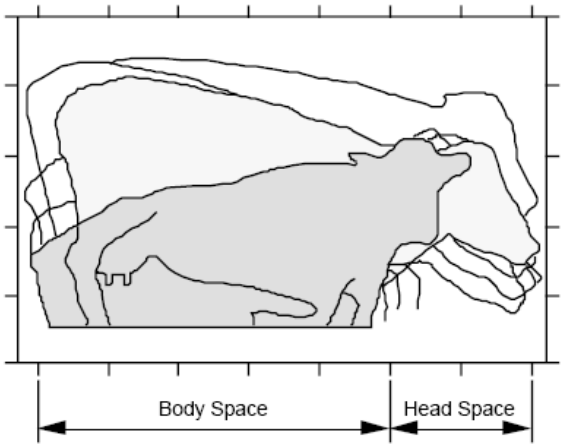
Watch the cows as they lie in the stalls. Think about how a cow gets up when she is on pasture (Figure 3). Their behavior in freestalls should be similar to this.Typically, a cow will first shift to move her front knees beneath her body. Then, she lunges her head forward transferring weight to the front of her body which also allows her rear end to be easily lifted. Next, she shifts weight to one knee and straightens the other front leg with the foot in front of the shoulder. Finally, she shifts her weight to the straightened leg pushing up and straightening the other front leg to finalize her standing position (McFarland, 2003).

Do the cows enter the stalls with ease and with minimal hesitation? Do they come into contact with any part of the stall while lying down? Watch cows as they rise from a resting position. Do they come into contact with any part of the stall while getting up? Is there adequate lunge space for their heads as they rise? Do you see any potential for injury as the cows get into and out of stalls? Do cows spend considerable time standing in the stall, showing hesitation, before lying down in the stall? Do they push their nose or mouth against pipes or stall structures? Do cows stand in the freestall, swinging their heads to the left and right? This behavior has been termed "the hesitation waltz" (Anderson, 2008a). Once cows are lying, do they appear calm or restless? Restlessness, or frequent changing of positions while lying, may be another sign of potential cow comfort shortcomings (Anderson, 2008a). Finally, spend some time looking at the cows focusing on the hocks, knees, and rumps. Do you see any evidence of injury, abrasions, abscesses, bumps, or bruises that may have resulted from getting into and out of the freestalls? If you stand in front of the stall and drop to your knees, is it a painful process? If so, how do you think this "knee test" reflects the cow's experience in using the stall? All of these observations may indicate potential improvements can be made through freestall modifications.

Figure 1. When a high proportion of cows choose to lie in the freestall alleys rather than in the stalls, this may be an indication that the freestalls do not provide a comfortable resting area.

Figure 2. In well-designed and well-maintained freestalls, most cows will be observed resting comfortably or standing straight in the stall. In both positions, cows should be located parallel to the length of the stall.

Figure 3. A diagram depicting the normal rising motion of a dairy cow (Irish and Merrill, 1986).



Selecting the Right Stall Dimensions

Once you have observed the cows, use a tape measure to assess the dimensions of your existing stalls. Be sure to collect measurements for all types of stalls in your barns. For example, the dimensions may be different for stalls on the outside walls or if a different type of loop is used in one row versus the others. Once you have collected this information, compare your dimensions to the recommendations listed below (Table 1). Select freestall dimensions for the largest cows in your herd. Varying cow sizes within a herd should lead to varying stall sizes. A one-size-fits-all approach to freestall design is not conducive to optimal cow comfort. When possible, first lactation cows should be provided a separate pen with smaller freestalls to accommodate their smaller frame size.

Table 1. Recommended freestall dimensions by cow size (Graves et al., 2005, Cow Freestall (Cubicle) Types and Details).

Animal Weight (lbs)	Total Stall Length Closed Front (in)	Total Stall Length Open Front (in)	Length to Brisket Tube or Board (in)	Length to Neck Rail (in)	Stall Width Center to Center (in)	Height to Top of Partition (in)	Height to Neck Rail (in)	Brisket Board or Tube Height (in)
900-1100	90-96	78-82	64-66	62-64	41-43	42-44	42-44	4-6
1100-1300	96-102	80-86	66-68	64-66	43-45	44-46	44-46	4-6
1300-1500	102-108	90-96	68-70	66-68	45-48	46-48	46-48	4-6
1500-1700	108-114	96-102	70-72	68-70	48-52	48-52	48-52	4-6

Renovating a freestall barn. Before renovating a freestall barn, it is important to first determine whether observed cow comfort or cleanliness problems are the result of ineffective maintenance rather than actual design problems. Spending time grooming and cleaning freestalls can have a dramatic impact on cow cleanliness (Figures 4-5). Often, the first step to renovating a freestall barn is to fix what is broken in the existing freestall barn. All too often cow comfort is compromised by broken or detached freestall dividers and stall structures (Figure 6). Not only can these stalls lead to sub-optimal stall use but they also can result in serious injuries. Reattaching or repairing stall dividers and structures is a simple step toward improving cow comfort. Sometimes, the best idea is to replace the existing stall dividers with new or slightly used stall dividers that may be more conducive to increased stall use. It is important to recognize that optimal stall use and lying behavior are the result of a combination of factors. Changing one factor may not necessarily remedy the situation immediately. Some trial and error may be needed during the renovation process. One should not expect to see immediate results and improvements. It may take time for cows to adjust to the redesigned freestalls and old problems (lameness, hock injuries, etc.) will not disappear overnight. When renovation is not a viable option, it may be best to tear down the existing barn and start over with a new one. When renovation is a viable option, here are some cow comfort bottlenecks that you may find in your facility. In addition, a description of the desired situation and potential solutions for fixing the problems are outlined.

Figure 4. Frequent, scheduled stall grooming can have a dramatic impact on stall usage and cow cleanliness.

Figure 5. Cow cleanliness problems can often be attributed to infrequent or inadequate removal of manure and urine from freestall alleys.

Figure 6. Detached or broken stall dividers or structures can lead to poor stall usage, dirty cows, or cow injury and entrapment.

Poor or Inadequate Resting Surface

Identifying the Problem. When cows are not provided with a comfortable place to rest, they will not utilize or occupy the stalls well. Hock injuries are commonly observed in situations where cows are forced to lie on a hard surface or when insufficient bedding is provided (Figure 7). Of course, the worst scenario is when cows are lying on concrete without any bedding. Bedding helps to minimize friction between the hock and the stall surface. In deep-bedded stalls, cows may dig out the bedding and effectively reduce their resting area if bedding is not replaced (Figure 8). This situation may also increase the effective height of the brisket board and stall dividers. In turn, cows may have difficulty getting in and out of the stall. Moreover, the potential for abrasions between the now-protruding rear curb and the cows' hocks can lead to severe hock abrasions and ulcers. When mattress or mats are used, inadequate bedding may also lead to hock injuries and poor stall use. This problem is worsened when the mattress cushions have lost their flexibility and are utilized past their useful life.

Understanding the Desired Situation. Providing a comfortable, soft surface cushion may be the most important factor affecting stall usage and lying time. An ideal stall bed conforms to the cow's shape, provides cushion while the cow is getting up and lying down, maintains effective traction to minimize slipping, and remains dry to minimize bacterial growth and promote optimal udder health. Many different combinations of stall bases and bedding types can be effective; however, sand bedding generally best meets the cows' needs. Stall usage and lying time tends to be higher for sand bedded freestalls than for mattress freestalls (Cook, 2006). Keeping sand filled to the top of the curb increases stall use. In one study, daily lying time was 1.15 hours longer when sand stalls were filled to the top of the curb compared to stalls with sand levels 2.44" below the curb (Drissler et al., 2005). Although mattresses, waterbeds, and mats may reduce the amount of bedding needed, bedding still must be used to minimize friction while the cow rises from the stall and to absorb moisture (Figure 9). In a British Columbia study, cows spent 1.5 hours more lying down in mattress freestalls bedded with 16.5 pounds of sawdust than those with no sawdust (Tucker and Weary, 2004). Thus, lying time can be improved considerably by providing cows with more bedding (Figure 10).

Selecting and Implementing a Solution. The solution to this problem may often be as simple as using more bedding. This is particularly true for sand. Sand provides such a good resting material for cows that it will often mask other freestall design limitations. Hard or worn-out surfaces may need to be replaced with deep-bedded sand or new mattresses (Figure 11). When adding a mattress on top of concrete, caution must be used to be sure that the height for the cows stepping into the stalls does not exceed 8 to 10." In a deep-bedded scenario without a mattress or mat, a minimum of 6" of bedding material is required. When mattresses or mats are used, at least 3" of bedding must be added to the top of the stall base. Freestalls should be groomed, removing manure and wet areas 2 to 3 times per day. Deep-bedded stalls should be leveled at least twice per week. Bedding should be added at least once per week and possibly once per day depending on the type of bedding used, environmental conditions, and observations of cow cleanliness. Bedding savers may be used to minimize bedding waste.

Figure 7. When cows do not have an adequate resting surface or when bedding levels are insufficient, the resulting friction that occurs as the hocks rub against rough surfaces may result in hock abrasions and injuries.

Figure 8. Over time, cows will pull sand out of stalls. This sand must be replaced frequently to maintain a comfortable resting area.

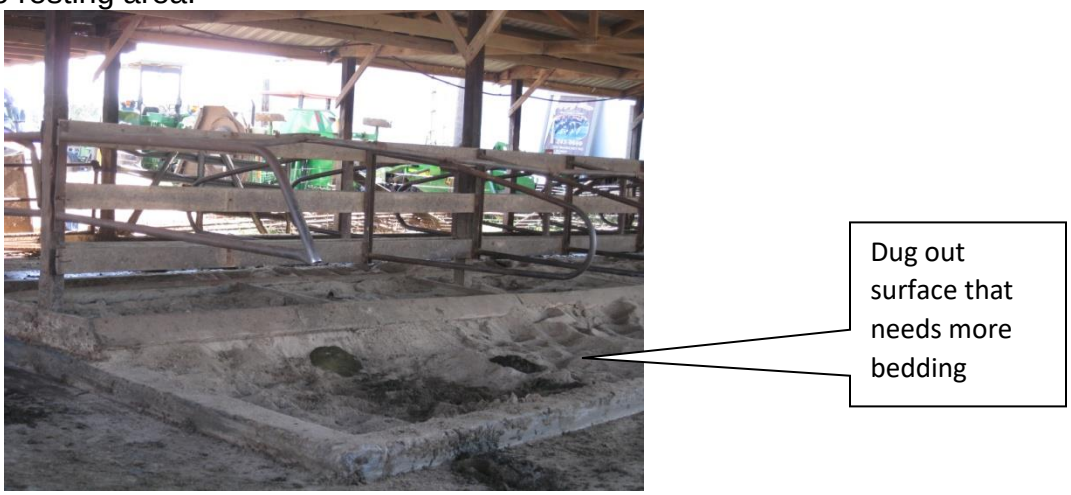


Figure 9. Although mattresses provide cushion for cows, adding bedding on top of the stalls is still essential.

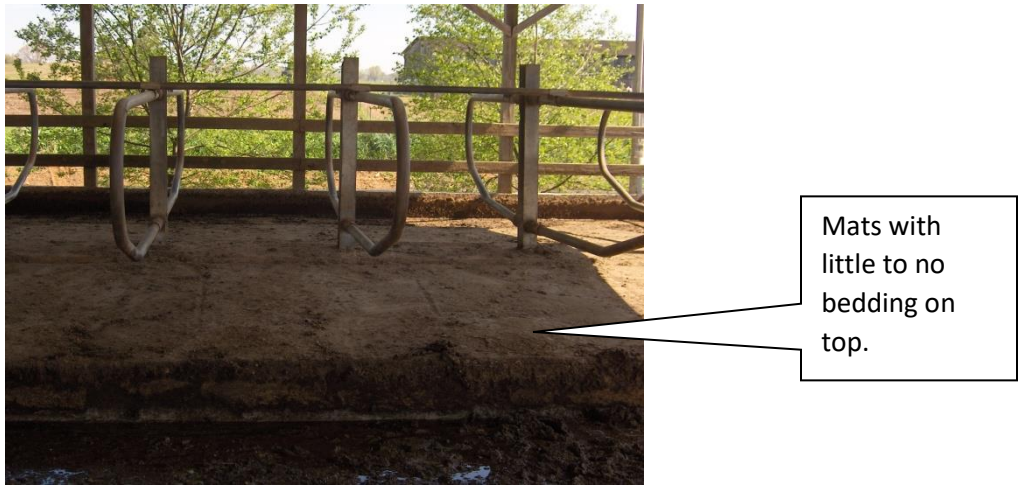
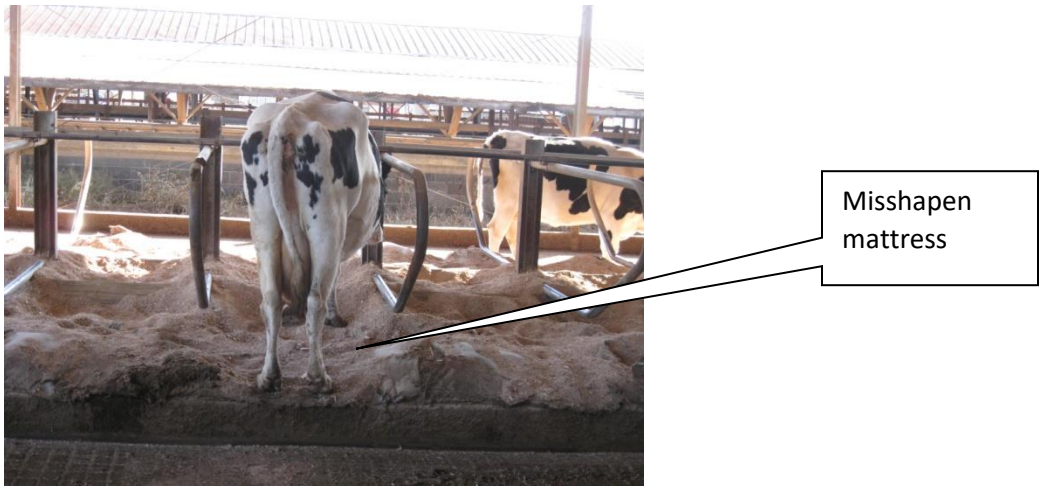


Figure 10. Deep bedding minimizes potential for hock injuries, improves stall usage, and increases lying times.

Figure 11. Over time, mattresses may become misshaped or damaged and may need to be replaced.



Inadequate Forward Lunge Space

Identifying the Problem. Forward lunge space is often blocked by walls or boards directly in front of the cows' heads (Figure 12). Generally, cows prefer to lunge forward when rising from a resting position. Thus, when obstructions are placed in front of the cows, there is no room for their heads to go in this natural rising motion. When cows do not have the ability to lunge forward, they may have difficulty rising from stalls. They may even become trapped against the wall while rising from the stall. Standing or lying diagonally in the stalls may also be a sign of cows searching for a way to preserve forward lunge space. Dog-sitting, where cows sit like dogs with weight placed on the rear end of their body and their front legs extended may indicate a lack of lunge space (Figure 13). Stalls that lack adequate lunge space are also characterized by overall poor stall usage and may contribute to perching (standing with front legs in the stall and rear legs in the alley).

Understanding the Desired Situation. Stalls must be long enough to allow cows to lunge forward when rising from the stall. Cows prefer to lunge forward rather than lunge to the side. To provide the cow with adequate forward lunge space, give 30 to 44" of space ahead of

where their front knee is positioned while resting. Thus, closed front stalls (such as stalls that face an outside wall) should be at least 1 foot longer than open front stalls to preserve this lunge space .

Selecting and Implementing a Solution. The key to solving this problem is to remove the lunging obstacles (Figure 14). For head-to-head stalls or inside stalls, remove walls and boards that may impede lunging leaving at least 6” above the stall surface and 32” of vertical clearance. Depending on how the stall dividers are attached to the support structure, removing these obstacles may require moving posts or modifying where the stall dividers are attached. If the stalls are located on an outside wall, building a sloping adjustable sidewall curtain support along the outside wall will give the cows ample opportunity to lunge forward while still protecting cows from adverse weather (McFarland, 2007). Another possible solution would be to use a stall divider that allows for side-lunging into the adjacent stall. In this case, the lower rail should be no higher than 11 inches above the stall surface and the upper rail should be no lower than 40 inches. Avoid piling bedding in front of the stall as this can unintentionally block lunge space. Some producers express concern that with open-front, head-to-head stalls, cows may attempt to go through the section between the stalls into the facing stall. This situation can lead to injury or cows restrained between the stalls. To remedy this problem, a deterrent bar, rope or strap may be placed 40 to 42" above the stall surface in 16 foot stalls (2 rows of head-to-head 8 foot stalls) or 34 to 36" above the stall surface in 18 foot stalls (2 rows of head-to-head 9 foot stalls). This deterrent may be wood, metal, galvanized pipe, nylon strapping, or rope (Anderson, 2008b).

Figure 12. Forward lunge space is often blocked by walls or boards placed in front of the cows’ resting space.

Figure 13. Dog-sitting may indicate a lack of lunge space or other freestall design problems.

Figure 14. Lunge space can be preserved by keeping the area in front of the cows' heads free of obstructions.

Improperly Placed Neck Rail

Identifying the Problem. One way we can evaluate neck rail placement is by observing cows for perching behavior. "Perching" refers to the behavior when cows stand with their front feet in the stall and their rear feet in the alley behind the stall (Figure 15). Generally, this behavior indicates improper neck rail placement. When the neck rail is too low, cows will sometimes stand with their head above the neck rail. If the bottom side of the neck rail has a polished appearance, the cows are likely hitting their neck against the neck rail when rising from the stall. If neck rails are too low, cows may also be hesitant to enter the stalls and have difficulty standing up. When the neck rail is too close to the rear of the stall, cows may lie diagonally rather than parallel to the length of the stall. If cows do not have enough space to lie down because the neck rail is too far back, hock injuries may be observed. If the neck rail is placed too far forward, lunge space will be limited and cows may become trapped while rising from the stall. Additionally, excessive manure and soil may be deposited in the rear of the stall. Early freestall designs recommended a much shorter neck rail height than we recommend today; however, experience and research have shown that these older recommendations were incorrect.

Understanding the Desired Situation. The neck rail helps position the cow when she enters the stall or when she is standing in the stall before or after standing up. Additionally, the neck rail helps encourage cows to preserve lunge space. When the neck rail is in the proper position, cows will stand with all four feet placed squarely within the stall, level backs, and the top of their necks gently touching the neck rail (Figure 16). The neck rail is typically a few inches lower and forward from the cow's withers. Wisconsin researchers (Fulwider and Palmer, 2005) demonstrated that the percentage of stalls with cows lying in mattress based freestalls was significantly higher with a 50 inch neck rail (51.4%) when compared to stalls with a 45 inch neck rail (40.0%). In one study, cows spent less time perching when the neck rail was further from the rear curb but cows were more likely to defecate in these stalls and had dirtier udders (Fregonesi et al., 2009). Cows showed significantly more evidence of lameness when the neck rail was positioned closer to the rear curb in a British Columbia study (Bernardi et al., 2009). For large-frame dairy cattle, the distance between the top of the stall bed (including bedding) and the bottom of the neck rail (also referred to as neck rail height) should be 48 to 52 inches. The horizontal distance from the alley side of the rear curb to the neck rail (also referred to as neck rail length) should be 68 to 70 inches.

Selecting and Implementing a Solution. In many situations, the neck rail can be moved without any major modifications. Increasing or decreasing the neck rail length generally involves unbolting the neck rail and moving it forward or backward along the stall divider to the desired length. Increasing the neck rail height may be a bit more challenging. Dairy producers should use their engineering ingenuity to determine the best modification for their facility. Wood blocks, box steel, welded pipe fixtures (Figure 17) and clamps are examples of strategies used to raise neck rail height (McFarland, 2007). In some situations, it may be possible to move the entire stall divider up though caution must be used to make sure that the distance between the divider and the stall base does not leave opportunity for cows to become lodged beneath the stall divider. The lower rail should be no higher than 11 inches above the stall surface and the upper rail should be no lower than 40 inches.

Figure 15. Examples of "perching" with cows standing half in and half out of stalls. Perching may indicate that the neck rail should be moved.

Figure 16. Examples of freestalls with proper neck rail placement. Notice that most cows are standing with their four feet squarely placed in the freestall.

Figure 17. An example of a welded pipe fixture used to raise the height of a neck rail.

Undesirable Curb Height

Identifying the Problem. If the curb height is too high, cows may be reluctant to use the stalls or hesitant and uneasy when exiting the stalls. This problem may be more evident in lame cows than in non-lame cows. With high curb heights, some cows may drag their teats and udders on the curb or bed when entering the stall. If the curb height is too low, manure from the alley may be pushed into the stalls while scraping or tracked into the stall by cows upon entry. Additionally, cows may back into stalls and lie facing outward.

Understanding the Desired Situation. The primary purpose of the curb is to keep manure from the alley from entering the back of the stall. When a cow places her rear leg on the concrete alley behind the stall, a tremendous amount of weight must be supported by that leg. Thus, the curb height plays a critical role in minimizing this stressful process. The ideal curb height is 8" though curb heights up to 12" may be tolerated.

Selecting and Implementing a Solution. When the curb height is too high, efforts to reduce the curb height through concrete removal may prove labor intensive and expensive. In some cases, it may be more feasible to raise the alley height. When the curb height is too low, additional concrete may be added to the curb. Alternatively, adding a mattress or bedding saver may effectively increase the curb height.

Narrow Stalls

Identifying the Problem. When cows invade the space of other cows in adjacent stalls or prevent the use of the adjacent stall because they are taking up part of the stall, stalls are likely too narrow. Stalls that are too narrow are often characterized by excessive body contact with the stall divider while lying down and rising from the stall (Figure 18). Cows may also not use stalls well and they may lie diagonally.

Understanding the Desired Situation. The stall divider helps position the cow in the stall and encourages cows to lie parallel to each other and to the length of the stall. British Columbia researchers found that cows in 52 inch wide freestalls spent 42 more minutes per day lying down than cows in 44 inch wide freestalls (Tucker et al., 2004). In this same study, cows spent more time perching in the narrowest freestalls. The wider stalls tended to be dirtier than the narrower stalls.

Selecting and Implementing a Solution. Increase the width of the stalls to accommodate your largest cows. Unfortunately, depending on how the stall dividers are attached to support posts, this modification may entail considerable effort and structural modifications to achieve. Additionally, this may reduce the total number of stalls in a barn.

Figure 18. When stalls are too narrow, cows may lie diagonally or come into direct contact with the stall dividers or structures while resting.

Brisket Locator/Board Position and Size

Identifying the Problem. When the brisket board is placed too close to the curb, diagonal resting may occur. If cows do not have enough space to lie down because the brisket board is too far back, hock injuries may be observed. Moreover, this situation can lead to perching just as an improperly placed neck rail does. If the brisket locator is placed too far forward, cows may become trapped while rising from the stall. Additionally, excessive manure and soil may be deposited in the rear of the stall. If the brisket board extends more than 6" above the stall surface, it may actually block forward lunging as the cow rises from the stall and prevent them from extending their front legs forward during the rising motion. Abrasions on the inside of the cows' front legs may be observed if the brisket board is too high or has rough edges.

Understanding the Desired Situation. The brisket locator keeps the cow from moving forward while resting and helps position the cow in the stall and preserve forward lunge space. It also provides a bracing point for cows as they get up. When positioned properly, the brisket locator provides all cows with ample space to lie down comfortably within the stall. The brisket board is positioned directly underneath the neck rail or slightly further toward the rear of the stall. In mattress or mat freestalls, the brisket locator should be 68 to 72" from the rear edge of the mattress or mat. In deep-bedded freestalls, the brisket locator should be 68 to 72" from the cow side of the rear curb. The best brisket locator is one that provides the cow with an opportunity to extend her front leg over the locator while resting (Figure 19).

Selecting and Implementing a Solution. If the existing brisket locator impedes forward lunge-space or does not provide a smooth surface for the cow to extend her leg over, the existing brisket locator may need to be removed and replaced with a smooth brisket locator no more than 4 to 6" above the stall surface. Flexible plastic barriers with rounded edges (i.e. PVC pipes) generally perform best. It may be possible to shorten the existing wood brisket board to the desired height, but care must be taken to avoid rough edges. The brisket locator should be attached to the stall surface and not to the stall divider.

Figure 19. Cows often extend their front leg over the brisket locator while resting. To allow for this behavior, a brisket locator with rounded edges is preferred over sharp or straight edges.

Short Stalls

Identifying the Problem. The most obvious sign of short stalls is when the cow's rear end hangs over the edge of the curb (Figure 20). This situation may also cause poor stall usage. Short stalls may also be characterized by diagonal standing, lying, and rising and may contribute to perching.

Understanding the Desired Situation. Each freestall should provide enough space for the cow to rest with additional space allotted for lunging and bobbing while the cow is getting up. For large frame cows, this equates to a total length of 8 to 9 feet with at least 7 to 8 feet of actual resting space. Stalls may be too short because the actual length of the stall is inadequate or because the neck rail/brisket locator combination has limited the space for the cows to rest.

Selecting and Implementing a Solution. If the stall length problem is related to inadequate forward lunge space, the solutions listed above will apply here also. Stalls facing an outside wall should typically be 10 feet long. Moving the brisket board and/or neck rail forward may increase the amount of resting space available to cows. Producers may consider adding additional concrete to the rear of the stall to increase the length of the stall. One precaution for this strategy is to be sure not to create cow traffic problems through narrow alleys. Alleys should be 8 to 10 feet wide.

Figure 20. When cows do not have enough space to lie down, they may be found lying diagonally in stalls or “half-in, half-out” with the front part of their body on the stall surface and rear part of the body in the freestall alley.

Excessive Space behind Stall Dividers

Identifying the Problem. The primary sign of having too much space behind the stall dividers is the observation of cows walking behind the stall divider on the stall surface (Figure 21). Additionally, cows may often be seen lying backwards in the stalls (Figure 22). Both of these behaviors may lead to dirtier stalls. Too much space behind stalls may also increase the likelihood of cows becoming trapped under the stall divider.

Understanding the Desired Situation. To keep cows in the stall but prevent them from walking behind the stalls and minimize backwards lying, less than 14" should remain between the end of the stall divider and the rear curb.

Selecting and Implementing a Solution. Any solution to this problem would involve moving the stall divider toward the rear of the stall. Accomplishing this task may be challenging, because it is impossible to stretch the stall divider. Solutions could involve replacing the stall dividers, moving the existing dividers toward the curb where possible, or adding a welded extension to existing dividers to increase their length.

Figure 21. If too much space is left between the stall divider and the rear curb, cows may be able to walk on the stall surface.

Figure 22. Cows may also be more apt to lie backwards in the stall when space is open at the end of the stall.

Poor Ventilation

Identifying the Problem. During warmer temperatures, poor ventilation may result in cows expressing obvious signs of heat stress (i.e. panting, breathing heavily, Figure 23). Cook et al. (2007) illustrated that mean lying time decreased from 10.9 to 7.9 hours per day as temperature increased. Thus, stall usage may be altered if barns are inadequately ventilated. When temperatures are cooler, poor ventilation can result in increased respiratory problems and transmission of other diseases (Figure 24). Lack of proper ventilation can lead to high moisture levels, manure gases, pathogens, and dust concentrations which create an adverse environment for dairy cows (Palmer, 2005).

Understanding the Desired Situation. For optimal production and well-being, dairy cows should be provided with a constant supply of fresh, clean air. Frequently exchanging air removes or reduces the concentrations of dust, gases, odors, airborne disease organisms, and moisture. Maximizing natural ventilation is the first step toward improving ventilation. Natural ventilation relies on barn openings and orientation to remove heat and humidity from the animal's environment. Exhausted air generally leaves the barn through sidewalls or ridge openings. Although old barn designs suggested closed-in barns, current recommendations are to open the barns up to allow for better air exchange. Sidewalls allow for air, heat and humidity to be easily and continuously removed from the barn (Figure 25). This is particularly critical during the summer. If producers are concerned about the potential negative effects of open sidewalls during the winter, sidewall curtains, which can be raised in the summer and lowered during the winter, may be added to eliminate this concern. A ridge opening should also be provided at the top of the building to facilitate air removal through the top of the barn. Warm, moist air rises and exits through the ridge opening even on calm days. The steeper the roof slope the better the movement of the warm moist air out of the ridge vent. The roof slope should be at least 3/12, 3 inches of rise for every 12 inches of run. A slope of 4/12 is preferred. The ridge opening should be at least 2 inches for each 10 feet of building width. With overshot roofs, this opening should be at least 3 inches per 10 feet of building. Producers are often

resistant to this change because of fears of precipitation entering the barn through the ridge opening. Although this is generally not a major problem, a ridge cap may be added to eliminate this concern (Bickert et al., 2000).

Selecting and Implementing a Solution. For many older barns with ventilation issues, the main opportunity for improvement is removing tin or wood sidewalls that block natural winds from entering the barn. Before removing these obstructions, consider how this change might affect the structural integrity of the building. Strive for at least 8 feet of sidewall opening. A 3 to 4 foot overhang should be provided to prevent precipitation from entering the barn. Curtains may be needed to block adverse weather during the winter (Bickert et al., 2000). Similarly, opening the endwalls may also prove beneficial. In some cases, there may benefit in raising the height of the roof to increase the amount of air flowing through the sidewalls. Adding or increasing the size of the ridge opening can dramatically improve natural ventilation. Natural ventilation can also be supplemented with mechanical ventilation with the addition of fans. Adding fans to an existing freestall barn is one of the highest return investments a dairy producer can make.

Figure 23. Cows housed in barns with poor ventilation are more likely to be affected by heat stress.

Figure 24. Barns that are completely enclosed do not allow for adequate air exchange resulting in a damp, dark environment and can lead to heat stress, respiratory problems, and increased transmission of disease.


Figure 25. The ideal freestall barn maximizes natural ventilation with high, open sidewalls, a ridge vent opening and supplements natural ventilation with fans used to increase air flow and exchange.


Conclusions

Cow comfort can be improved dramatically through modification of existing freestalls. Often, these changes can be made with minimal expense. Before undertaking such an effort, one should be evaluate long-term plans. It is important to determine whether the existing facility truly has enough positive attributes to renovate or if building a new facility would prove more beneficial and cost effective. Observing cow behavior can provide clues for evaluating what changes could be made. Modifying one shortcoming may not always improve the situation if other bottlenecks still exist. But, cow comfort improvements achieved through freestall modification can provide immense benefits to animal well-being, milk yield, cow longevity all while minimizing farmer frustration and stress.

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