Building and Remodeling Freestall Housing for Cow Comfort

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Take Home Messages

- Proper freestall design, construction and care are essential to cows using the stalls and realizing the potential benefits to comfort and health.
- Freestall design is a compromise between comfort and cleanliness.
- Of all the factors that discourage cow's from using freestalls, the condition of the bed is likely the most important.
- The only logical reason for not using sand as a base and bedding has little to do with cow comfort and udder health, but with the difficulty it adds to the manure system or the availability of high quality sand.
- Other essential aspects of freestall housing related to cow comfort are ventilation, access to feed and water, and walking surfaces.

Introduction

A freestall is an integral component of a complex system that can be used to enhance profitability on a dairy farm. The freestall itself is a system made up of individual parts that act together to become a vital element of the cow's environment. Therefore, understanding relationships between the cow and the freestall as well as the interactions among individual freestall components is important to freestall design.

Judging freestalls according to criteria that contribute to comfort and cleanliness is more important than the mechanisms used to implement those principles. For example, there are many types of freestall partitions, several of which may satisfy the basic needs of the cow. Evaluating the different

partitions on the basis of how they satisfy the needs of the cow is more valuable than basing decisions on biases and prejudices.

Other aspects of freestall housing—ventilation, access to feed and water, and walking surfaces—will be discussed also.

▪ Basis for Freestall Design

Cleanliness and comfort are two basis prerequisites that must be satisfied in freestall design and construction. Cleanliness relates to clean, dry conditions, especially the stall bed in the vicinity of the udder. Comfort means a comfortable bed and roomy dimensions to accommodate the cow's ability to easily move in and out of the stall and allow her to lie comfortably in the stall.

In simplest terms, the main purpose of a freestall is to reduce exposure of the teat ends to mastitis causing organisms. So we make every effort to provide a clean, dry place for the udder on the freestall bed. Then we expect the cow to choose a freestall for a place to lie down. An effective freestall must be sufficiently appealing to a cow to cause her to choose to lie in a stall 10-14 hours per day.

A freestall should enable a cow to rise and lie down naturally (See Figures 1 and 2 for illustrations of the rising movements of a cow). A 635 kg (1400-lb) cow requires 168 cm (66 in) for body space and about 47 cm (18 in) for head space. This adds up to 215 cm (7 ft), a commonly recommended freestall length.

Freestalls also must provide lunge space for cows. This space ranges from 25-55 cm (10-22 in) added onto the combined 215 cm (84 in) body and head space. (Or, the space is 70-100 cm (28-40 in) measured ahead of the foreknees.) Accounting for this lunge space is the first and most important aspect of stall design. It is the key to providing stalls that cows will use readily.

Whether the lunge space is provided either forward to the side determines both the type of partition to use and the overall length of the stalls. If the forward lunge is to occur within the stall envelope, the recommended length overall is at least 245 cm (8 ft). Or, if space for the lunge is provided to the side into an adjacent stall space, overall stall length need be only 215 cm (7 ft). Other alternatives are to allow the cow to lunge forward into a stall space opposite the cow, or into an adjoining alley or even to the outside of the barn itself.

Types of Freestalls and Components

Depending upon provisions for the thrust of the cow's head during the lunge, freestalls may be in one of two categories—forward lunge or side lunge. Figure 1 shows two examples of forward lunge stalls, Figure 2 of side lunge stalls. Certainly other designs may satisfy the concepts and principles of free stall design equally well. Therefore, an evaluation of a particular freestall begins with assessing its merits in meeting the basic needs of the cow from the standpoint of comfort and cleanliness.

Side lunge and forward lunge freestalls differ in partition shape and in stall base design at the front of the stall. Designs are similar at the rear of the stall. To reduce injury, both types provide space beneath the lower rail to minimize contact with the hip and pelvic area of the cow.

In a side lunge freestall, the cow turns and thrusts her head into an adjacent stall space as she rises. The lower rail of the partition is either high enough in the front to allow the cow to thrust her head under the lower rail or low enough to allow the cow to thrust her head over the lower rail without interference. If the cow thrusts her head under the partition rail, the bottom partition rail should be installed a minimum of 72 cm (28 in) above the stall surface. If the cow thrusts her head above the bottom rail, the bottom partition rail should be a maximum of 18 cm (7 in) above the stall surface. In the figures, the values given for these dimensions are greater since the dimensions are measured from the top of the back curb, a more stable reference point especially in sand-based freestalls.

In a forward lunge freestall, additional stall length is needed to allow the cow to lunge forward—either within the stall envelope or through an open front to space beyond. If the lunge is within the stall envelope, the stall must be at least 245 cm (8 ft) long. If the lunge is through an open stall front, provide a minimum of 54 cm (21 in) of open vertical space.

The brisket board defines the space for the body of the lying cow and discourages her from moving too far forward into the stall when she is in a lying position. A brisket board is essential in a stall where space for the lunge is provided ahead of the cow.

A neck rail across the top rail of the stall partition is important to maintaining stall cleanliness. The neck rail encourages cows to back up when rising and stops cows from moving too far forward when standing without being a nuisance to them. A neck rail that is too low hinders the rising movement. Neck rails should be 168 cm (66 in) ahead of the alley side of the curb and at least 102 cm (40 in) above the stall bed.

With side lunge stalls, make sure that cows have easy, natural access to the lunge space. When the recommended freestall length is used, the partition is mounted such that the cow can easily reach the lunge space. However,

making the freestall longer than necessary, say 228 cm v 215 cm (7-1/2 ft v 7 ft), positions the lunge space 15 cm (6 in) farther forward in the stall, well ahead of where it should be for the cow's comfort. Without a brisket board, the cow will move too far forward in the stall, increasing the likelihood of her defecating in the stall. A brisket board will help position cows to prevent dirty stalls. But, cows will still have to reach forward awkwardly to use the lunge space in a longer stall.

▪ Recommended Freestall Dimensions

Dimensions chosen for freestalls represent a compromise between cow comfort and cow cleanliness. Stalls must enable cows to lie down and get up naturally and comfortably. Stalls should be wide enough that cows normally do not contact stall partitions in any way that could cause injury or that could damage the partitions. But, stalls that are too wide may allow cows to turn around in them or lie diagonally. Stalls that are too long may allow lying too far forward unless brisket boards are used. All of these conditions increase the possibility of manure being deposited on the stall bed.

Table1. Suggested freestall dimensions

Weight, kg	Freestall width, cm*	Freestall length, cm*		Neck rail height above stall bed, cm	Neck rail and brisket board, from alley side of curb, cm
		Side lunge	Forward lunge		
365-545	107 to 112	198	230 to 244	94	158
545-680	112 to 122	215	244 to 260	102	168
over 680	122 to 132	228	260 to 275	107	180

*Width: "center-to-center" with 5-cm pipe partitions. Length: alley side of the curb to the front of the stall.

Table 1 shows a range in the recommended stall widths and lengths. In my opinion, the lower values of the ranges in the table represent a livable compromise between cow comfort (high rate of stall usage) and cow cleanliness. The upper values, which provide for wider and longer stalls, favor cow comfort over cleanliness and will result in more time being spent in stall maintenance.

With two rows of freestalls placed head-to-head and designed for space-sharing, stall partitions are usually mounted on posts. This allows for

unrestricted open space for the forward lunge into the adjacent stall space. When a row of building support posts are located down the center of the two facing rows, spacing between the support posts must be a multiple of the freestall width, 115 cm (45 in) on center for typical Holstein herds. Otherwise, building support posts will periodically be located in the forward lunge space needed by the cow. Freestall width should determine building post spacing, not vice versa.

In hot climates, consideration to heat buildup in the freestall area may lead to wider freestalls, say 120 cm (48 in). Although, in a well-ventilated building equipped with cooling fans, the advantage of wider freestalls has not been established.

▪ Freestall Base and Bedding

The stall base and bedding act together to provide a resilient bed and a clean, dry surface. Of all the factors that discourage cow's from using freestalls, the condition of the bed is likely the most important. Avoid beds that are too hard (concrete, concrete with a rubber mat, compacted earth). Swollen hocks and knees result from a bed that does not provide sufficient cushion. Avoid beds with mounds, lumps or holes. Such conditions reduce comfort for the cow, but, worse yet, can cause difficulties for the rising cow. Lack of comfort and difficulty in rising both discourage freestall use.

Slope the base upward 4% from the rear to the front. Use a curb that puts the stall beds 15-25 cm (6-10 in) above the alley. The curb must keep scraped manure or flush water out of stalls.

Bedding material added on top of the base absorbs moisture and manure tracked into the stall, adds resilience, makes the stall more comfortable and reduces the potential for injuries. Possible materials are straw, sawdust, wood chips, sand, composted manure, ground limestone, shredded newspaper, rice hulls, corn stalks and peanut hulls. Choice of bedding material may influence selection of a manure handling and storage system. Too much straw or other organic material can build up a substantial crust in a storage creating problems with agitation at emptying. The use of short, fine bedding material reduces the amount of bedding material dragged into the manure alley.

Two methods have emerged as top candidates: i) mattresses with bedding on top and ii) a deep layer of sand. In our opinion, sand can be considered as the gold standard for a freestall base and bedding. If other materials are to be considered as alternatives and are to be evaluated on the basis of cow comfort, sand is the basis for comparison. The only logical reason for not using sand has little to do with the cow comfort and udder health, but with the difficulty it adds to the manure system or the availability of high quality sand.

As a cushion or for resilience, loose sand conforms to the shape of body components—knees, hocks, etc. This reduces pressure on projecting bones and body parts by distributing downward force or weight over a larger area. This is important to the lying cow—the total weight of the cow is transferred to the lying surface via the contact point of the cow's body.

Spreading the cow's weight over a larger area protects the front knees of the cow during rising also. A cow rising from a lying position lunges forward, transferring the weight of her body forward so she can more easily rise on her hindquarters. The knees act as the fulcrum for this teeter-totter action with the stall bed providing the cushion for the knees. During the lunge, the weight transfer process increases the downward force on each knee from 160 kg (350 lb) (about 1/4 of the cow's weight) to 230 kg (500 lb) or more—on each knee! As the sand conforms to the shape of the knee, increasing the area over which this downward weight of the cow is distributed, the less is the potential for injury to the knee.

Loose sand serves to consistently distribute the downward weight better than probably any other material or combination of materials currently in use. Thus, loose sand represents the standard of comparison when evaluating stalls beds of various materials for their cushioning effect.

Good footing in the freestall is essential to the cow's ability to lie down and rise easily. In this case, "footing" means not only the reducing the tendency to slip, but allowing the cow to more-or-less embed her foot in the surface so as to provide good leverage. When a cow can rise more confidently, rising time is reduced. Also, the tendency to rock back-and-forth is lessened and rising is accomplished more smoothly, reducing trauma to knees, ankles, etc. Loose sand provides excellent "footing". Beds of other materials must be equivalent

A bed of loose sand (15 cm minimum) maintained in the stall area acts as both base and bedding in a freestall. Sand contributes to cow comfort, good udder health and clean cows. In addition, sand kicked into the alleys improves cow footing. However, the sand should not contain small rocks or pebbles which could cause damage to the hoof or lameness.

Every one to four weeks, add sand to the front of the stall bed, leaving it to the cow to work toward the rear of the stall. Replenish sand before the front of the stall bed becomes lower than the rear, a condition that makes it difficult for cows to rise and causes them to lie diagonally in the stall. This tends to put more manure in the stalls and leads to dirtier cows.

Sand bedding has many advantages for cow comfort and health but it may greatly complicate the manure handling system. Good planning—including selection of a handling system, storage needs and equipment—is essential.

A dry surface is essential to minimizing bacterial growth. The surface of a sand bed stays dry due to the infiltration capacity of the sand itself. Dryness of the

surface of a bedding mattress is assured only by the presence of dry bedding—chopped straw, sawdust, etc. Thus, dry bedding on the surface is an essential aspect of a mattress system.

Bedding mattresses, 8-10 cm (3-4 in) thick, over hard stall bases such as concrete or well-compacted earth can provide a satisfactory cushion. A bedding mattress consists of bedding material sandwiched in a fabric—heavyweight polypropylene or other material. Various materials are used as filler—long or chopped straw, sawdust, shavings, shredded or ground rubber. Mattresses need to be covered with bedding to reduce friction and to keep the mattress dry. Small amounts of bedding (chopped straw) maintained on top of the mattress help keep the surface dry and improve cow comfort.

When the lying cow tends to slide around while lying down, the friction between her hide and the lying surface can be abrasive. Chopped straw or similar material on a bedding mattress acts as lubricating layer reducing abrasions to the skin. Sand sliding over sand has a similar positive effect.

The search goes on for the ultimate freestall bed. Meanwhile, a bed of loose sand and rubber-filled mattresses with organic bedding on top are two methods for satisfying the requirements for freestall beds that promote cow comfort and good udder health. Sand appears to have the advantage. However, either system, properly installed and maintained, can contribute to a desirable environment for the dairy cow.

▪ Freestall Care

Proper free stall care includes daily inspection and removal of wet bedding and manure, besides adding dry bedding periodically. Neglected free stalls with excessive moisture or accumulations of manure can lead to an increased incidence of mastitis.

Also, for stalls with bases that must be replenished such as sand, always maintain an upward slope of the base toward the front. This upward slope helps position cows more squarely in the stall when lying down, and this contributes to cleaner stalls and cleaner cows.

▪ Other Factors Related to Cow Comfort

Besides freestalls, other aspects of housing influence cow comfort. Proper ventilation leads to good air quality that is conducive to good health. Moreover, proper ventilation leads to dry bedding, an aid to controlling mastitis. Proper ventilation leads to dry alley surfaces that are less slippery and an aid to

maintaining good foot health. Proper ventilation in the feed manger area during hot weather keeps cows more comfortable, thus maintaining dry matter intake and avoiding slumps in milk production. High humidities in winter and heat buildup in summer are avoided. Concentrations of disease organisms, noxious gases and dust are minimized. To accomplish these goals, cold, naturally ventilated freestall barns have proven their value.

Adequate supplies of feed and water, besides being of suitable quality, must be easily accessed as a result of proper feed manger and waterer space and design. Providing a minimum manger space of two feet per cow is recommended. Waterers should provide a space for every 15-20 cows in a group. Two waterer locations per group are recommended.

Skid-resistant walking surfaces reduce injuries, improve movement to feed, water and resting areas and enhance estrus detection. As in all aspects of facilities design, a compromise must be reached. On the one hand, the surface should provide enough texture so as to keep the animal from skidding. On the other hand, the surface cannot be so aggressive as to injure the underside of the foot of the cow. Grooves in concrete surfaces, up to 12 mm (½ in) deep and 12 to 19 mm (½ to ¾ in) wide, spaced 90 mm (3-½ in) on center are an acceptable method.

▪ Summary

Proper freestall design, construction and care along with proper ventilation, access to feed and water, and skid-resistant walking surfaces are essential to comfort and health. Freestall dimensions depend upon particular designs and are a compromise between the need to control the cow to ensure optimum cleanliness and the desire to give the cow a spacious area for the ultimate in cow comfort. Freestalls designed on the basis of meeting the fundamental needs of the cow will lead to the greatest success. Most likely, there is no perfect freestall design. Rather, there may be several freestall designs that satisfy the basic requirements of the cow perfectly well!