Dairy Cattle Behavior: Cows Interacting with Their Workplace

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Introduction

For economic and humane reasons, dairy producers are looking for facilities and management practices that contribute to cow health and productivity. The mismatching of housing features or husbandry with a cow's needs contributes to abnormal, unwanted, or injurious behavior. Behavior is one of several measures of cow welfare. Others are body condition, health, shelter, feed and water, weight gain or milk production, feelings and freedoms.[8]

I was asked to comment on cattle behavior and show cattle-man interactions using time-lapse video recordings as a follow-up to a presentation given in Vancouver in 2001.[2] For the most part, cattle-man interactions are cattle-facility interactions, and facilities symbolize how man chooses to interact with cows. A cow's behavior indicates her pleasure or displeasure with the relationship. This article for the *Proceedings* cannot depict what will be shown on video. Nonetheless, it attempts to describe a few coping behaviors of cows in confinement housing, to explore factors that predispose to those behaviors, to increase awareness, to stimulate debate and to offer suggestions for sizing stalls to fit the dimensions and needs of cows. If the barn harms the cows, the take-home message is to remove the cause without delay.

Injury and Pain – Fear and Frustration

Injure means to affect in such a way as to lessen health, strength, value, beauty, etc. Pain is a general term describing sensations of discomfort or suffering. It may refer to a bodily hurt, to mental anxiety, or to both a physical cause of discomfort, and the consequent mental discomfort. Fear and frustration are two feelings that alter cow behavior. Fear is the feeling of alarm or disquiet caused by the expectation of danger, pain, or disaster. Frustration arises when cows are kept from achieving something. The signs of fear or frustration may be obvious or subtle enough to go unnoticed. The following is a list of several for consideration:

- perching
- standing or lying bouts
- stall refusal
- crowding in a barn location
- lying backwards in stalls
- apprehensive behavior before lying in stalls
- unusual actions when rising or lying
- lapping at water
- feed tossing
- head pressing
- unusual and unexpected approaches to eating or drinking
- unusual walking – gait or stride
- reluctance to cross gutters or enter some areas of a barn
- reluctance to enter parlors
- a large flight zone
- impaired performance

Behaviors Used to Judge Stalls

Several of the above behaviors are useful for judging a cow's feelings about her housing or the adequacy of the facility to meet her needs.

1. Resting (lying) Positions

Resting describes lying in the stall in one of four normal resting positions - long, short, narrow or wide. In the long position, cows rest with their heads extended forward. In the short position, they rest their heads along their side and go into active sleep. While in the narrow position, a cow rests more on her sternum with the neck in a slight crook and the rear legs close to the body. Her front legs may or may not be extended. In the wide position, a cow rests more on her side with the rear legs extended. Another position is lateral recumbency, where a cow lies totally on her side with legs and head extended.

2. Idle Standing

Idle standing describes pointless positioning with all four feet in the stall. It includes failed attempts at lying. Stereotypic behaviors also may be seen with idle standing. These include pushing of the nose firmly against the stabling or grasping onto pipes.

Some cows stand in a stall and swing their heads repeatedly left and right, as if checking traffic before crossing a busy street. The activity has been described

as "the hesitation waltz." Cows standing idly in stalls are pointing to hazards and are waiting patiently for caregivers to take action.

3. Perching

Perching describes cows standing with their front feet in the stall and rear feet in the alley. The behavior may also describe cows lying with part of their body in the stall and part in the alley. Claw horn diseases of the rear feet are more common in barns with perching cows.[11] In lying cows, perching contributes to contamination of udders, teats, legs, and tails and risks of mastitis. Bouts of perching may last for several minutes or greater than one hour. Perching often accompanies efforts to control stall cleanliness through placement of neck rails to the rear of the stall, deterrents at the front of the stall, short beds, or use of an uncomfortable resting surface.

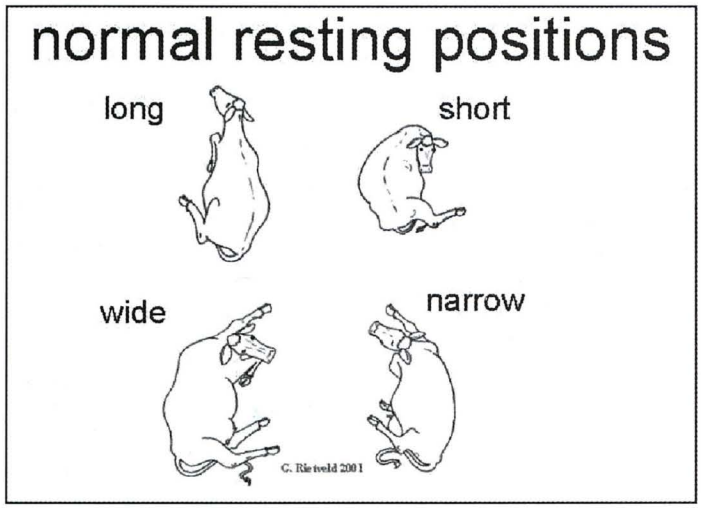


Figure 1. Four normal resting positions include long, short, wide and narrow. The fifth is lateral recumbency.

Figure 2. Dairy cows standing idly in their free stalls should be viewed as "pointers" pointing towards hazards in their workplace.

4. Diagonal Standing and Lying

Diagonal standing or lying describes the corner-to-corner use of a stall. This behavior provides space for placing four feet in a stall, lunging, avoiding a cow in a facing stall, or lying with body parts on the bed. Cows stand or lie diagonally in a stall because of a lack of space for standing or lying straight or lunging straight. They use the hypotenuse of an imaginary right-angled triangle in the stall to alert us to obstructions in their stalls.

5. Straight Standing and Lying – Forward Open Space

Straight standing or lying describes cows positioned parallel to the dividing loops in a stall. Forward open space is the unobstructed space at the front of a

Figure 3. Perching describes cows standing with front feet in the stall and hind feet in the alley. It also could describe cows lying partially in the alley and the stall. Perching cows are sentinels pointing to perils in their stalls.

Figure 4. Cows standing or lying diagonally (corner-to-corner) in a free stall are avoiding obstructions and pointing to obstructions to normal activities.

free stall. It allows cows to stand, go down, lie and rise straight in a stall.

Straightness in the stall, rapid entry and lying, infrequent standing, and rare perching behavior characterize stalls with adequate frontward open space. Forward open space is the reason for 18-foot head-to-head stalls or 10-foot stalls facing a wall.

6. Lying Backwards

Lying backwards describes cows resting with their heads facing the alley. Calves and heifers learn the behavior when raised in ill-fitting free stalls. They often carry the behavior into the milking barn. Some will persist with it even when stalls are adequate for normal behavior. Mature cows adopt the behavior to avoid frustrating or painful stall features. Some believe cows lie backwards because the stalls are too wide. This may be true with stalls wider than 54 inches – an extremely rare free stall. Lying backwards may be the most obvious of avoidance behaviors.

7. Restlessness

Restlessness describes cows fidgeting while lying or moving frequently from the narrow (upright) to the wide resting position. When restless, the bottom rear leg moves over the bed, chafing the outside of the hock. In addition, the top leg falls off the bed into the alley, chafing the inside of the hock. High brisket boards obstruct forward extension of the front legs and contribute to restlessness. Other obstructions make rising difficult or painful, so cows lie for long bouts without rising or changing sides for lying.

8. Alternate Occupancy

Alternate occupancy describes cows lying in every other stall with an empty facing stall. Alternate occupancy provides the opportunity for social space, unobstructed lunging, and avoidance of a dominant cow in a facing stall. Alternate occupancy is obvious in underpopulated pens where cows have a choice.

9. Rising and Lying Motions

Rising and lying are normally continuous and smooth motions. They include a forward lunge and retraction and a bobbing down and up of the head. The head bobs downward until the chin touches ground level. It acts as a counterbalance for the hindquarters. Rising

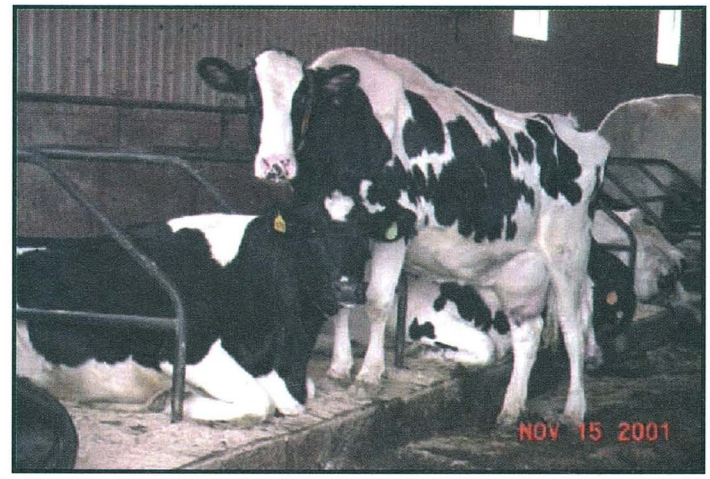


Figure 6. Cows lying backwards are turning away from stall features that they abhor and pointing to open space needed for freedom of normal motions.

Figure 5. Forward open space facilitates straight standing and lying in stalls. The forward open space in these 18-foot stalls also permits front lunging, heat dispersion through cow separation, and avoidance of dominant/subordinate behavior.

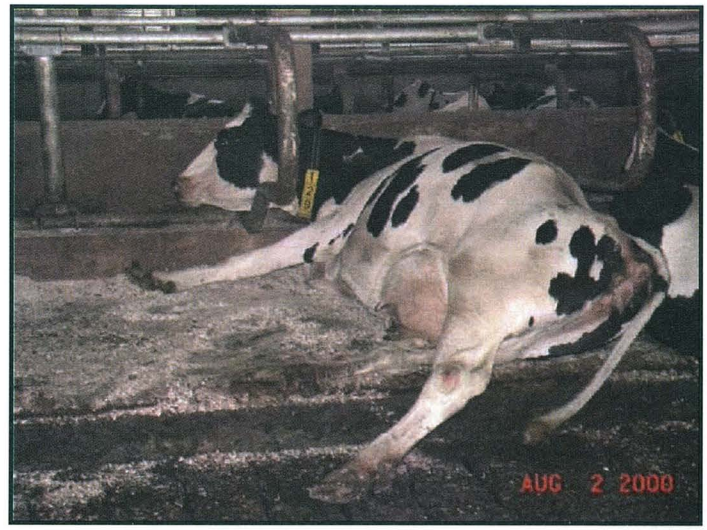


Figure 7. Restless cows change positions frequently, kick the bedding off the stalls, and develop injuries to legs from repetitive trauma. Their activity and injuries point to discomfort or obstructions to normal lying positions.

begins with the front quarters raising slightly and then the hindquarters follow, propelled by the rear legs.

The rising motion includes a stride of about 18 inches forward of the folded foreknee by one front foot. While striding, the foot rises about 5 inches above the resting surface. When lying, a cow kneels with one front leg, followed by the other, and then tucks one hind leg under the abdomen as she lowers her hindquarters. The front quarters recline first and the hindquarters rise first.

Any object in the range of normal motion obstructs rising and lying. Keen observation and listening point to obstructions – e.g., chin cuffers, skull smackers, withers whackers, foot bangers and knee knockers. Cows cope by altering the normal bob, lunge and pendulum motions of the head, and smooth motions become shuffles of the front and hindquarters.

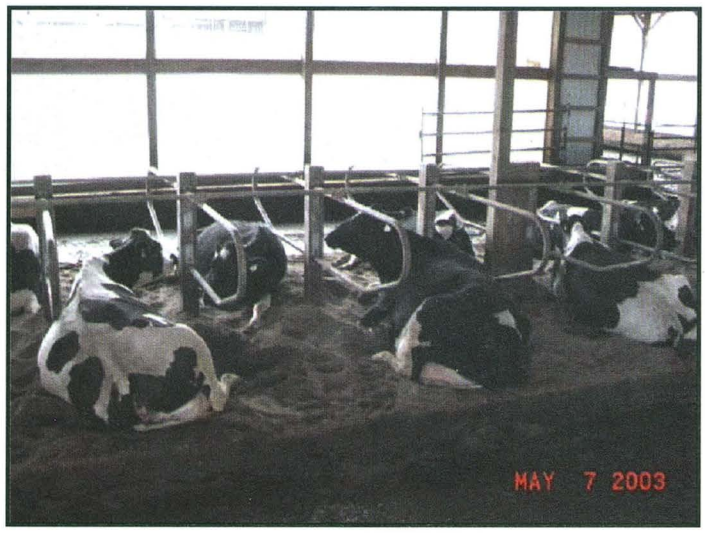


Figure 8. Alternate occupancy with cows lying in every other stall is evident in the 15-foot head-to-head free stalls. The behavior primarily indicates short stalls and inadequate social space rather than a dislike for facing another cow.

10. Walking

A healthy cow walking on pasture places the rear foot into the position vacated by the front foot on the same side. On slippery floors or in dark conditions that alter a cow's confidence, she places her rear foot outside the track of the front foot, alters stride and step length, and walking speed. This altered walking behavior provides greater stability, but places more weight on the outside claw.

Choices of flooring and lighting influence walking behavior, foot health and cow movement. Foot placement, length of stride and step, and walking speed are a few items of locomotion pointing to walking behavior. Observation of walking patterns provides an opportunity to assess floors for traction and flatness of surface for the claw to rest upon. In addition, birdbaths in concrete floors are health risks that pool wastes, contaminate feet and tails, and allow splashing onto beds, teats, or legs.

Injuries Used to Judge a Barn

Injuries to hocks and necks, and broken tails, are useful for judging physical discomfort, the safety of the barn and interactions with man.

1. Neck Injuries - Gall, Callus, Hygroma, or Bursitis

Neck injuries occur when the skin, the nuchal ligament and its bursae, and the spinous processes of the first few thoracic vertebrae at the withers experience repetitive trauma. The injuries may be gall, callus, hygroma, or bursitis.

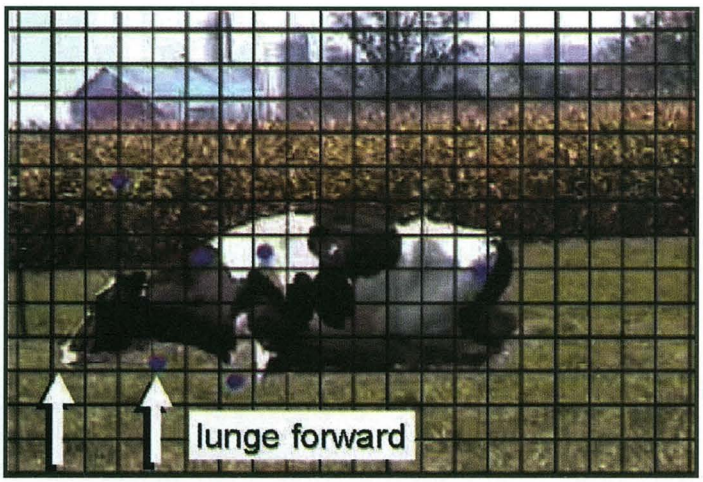


Figure 9a. Rising motions include a forward lunge. The arrows show the distance the nose travels forward of the resting position. The motions also include a downward and upward bobbing of the head.

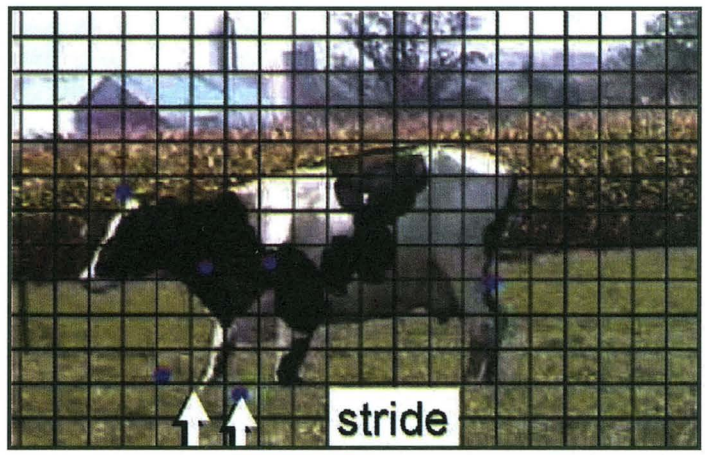


Figure 9b. The rising motion also includes a stride forward of about 18 inches by one front foot. The striding foot usually clears a 4-inch obstacle, and this sets the maximum height for a brisket locator.

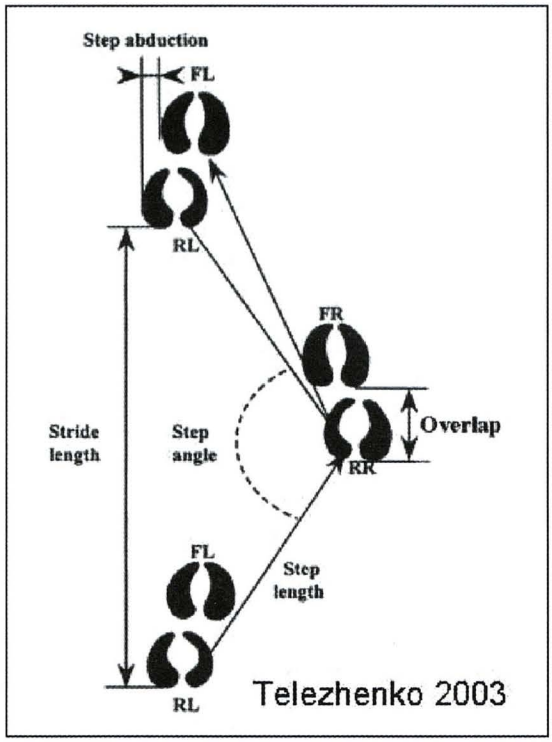


Figure 10a. Claw prints of a cow show several components of walking – including stride, step, step angle, overlap and abduction.[14]

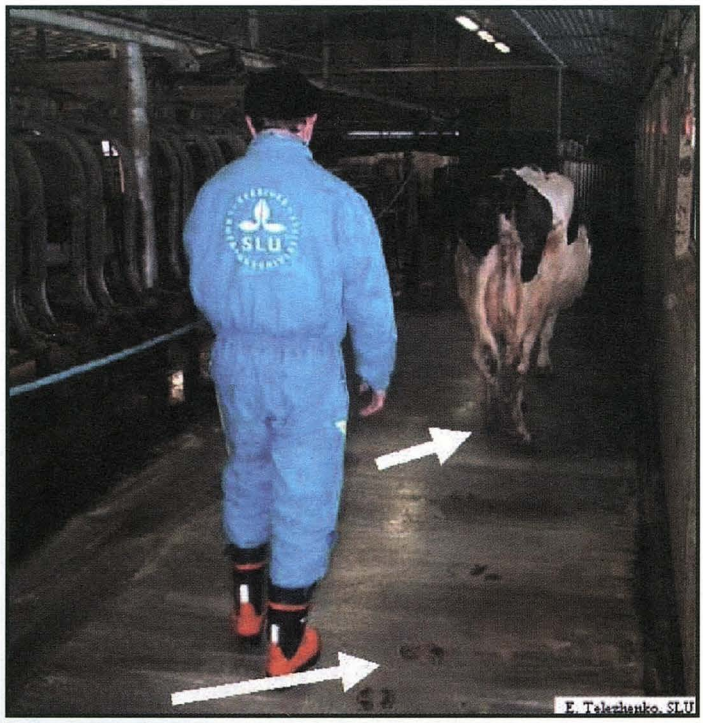


Figure 10b. A cow's foot placement and walking speed change with confidence in the flooring or lighting in a barn.

Another source of trauma is the restraint used at a feed bunk. Wire cable is one type of restraint. Pipe attached either directly to a post or on a mount to locate it forward of the post and over the manger, may be the most common restraint. A novel restraint uses pipes mounted on a pivot. With this devise, the larger cows in the group raise the restraint and carry the burden while feeding at the bunk.

2. Hock Injuries

Repetitive trauma to the skin of the hock and tuber calcis also leads to injuries. The injuries may be mild to severe. The common lesions include hair loss, gall, callus, hygroma and bursitis. Extreme cases in-

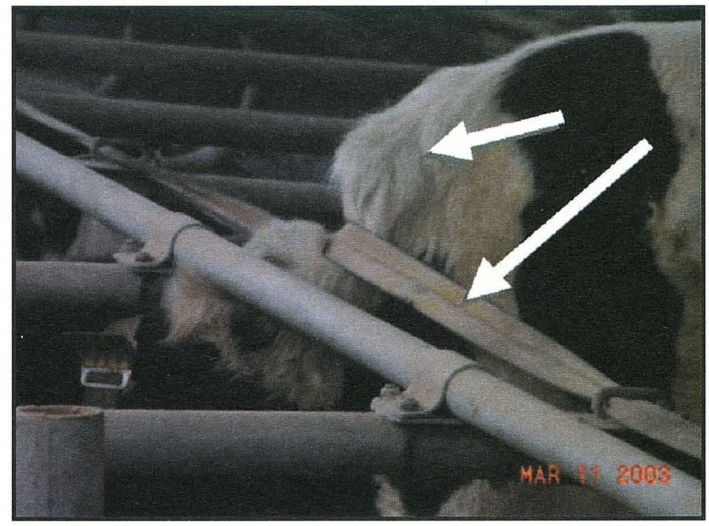


Figure 11. The region of the supraspinous bursa of the neck can experience repetitive trauma from a neck rail or strap when a cow stands in a stall, during the motions to lie, or during the motions to rise.

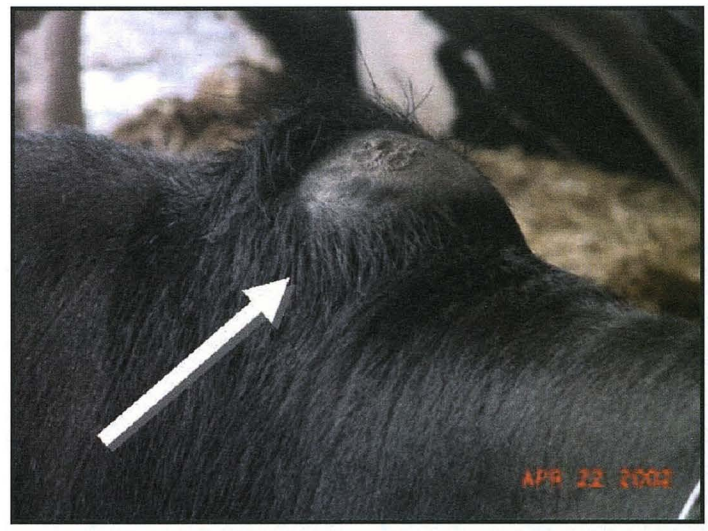


Figure 12. The arrow points to an injury on the neck related to a feed bunk restraint mounted 45 inches above the cow's feet.

clude infection of the tissues and joint space of the hock and lameness.

Injuries on the medial aspect of the tuber calcis arise when the upper leg of a resting cow extends over the curb when moving off the bed and into the alley. The lesions on the lateral aspect of the hock arise from friction following movement over the bed surface or from curbs and beds that lack suitable cushioning surfaces.

Cow Dimensions and Free Stall Features

A knowledge of cow measurements and their space requirements is necessary to design stalls or locate rails at feed barriers. Stall dimensions must be appropriate for standing, lying, rising and resting without injury, pain or fear. The next section of this document describes cow dimensions, space requirements and stall dimensions for modern Canadian Holsteins.

Figure 13a. Hair loss, skin abrasion and scab formation on the medial aspect of the tuber calcis arose from repeated contact with the concrete curb.

Figure 13b. Swelling and hair loss on the lateral aspect of a hock.

Cow Dimensions

Due to variation in cow size between herds, the first step in planning stall size is the measurement of lactation 1 and mature cows in your client's herd. To size stalls to fit the majority of their cows, measure the larger representatives in a group. Rump heights and hook bone widths are useful to estimate several other body dimensions. Since several body dimensions are proportional, the ratios provide reasonable estimates of dimensions for other dairy breeds.

It is becoming common to build pens with stalls sized for lactation 1 heifers, milking cows, and dry or special-needs cows, in recognition of variation in size and needs within a herd. A barn with one group of cows and one stall size poses several challenges to management and cows. Stall cleanliness, labor, mastitis, lameness and cow comfort are issues to consider in one-group barns.

Table 1 shows measurements of mature Canadian Holsteins taken at a local herd, and some calculated proportions. For example, the cows had a rump height of 60 inches, a nose-to-tail length of 8.5 feet, and a hook bone width of 25 inches. Their weight exceeded 1550 pounds.

Space Requirements

Observations of cows freely lying and rising reveal that a mature Canadian Holstein cow uses 102 x 52 inches of living space and another 20 inches, or more, of open forward space for lunging motions. Several cow dimensions that define this living space include those shown in Figure 15 plus imprint length and width. Imprint length describes the length from folded foreknee

Figure 14. Variation in cow size within and between herds highlights the need to measure cows before choosing stall size and to build pens of stalls accordingly.

to tail while lying in the narrow position. It defines the bed length needed for resting with all body parts on the stall. Imprint length is greater when the cow extends her front legs forward.

When resting in the narrow position, the point of the hock on the upper hind leg and the extension of the abdomen on the opposite side defines the imprint width. This width is the minimum stall width for a resting cow.

Nose-to-tail length describes the measurement from the tail to the nose of a cow standing with her head forward. When lying, the nose-to-tail length varies with the deviation of the head and neck.

The space needed for lying and rising motions (lunging) extends forward, downward and upward for head lunge and bob, vertically and forward for standing, and laterally for hindquarter movements. Knowledge of this space is essential for positioning neck and tie rails, deterrent straps, solid stall fronts, or provision of social space in open-front head-to-head stalls.

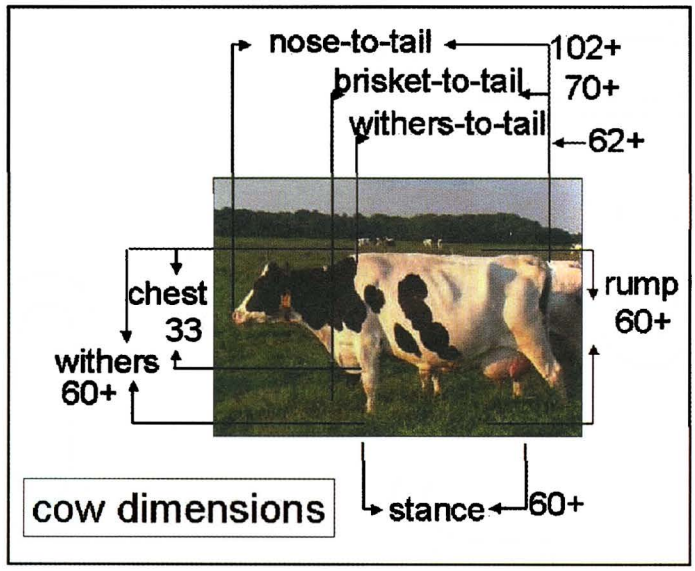


Figure 15. Several cow measurements taken on standing cows are useful for building free stalls. Other essential measurements are imprint length and imprint width of resting cows.

Stall Dimensions as Ratios of Body Dimensions

Hook bone widths and rump heights provide useful references for sizing stalls. The standing surface for the feet is the reference point for vertical placement of the neck rail or deterrent strap. The neck rail forward location is a horizontal measurement from the alley curb. Figure 26 shows head-to-head stalls and several example dimensions. Table 2 shows several stall dimensions of interest, estimated relationships to body dimensions, and an example calculation.

Stall Features to Consider

Caregivers must make several decisions when choosing stalls or feed bunk barriers. The loop or divider is one example. Some styles have a top and bottom pipe that is straight, while others have more complex bends as shown in Figure 19. Loops that arch downward at the rear of the stall allow cows to swing their heads over easily and turn out of stalls with their front feet still in the stall. This latter action may save bedding from being dragged out of the stall. The style of loop also is less likely to sustain damage from skid-steer buckets while filling stalls with bedding. Here are several items to consider when building or remodeling a barn.

1. Neck Rail

The neck rail is the restraint (often a pipe) mounted to the top or underside of the top pipe of a loop. It controls the forward location of a cow while standing in the stall. Proper location of the neck rail lets a cow stand straight with all four feet in the stall and rise without contacting the rail. The location is several inches lower and forward of the withers. It is usually directly above or an inch or two to the cow side of the brisket locator.

Table 1. The table shows body dimensions of interest, examples of measurements for mature Holsteins, and ratios to rump height and hook bone width.

Body Dimension	Inches	Proportions
Nose-to-tail length	102 (range 96-110)	1.6 x rump height
Imprint length – resting	72 (68-76)	1.2 x rump height
Imprint width	50	2 x hook bone width
Forward lunge space	24	0.4 x rump height
Stride length when rising	18	0.3 x rump height
Rump height – mature	Median 60 (range 58-64)	
Rump height – lactation 1	Median 58, top 25% - 59	
Stance – front to rear feet	60 (range 58-64)	= rump height
Withers (shoulder) height	60 (range 58-64)	= rump height
Hook bone width	25 (range 24-27)	

Table 2. The table shows stall dimensions, estimated relationships to body dimensions, and example calculations for mature Holsteins in a study herd.

Stall dimension	Ratio and reference body dimension	An example, a median cow
Stall length from curb to solid front	2.0 x rump height	2.0 x 60 = 120 in.
Stall length for open front head-to-head	1.8 x rump height	1.8 x 60 = 108 in.
Bed length = imprint length	1.2 x rump height	1.2 x 60 = 72 in.
Neck rail height above cow's feet	0.83 x rump height	0.83 x 60 = 50 in.
Neck rail forward location = bed length	1.2 x rump height	1.2 x 60 = 72 in.
Deterrent strap in open-front stalls	0.7 x rump height	0.7 x 60 = 42 in.
Stall width – loops on centers	2 x hook bone width	2 x 25 = 50 in.
Space between brisket locator and loop	foot width	5 inches

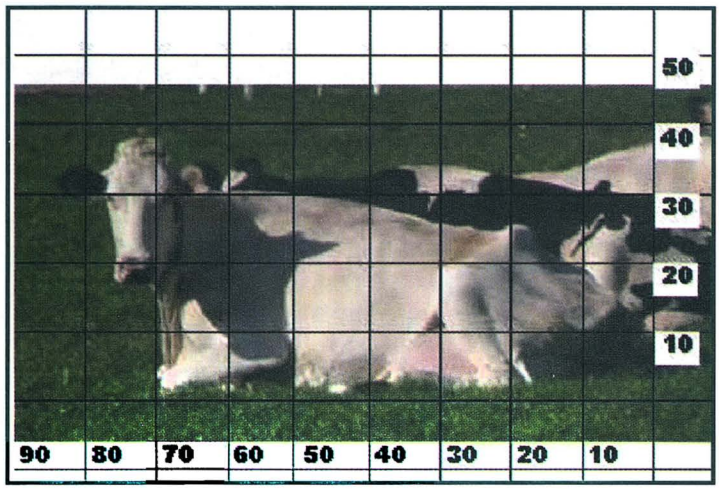


Figure 16. Imprint length extends from the folded foreknee to the tail. This length defines the bed length of a stall. For mattress barns, bed length is curb-to-brisket locator distance, but for most sand stalls the measurement is from the inside of the curb.

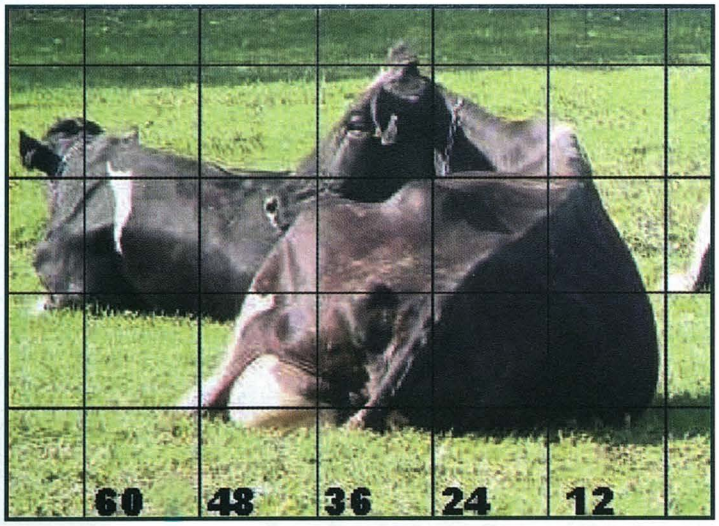


Figure 17. For the rear view of the cow in the photo, imprint width extends from the left hock to the right abdomen – a distance of about 52 inches. It increases when the rear legs extend outwards or the cow reclines in wide resting positions.

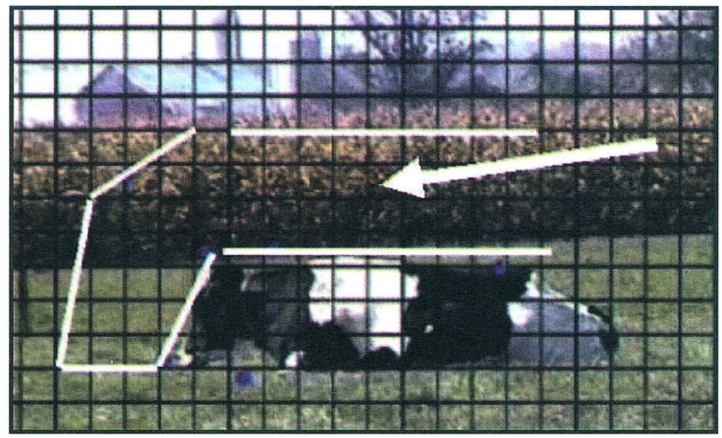


Figure 18. While rising freely on pasture, a cow uses the forward, downward and vertical space outlined by the white lines in the photograph.

Perching and diagonal behaviors are the most obvious signs of incorrect placement of the neck rail.

2. Wide Loop Opening – Forward or Diagonal Lunge

When rising or lying normally, a mature Holstein uses about 10 feet of space measured from her tail to her most forward lunge distance. This space requirement verifies that stall length should be 10 feet for stalls facing a wall, and 9 feet for head-to-head stalls when a cow can use space on the opposite side of center. The forward space must be unobstructed for frontward lunging and bobbing of the head.

Shorter stalls and stalls with obstructions in the lunging space lead to diagonal (corner-to-corner) standing, lying and rising. Cows still lunge forward, relative to their body direction, but diagonal or sidewise to the stall. Since the top pipe of the loop becomes the neck rail when cows lunge through it, the loop must have a wide opening. It also must have a low mount that does not inhibit the ability to lunge over it. The measurement from the top of the mattress to the top of the bottom pipe should be less than 12 inches. Since the top pipe of the loop becomes the effective neck rail, it should be about the height recommended for the neck rail.

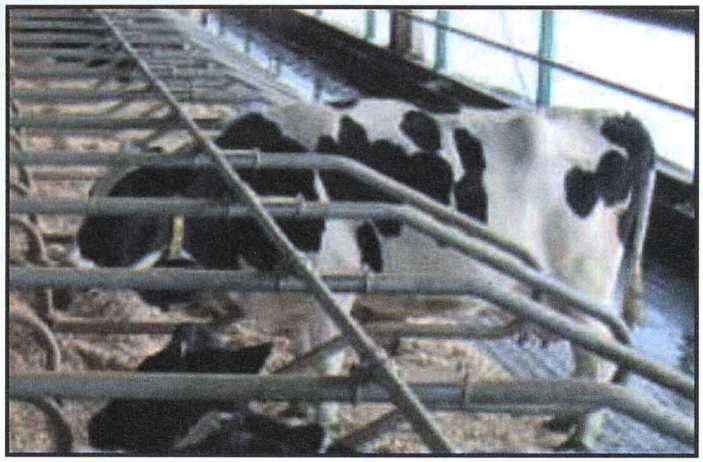


Figure 19. A neck rail placed 50 inches above the mattress and 70 inches forward of the curb allows this cow to stand straight in the stall with four feet on the bed.

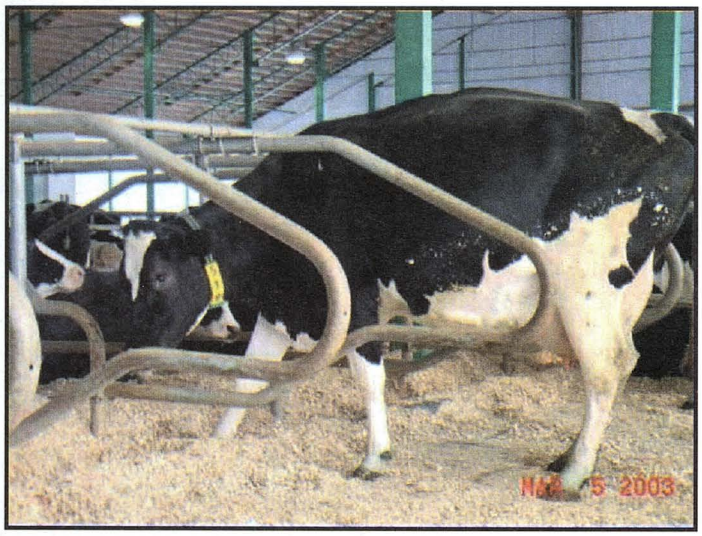


Figure 20. A wide loop opening and open-front stalls allow cows to lunge both diagonal and frontward. While rising, this cow did not contact the neck rail and she took the stride over the low brisket locator.

3. Brisket Locator

A brisket locator restricts the forward location of a cow lying in the stall. It defines the forward limit of the bed length measured from the rear curb. Boards of varying heights, concrete curbs, nylon straps and metal pipes have been the most common items used for brisket locators. Many barns have brisket locators that are too high and interfere with the stride taken during rising. A cow usually swings her foot high enough to clear a 4-inch obstacle. This establishes the maximum height of a brisket locator above a mattress or sand bedding.

It should have a rounded and smooth surface to ease movement of legs over it. The brackets used to support brisket locators on the lower pipe of a loop are an obstruction to extension of the legs. Brackets can be avoided by mounting the brisket locator on or below the stall surface. A 5-inch space between the brisket locator and the loop prevents entrapment of a leg.

4. Area Forward of the Brisket Locator

Objects in the essential space forward of the brisket locator are obstructions to the head lunge and bob, the stride, and resting positions for the front legs. This area should be the same height as the stall bed. The use of one support structure for the loop in single stalls or pairs of loops in head-to-head stalls keeps the area unobstructed with support pipes. Preplanning the stall layout first, and then adjusting roof truss and support-post spacing, assures that posts fall immediately adjacent to loops or their supports rather than in the forward stall space.

5. Deterrent Strap – Open-Front Stalls

Open-front stalls provide cows with a convenient route for escaping a dominant cow, a cow in heat, equipment used to bed stalls, or an aversive handler. A nylon strap will deter cows from exiting through the front of stalls. The usual mounting point is the support post for the loops. The deterrent must not interfere with the upward bob of the head. If it does, expect unwanted behaviors.

6. Sand-Bedded Stalls

The effective bed length for sand-bedded stalls is the distance from the inside of the curb to the brisket locator. This is especially true with sand maintained below the level of the curb. The rear curb is the fixed reference point for vertical measurements to locate neck rails. Neck-rail height and cow comfort change with the height of sand stored at the front of the stall. Ideally, the sand bed should be slightly sloped and filled to curb

Figure 21. A cow-friendly brisket locator is 4 inches, or less, high, has a smoothed surface, and attaches to the stall surface rather than the loops.

Figure 22. The area forward of the brisket locator must be free of obstructions to lunging and bobbing of the head. Plan the stall layout first, then the roof and its supports, so posts are adjacent to the loops.

Figure 23. If used, a deterrent strap must not interfere with the upward bobbing of the head. A suggested placement is 0.7 x rump height above stall surface (cow's feet).

height. Piles of sand stored in stall fronts are obstructions to lying, rising and resting behaviors.

7. Cautions and Precautions – Open-Front Stalls

A comfortable and safe stall requires attention to detail in construction and maintenance. Two accident cases illustrate that a stall is a unit and all features must be maintained to assure cow safety. At one farm, three cows injured their spines while attempting to exit forward. Two features contributed to the accidents. First, the sand bedding was several inches below curb height, and this effectively raised the neck rail relative to the cow's feet. Second, the stalls had a concrete slab that acted as a brisket locator and filled the space between the head-to-head stalls. After filling the stalls level with sand from rear curb to the forward concrete slab, and installing a deterrent strap, there were no further accidents. At another farm, piles of bedding stored forward of the brisket locator and a neck rail positioned 64 inches from the rear of the stall provided the cow trap. When rising, a cow wedged her chime under the neck rail, moved forward, and became trapped at the hips. The pile of bedding stored forward of the brisket locator made her predicament worse because it effectively lowered the neck-rail height. After removing the stored bedding, moving the neck rail forward and upward, and installing a deterrent strap, there were no further accidents.

8. Post and Rail Feed Barriers

The height for placement of a feed-barrier rail is measured vertically from the cow's feet on the alley side of the bunk. It is about 85% of the rump height of mature Holsteins – a location similar to neck-rail height in free stalls. The stabling is often adjustable and could be raised or lowered to suit cow size in various pens. A mount offsets the rail about 8-10 inches over the feed bunk. The drive-through feed alley must be 20 feet wide to permit passage of feed wagons without damage to the rail.

In tie-stall barns, producers have relocated the tie rail to 46 to 50 inches higher than the cow's feet, and 10 inches forward of the manger curb. They lengthen the tie chain to just touch the top of the manger curb.

Discussion

To evaluate behaviors of cows interacting with their housing, normal behaviors when free of obstructions must

Figure 24. The soft resting surface of sand-bedded stalls includes the space between the inside of the concrete curb and the brisket locator. This distance is the resting surface for the cow.

Figure 25. A post and rail feed bunk restraint mounted 51 inches above the cow's feet and about 8 inches forward of the center of the manger curb.

be known. It follows that altered behavior must be recognized, and that the reasons for it must be investigated. Injury, pain, fear, and frustration are great motivators to alter behavior and performance. Fear of humans has specific effects on cow behavior, performance and cow welfare.[13] Cows form a permanent fear memory after having painful or intimidating experiences. They relate the memory to a specific place, but the memory can be overridden.[7] Case studies in several Ontario herds show remarkable changes in behavior of cows following removal of obstructions in stalls. These could be examples of cows overriding fear memories. Then again, it may illustrate the innate wisdom of cows to use facilities that do them no harm.

Textbooks[1,12] contain descriptions of behavioral needs, normal behavior and problem behaviors of cattle. Problem behaviors are often subdivided into stereotyped, injurious and redirected. Idle standing, perching, diagonal standing and lying, and lying backwards behaviors could fit in one or more of those categories. However, the term **avoidance behaviors** would focus attention on reasons for the behavior – obstructions to freedoms, pain, injury, fear and frustration – rather than outcomes. Through the five avoidance behaviors described above, cows point to hazards in their workplace, often under manifesting their displeasure, suffering in silence, or coping as best they can.

It is puzzling that injuries receive minimal attention. For example, the cow in Figure 11 was one of several cows with neck injuries in a new multi-million-dollar dairy that I visited last winter. Before lying, she had to wedge herself into the stall with her neck tight against the neck rail, and her hind feet had to be placed well forward under her body to get footing inside the concrete curb. While few noticed the plight of the cows, most tour members gaped at the awesome facilities. Closer to home, producers participating in management clubs have been judging cow comfort by scoring hocks, necks, tails and other body parts for injuries and cleanliness. The exercise focuses attention on something they confess to overlooking during their barn meetings.

Neck injuries also can be found on cows in tie-stall barns. It is perplexing that neck injuries are rare in some barns with low tie rails, and common in other barns with tie rails fitted at the same location. The sparing effect may be the traction afforded by a very good bedding pack or a rubber-filled mattress. Cow size, ability to cope, scant bedding, slippery bed surfaces, a manger level with or lower than the cow's feet, or short tie-chain length also may be risk factors. Many producers, striving for cow comfort in older tie-stall barns, raise the tie-rail and move it forward, lengthen the tie chains, and install rubber-filled mattresses with suitable bedding.

Hocks and necks are two sites that should be audited for injuries. Some producers are unaware that their cows have the injuries, that the injuries are significant, or that their barn design is a contributing factor. Some farms have no cows with injuries. On other farms, the frequency varies from a few to the majority of cows in the herd.

Diagonal standing and lying in stalls are behavioral concerns to dairy producers because cows are more likely to defecate on the stalls and issues of stall cleanliness, labor, or mastitis follow. Remedies have been applied to prevent idle standing in stalls (neck-rail location), diagonal lying (narrow stalls, extension of bottom pipes of loops further into the stall), and forward resting positions (location of the brisket locator, deterrents at stall fronts, or stall length). When built to keep cows out, stalls stay clean, and workers are happy. However, the remedies focus on the self-evident – e.g., controlling diagonality and defecating in stalls because of the perception that the stall is too wide or the neck rail is too far forward or too high. Until recently, the focus has been on controlling the behavior rather than providing space in one or more dimensions for normal and desirable behavior.[3] Resting, standing or perching behavior may be as important for health as position control is for stall cleanliness because those behaviors have an impact on lameness, leg injuries, production, or longevity.

Cow dimensions collected in the 1950's have been the basis of standard recommendations for sizing stalls and dairy-cattle housing. There is no doubt that today's cows are larger and that the guidelines need to be updated. Although there are recommendations from the United Kingdom[5] and America[9] to use body dimensions for sizing stalls, North American extension publications use body weight as the reference for stall size.

Rising motions of cows have been photographed, studied, illustrated with diagrams,[5] and perpetuated in

modern texts,[4] yet there appears to be either confusion or disagreement about the space needed for forward lunging, or a reluctance to provide the necessary space. Three historical references recommended distances forward of the foreknee of 28-29 inches (UK), 31 inches (France), and 39-47 inches (NL) and the addition of this distance to body length to define stall length.[15,16] Another recommendation, cited in the same papers, suggested a stall length equal to 1.3 times body length. Body length, the common dimension for reference, was extrapolated from pin to shoulder length.

Using similar methods of calculation based on body length, it has been suggested that a full forward lunge space for all (US) Holstein cows would be available in an 8.0-foot free stall.[10] However, measurements and observations of mature Holsteins at several Ontario farms show that nose-to-tail length exceeds 8 feet, and imprint length while lying exceeds 70 inches. Our cows cannot lunge forward in an 8-foot stall. In it, they lunge diagonal or cope by bending their necks.

Since the space needed to lunge is forward of a cow's nose, it seems reasonable to use nose-to-tail length as the starting point for determining stall length. Video observations led to recommending 1.2 times nose-to-tail length to describe stall length. Stall length is the distance from the rear curb (in stalls with mattresses) to the forward-most obstruction. For mature Canadian Holsteins, stall length should be greater than 10 feet. This distance is made up of a bed length (curb to brisket locator) of 6 feet (imprint length) and the forward open space of 4 feet. In head-to-head open-front stalls, a distance of 6 feet between brisket locators provides the necessary space for facing cows. Stall length would be increased by the width of the concrete curb in sand-bedded stalls where sand level is maintained below curb height.

Observations showed that two times hook bone width approximates imprint width. This ratio provides a basis for determining stall width and the spacing of loops in free stalls. It is consistent with recommendations made almost two decades ago.[9] Cow dimensions and ratios in this document arose from limited data. They should not be viewed as definitive, but rather a means to stimulate discussion, awareness and possible research projects to collect data on modern North American dairy cows. For example, there is a need for the cow dimensions for each dairy breed – work that could be done with precision using digital images and computer-assisted programs. There also is a need to study the resting space occupied and required by North American dairy cows. The work could be done using enhanced photometric techniques along the line of those employed by Schnitzer and Kammer in 1975 (as referenced in Tillie). Judging by the number of cows with 'hangovers' (body parts off the bed), there is a need to survey existing barns for adequacy of stall size in a fashion reported in the UK.[6] A glossary of standardized terms and measuring points on the cow would be an asset.

Stall dimensions are chosen because of a neighbor's advice, a contractor's preference, an expert's opinion, barn cost per stall, or extension recommendations. When choosing stalls, performance data about resting, standing, and perching times, diagonal lying, and injury and cleanliness scores would be useful for making an informed decision. Regrettably, the data are not presently available.

Similarly, many characteristics of stalls are chosen for cow control and stall cleanliness, owner preference, or ease of construction. However, there is a growing trend to build barns with the cows' needs taking precedence. To do so, local contractors want to know what features are cow friendly. They also want and need to know why the features and dimensions are important. Those with the appropriate information become strong advocates for the cow.

The video portion of this conference presentation aims to stimulate questions about cow ergonomics. Time-lapse video has empowered cows. It gives cows a voice, a way to consult them about their pleasure or displeasure, and a means to involve them in changing their workplace. With video, the obvious becomes more self-evident.

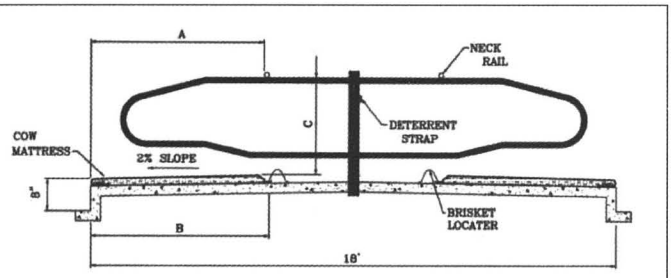
Conclusions

Behaviors that are detrimental to a cow's health, performance, longevity or welfare need to be recognized by those who care for cows. The provision of space for normal rising, lying, resting and eating activities leads to normal and acceptable behavior of dairy cows. The key to preventing unwanted or abnormal behavior lies in eliminating injury and pain and fear and frustration. Owners, caregivers, engineers, and contractors share the responsibility for providing a comfortable and safe workplace for dairy cows. If the barn harms the cows, remove the cause without delay. An easy yoke and a light burden are part of our responsibility to the cows.

The yokes He made were true,
because the man who dreamed was too
a craftsman. The burdens that the oxen drew
were light.

At night
He lay upon his bed and knew
no beast of his stood chafing in a stall
made restless by a needless gall.

ANON



	A	B	C	Width
Milking Cows	70	72	50	52
Lactation 1	68	70	48	48
Dry Cows	70	72	50	54

Figure 26. The diagram shows head-to-head, open-front free stalls with an 18-foot platform. The open space between brisket locators is about 6 feet. The table shows variations in stall dimensions to meet the needs of mature milking cows, lactation 1 heifers and dry cows.

Acknowledgements

Harold House, Agricultural Engineer, OMAF, Clinton, Ontario and Gerrit Rietveld, Animal Care Specialist, OMAF, Fergus, Ontario kindly provided the drawings in Figures 26 and 1, respectively. E. Telezhenko generously provided the illustrations in Figures 10a and 10b.

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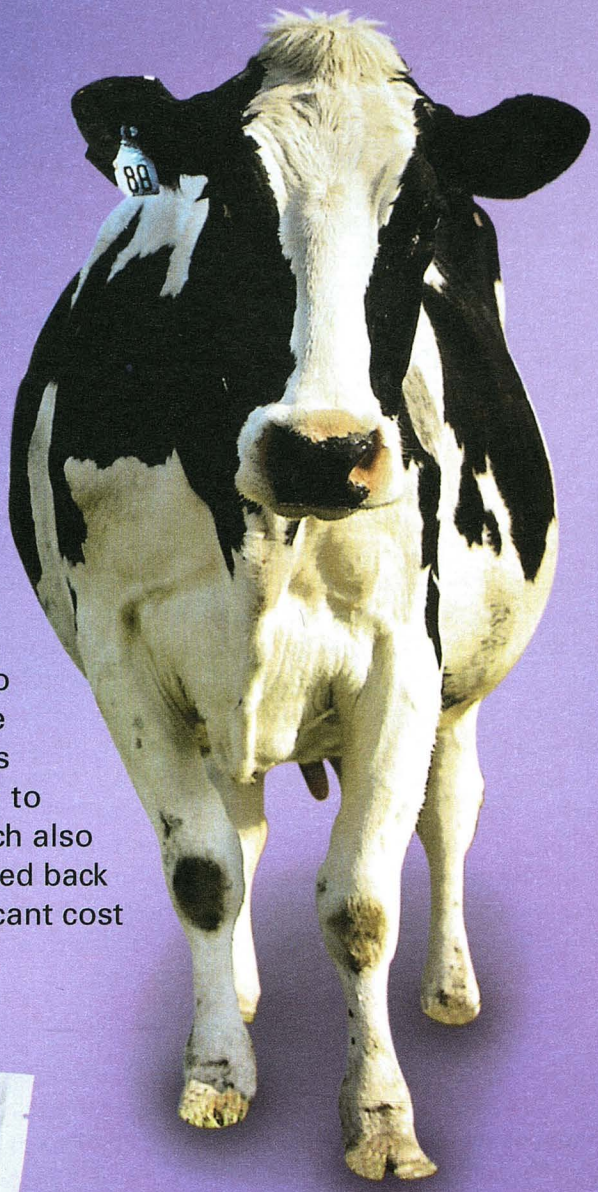

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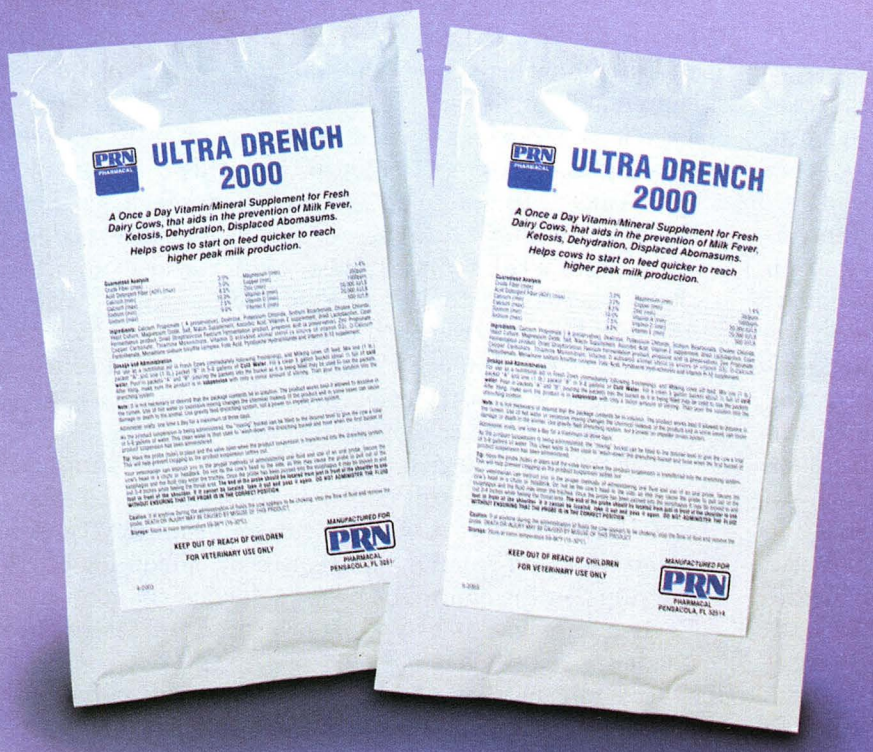

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