Troubleshooting and Evaluating Cow Comfort and Freestall Design on Dairy Operations

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Introduction

There is nothing worse than visiting a farm with major health problems, to find that they have only recently invested in a disastrous stall design. A matter of inches can determine whether a new barn is a success or a failure – resulting in poor lying times, lameness, mastitis, injury and in some cases fatality. Farmers place a great deal of faith in builders and agricultural engineers, relying on them to make sure that the stall measurements are right – frequently this faith is misplaced.

We can start to understand stall usage behavior if we spend a little time considering the requirements of the dairy cow entering the stall, lying down, rising and leaving it (Nordlund and Cook, 2003).

We need to consider five main critical areas:

- Adequacy of stall surface cushion
- A defined resting area of appropriate size related to the type of animal
- Adequate room for lunging and an unobstructed "bob zone"
- Adequate height below and behind the neck-rail to rise without hindrance
- A curb height no higher than eight inches

1. Adequacy of Surface Cushion.

The most important factor determining stall usage is surface cushion. Cows appear to tolerate many inadequacies of design to lie on a cushioned surface. Work by Wandel et al. (2002) showed daily lying times increase with increasing surface cushion in the same stall and Gebremedhin et al. (1985) demonstrated a cow preference for a deep soil bed over a rubber mat or concrete. Palmer and Wagner-Storch, (2003) has shown a cow preference over rubber mats for the most cushioned mattresses – containing foam, rather than packed rubber. Sand carries considerable potential benefits with regard to its use – giving cushion, conforming support and traction without abrasion. There is however a paucity of data with respect to lying times and cow use in sand stalls, and much of what has been published suggests other surfaces perform as well or better (Palmer and Wagner-Storch, 2003; Tucker et al., 2003). Poorly maintained sand stalls can be a disaster for cows, and the handling of sand laden manure is also problematic. Dug out stalls do not provide the necessary surface cushion to attract the cow and there will also be associated lunging problems, related to changes in the relative height of the divider rails.

Lameness prevalence has been reported to be lower in herds with sand stalls (Cook, 2002), when managed correctly and recent data collected by the author suggest that sand is the preferred stall surface for dairy cows.

The keys to successful sand management are:

- Using washed, screened and graded sand – to remove soil and rocks and to make the particle size uniform
- Maintaining the sand level at a minimum depth of 6 inches by adding fresh sand weekly and leveling daily.
- Making sure that stall dividers are correctly mounted to allow for side lunging if needed
- Providing a settling pit with easy tractor access to remove sand from the main lagoon

2. A Defined Resting Area of Adequate Size

Anderson (2002) suggests sizing stalls to the largest 25% of cows in the herd, providing these cows with sufficient room to use the stalls. The fear of many farmers is the problem of maintaining adequate standards of hygiene. We therefore suggest that if the farm aims to pen heifers separately and provide accommodation for transition cows in the barn, stalls should be designed to meet their respective sizes.

We have developed regression equations from several published articles on freestall design to give appropriate dimensions for width, length from curb to brisket board, total length for a full forward lunge and height below the neck-rail (Table 1).

Table 1. Regression equations for the calculation of stall dimensions and neck rail placement in inches from body weight in lbs (Nordlund and Cook, 2002)

Dimension	Equation
Stall width (inches)	0.018 (Body weight) + 21.9
Resting length to brisket board (inches)	0.0224 (Body weight) + 34.2
Total stall length for forward lunge (inches)	0.0405 (Body weight) + 41
Height of lower surface of neck rail (inches)	0.0136 (Body weight) + 26.4

A brisket board that has a rounded edge and protrudes above the bed no higher than 6” can be used to prevent the cow lying too far forward on a freestall bed. We need to allow the cow to put her front leg forward when she lies down and when she completes the rising motion, so the board must be no higher than this. In some herds with sand bedding and high neckrails, these boards have been completely removed with apparent little ill effect.

3. Adequate room for Lunge and Bob

The modern Holstein cow needs a space of at least 9-10 feet from tail to chin in order to lunge forward and rise without hindrance. In head to head stalls, although there is the potential for space sharing if the stall in front is empty, the presence of a cow in that stall effectively shortens the stall, making the side lunge option a necessity in head to head designs. Cows are

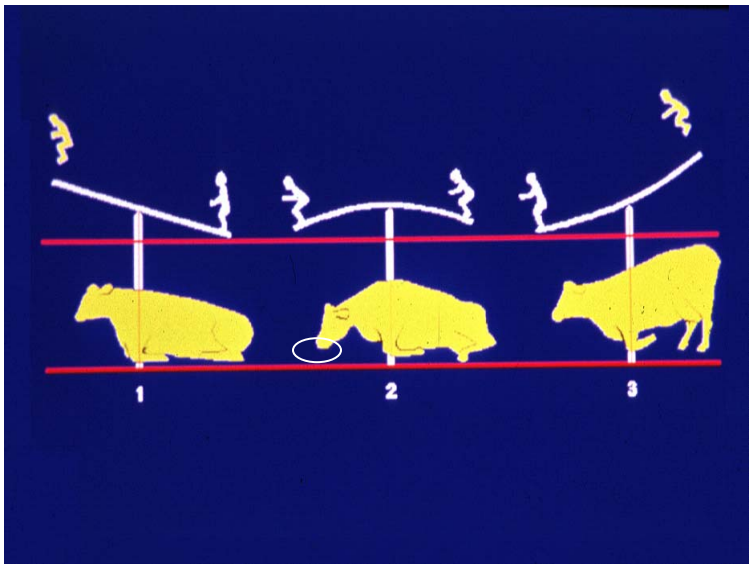
reluctant to lunge into the head space of another cow. Head to head stalls should therefore be built on an 18 foot platform. Against a solid wall, if the stall is shorter than 9-10 feet long, the cow must side lunge to get up.

For side lunging to occur, we must choose a wide loop divider, with the lower rail of the divider no higher than 11" off the surface of the stall, where the brisket board meets the bed. Some of the biggest stall disasters we see are where a narrow loop divider, with a lower rail around 18" above the stall surface is used in a short stall (Figure 1). Cows commonly become entrapped as they shuffle forward on the bed and attempt to rise over a lower section of side rail. A similar problem may present when sand stalls are poorly maintained and the relative height of the divider rail increases as the surface erodes away.

Figure 1. This stall is 7'6" long against the wall. The lower rail of the narrow loop divider is 18" off the stall surface at the level of the brisket board. This cow shuffled forward on the bed to lunge over the lower section of side rail, only to find the neck rail in the way.

If we closely study the mechanics of rising in the cow, elegantly shown in Figure 2 from the illustrations by Schnitzer (1971), we will see that she uses the front legs as a fulcrum on which to balance, transferring weight from the rear legs so that they may be moved. To achieve this weight transfer, the chin must almost touch the ground in an area we call the "bob zone".

Figure 2. Notice how low the chin has to go for the cow to achieve balance over the knees – which act as a fulcrum, taking weight off the hind legs as the cow rises. (from Schnitzer, 1971).



We frequently see obstructions in the bob zone – stored bedding, mounting rails and concrete, all of which we believe impact stall usage. The cow will rise awkwardly with her chin in the air. Complete transfer of weight will not be achieved, meaning that the rear legs may slip away from under the cow, creating fear associated with rising and lying, which ultimately reduces stall use. Freestall dividers should be mounted on vertical posts, not on horizontal mounting rails in front of the stall. This is more expensive, but the cost is insignificant compared to the losses from poor stall use.

Figure 3. This cow hits her chin on the divider mounting rail located 10” off the stall surface and 7’6” from the rear curb.

4. Location of the Neck rail

The cow should have enough room to rise behind and below the neck rail unhindered. The best location is immediately over the brisket board. Behavior studies have shown that by moving neckrails higher and forward, cows can stand with all four feet on the stalls more easily (Gaworski et al., 2003). If the rail is incorrectly located, the cows will tell us, by rubbing the rail every time they rise in the stall. We will also see more cows perching in the stalls, with only two feet located on the platform.

Diagonal lying relates to neck rail placement, and lunge and bob room. Diagonal lying results from cows lunging diagonally across the stall to rise and lie down. They will do this if:

- There is a bob zone obstruction in front of the stall
- There is a cow in the stall in front
- The neck rail is located too near the rear curb. Large cows must stand diagonally on the bed to lie down.

Ironically, stalls become contaminated with manure while the cow lies across the stall – locating the fecal pat below the divider (Fig 4). Farmers see this as a neck rail problem, believing that the contamination occurs when the cow is standing in the stall, and in response they move the neck rails nearer the rear curb!

Figure 4. Front lunging in this wide loop stall is inhibited by a lower horizontal mounting bar. This tends to make cows lie diagonally across the bed, forcing her to side-lunge.

Raising neck rails on spacers in stalls where cows must side lunge is futile. The upper divider rail, which is not moved, remains the effective neckrail in these stalls. I therefore recommend moving the rail further away from the curb in these stalls and tolerating the lower height.

5. Curb Height

Typical curb height in the US is around 10”. We believe that too high a curb reduces stall use by heifers and stretches rear flexor tendons of cows standing half in and half out of stalls.

Both high curbs and perching behavior have been linked with increased lameness in several studies. Curbs should be no higher than 8" above the alley, a height which includes the mattress surface.

Conclusions

Cow comfort is critical to the success of any farm, the cost of getting stall design wrong is enormous and correcting problems is a frightening prospect in many cases. Even now, we still see brand new installations with major design faults, which do not allow for the cow's needs for rest and rising room.

If we can look at stall use through the eyes of the cow, we can solve many of the health issues related to stall design and make recommendations that will avoid problems developing. It seems ridiculous that farmers actually tie "stupid heifers" into stalls at night to "make" them use them! Perhaps we should listen to and act upon the heifer's grievances. We should build barns that maximize cow health and productivity, not for the best way to manage manure. We can go a long way to achieving acceptable standards of cow comfort, lameness and welfare, while still having a system that is manageable for the farmer at a cost that will be acceptable to everyone, including the cow!

References

Anderson N: Observations on cow comfort using 24 hour time lapse video. *Proc 12th Int Symp Lameness in Ruminants*, Orlando, pp 27-34, 2002

Cook NB: Lameness prevalence and the effect of housing on 30 Wisconsin dairy herds. p 325-327, *Proc 12th Int Symp Lameness in Ruminants*, Orlando, 2002

Gaworski MA, Tucker CB, Weary DM, Swift ML. Effects of stall design on dairy cattle behavior. *Proceedings of the Dairy Housing Conference*, p 139-146, 2003

Gebremedhin KG, Cramer CO, Larsen HJ: Preference of dairy cattle for stall options in freestall housing. *Transactions of ASAE* 28: 1637-1640, 1985.

Nordlund K, Cook NB. A flowchart for evaluating dairy cow freestalls. Bovine Practitioner 37:89-96, 2003.

Palmer RW and Wagner-Storch AM. Cow preference for different freestall bases in pens with different stocking rates. *Proceedings of the Dairy Housing Conference*. p155-164, 2003

Schnitzer U: Abliegen, Liegestellungen und Aufstehen beim Rind im Hinblick auf die Entwicklung von Stalleinrichtungen fur Milchvieh, KTBL-Schrift 10. KTBL, Darmstadt, German Fed. Rep., Report, 1971.

Wandel H, Jungbluth T, Benz B: Cow comfort in loose house systems. p313 *Proc 12th Int Symp Lameness in Ruminants*, Orlando, 2002