

Requirements

- The Red Tractor Scheme and the FAWC Report require that a cubicle housing system has a minimum of one cubicle per cow
- The Red Tractor Farm Assurance Dairy Scheme requires an adequate loafing area of at least 120% of the cubicle lying area
- BS5502 suggests that head rails should be adjustable and located 150-250mm below wither height and 20% of the length of the cubicle away from the head of the bed.

7.1 Cubicle design and cubicle bedding

There are a number of cubicle features that can affect welfare. Ideally, a cubicle will allow an animal to lie down and rest without colliding or rubbing against partitions.

An appropriate cubicle length will prevent soiling of the bedding and reduce risk of injury. Cubicles that are too short for the cow or partitions with rear support legs (eg Newton Rigg) may cause rubbing and swelling on the hocks. A good depth and cleanliness of cubicle bedding will create comfort and also prevent knee swelling and hock injuries.

The cubicle must be wide enough for the cow to lie comfortably but narrow enough to prevent her turning around. The cubicle also needs to accommodate the natural rising behaviour of the cow. Brisket boards that provide space for the cow to lunge forward when she kneels down to reach a lying position will facilitate the easy movement to lying which may prevent awkward twisting of the neck, back and front legs. The cow should not come into contact with the cubicle partition in such a way that could cause injury. This is particularly

important when the cow lies down, since the last stage in this movement is uncontrolled.

Think about

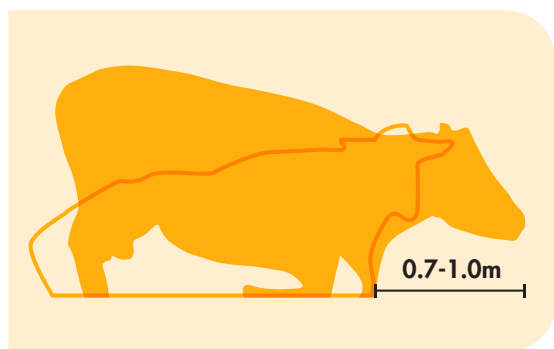
Poorly designed and managed cubicles can lead to poor occupancy, wet and soiled cubicle beds, increased risk of udder disease and lameness as well as physical damage to the cows.

Well occupied cubicles



Figure 7.a shows that when a cow rises from a lying position, she lunges forward to transfer the weight from her hindquarters onto her front legs. She will then raise her hindquarters before raising her forequarters. To accommodate this transfer of weight, the cow thrusts her head forward as she lunges. Observations have shown that a cow requires between 0.7 and 1.0m of space in front of her to rise easily. If the forward lunging space is restricted, she will have difficulty in rising. She also throws one foot forward when rising and any barrier to this normal activity may compromise the way she raises and possibly lead to lameness and reduced cubicle occupancy.

Figure 7.a - Illustration of cow rising



7.2 Number of cubicles

The Red Tractor Scheme and the FAWC Report require that a cubicle housing system has a minimum of one cubicle per cow.

When there is not a cubicle for every cow, lying time reduces, aggressive interactions between cows increase, incidences of lameness and mastitis both increase. EFSA advise at least as many cubicles as there are cows in the house. However, it is essential that all cubicles are usable by the cows. If some cubicles are less attractive or unusable then it is necessary to have more than one cubicle per cow.

A paper published in the USA reported that for every 10% increase in stocking rate above 80% occupancy, there is reduction of 0.73kg milk per cow per day.

Overstocking of cows (ie more cows than cubicles) can result in:

1. Additional soiling of hooves and bedding. One extra cow can contribute an extra 60 litres of slurry each day. This extra slurry is then distributed across the flooring surface resulting in increased hoof soiling which in turn increases the amount of slurry trampled onto the cubicle bed.
2. Reduced lying times because there are not enough cubicles for all cows to lie down together.
3. Increased lameness and claw lesions as a result of increased standing times as a direct result of cows not being able to lie down because of the lack of cubicles.

Think about

When cubicle systems are designed and built, the feed space allowance per cow and available water troughs should be calculated using a known number of cows. Increasing stocking rate above this threshold can have a negative impact on dry matter intake and water consumption.

Animals which are lower in the social hierarchy spend between 10 and 45% of their day standing in the passages. As a result, subordinate cows suffer more sole, interdigital and heel lesions. Providing additional cow places in the cubicle system will allow these cows to lie without risk of aggressive interactions. Other studies have demonstrated that not all cubicles are occupied to the same degree, with some being more preferred to others. This will also result in subordinate cows standing for longer periods of time.

There is also considerable debate regarding the location of cubicles within a building and how this can affect occupancy. In a Canadian study, cubicles closest to a feed passage were occupied for 68% of the day compared with only 48% occupancy for cubicles which were further from the feed area. In addition, cubicles at the end of rows were occupied 25% less than cubicles located in the centre of the row.

This may be because the cows have to walk further to food or have to navigate certain physical barriers (eg narrow passages) or social obstacles (eg dominant cows) on their way to more distant cubicles. Work carried out in Cambridge in 1990 indicated that the movement and resting of subordinate animals is heavily influenced by the location of dominant animals.

Think about

There should be at least 5% more cubicles than cows (eg a 100 cow group should have access to 105 cubicles).

7.3 Number of rows of cubicles

When considering a cubicle housing system with a central feed passage, the system is likely to be either a two-row system (two rows of cubicles accessing one section of feed stance) or a three-row system (three rows of cubicles accessing one section of feed stance).

Three row cubicle system



Various cubicle layout examples are shown below.

Figure 7.b – Central drive through three-row system, with 246 cubicles in two groups of 123. Suitable to house 234 cows (5% additional cubicles).

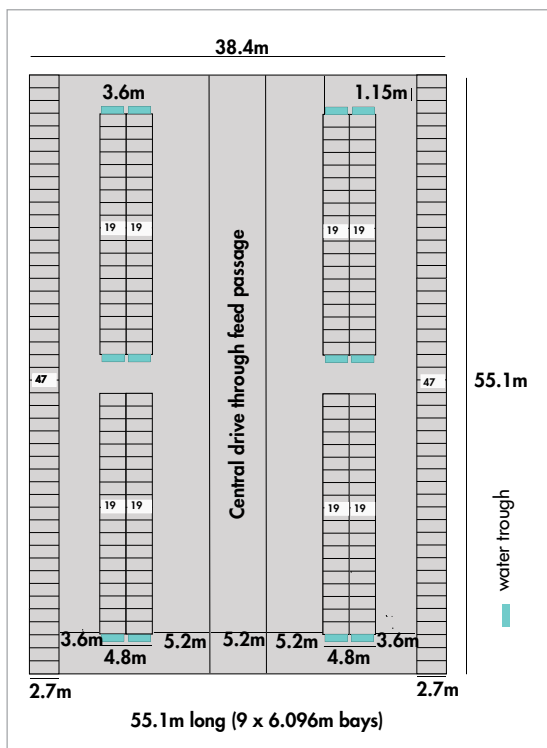
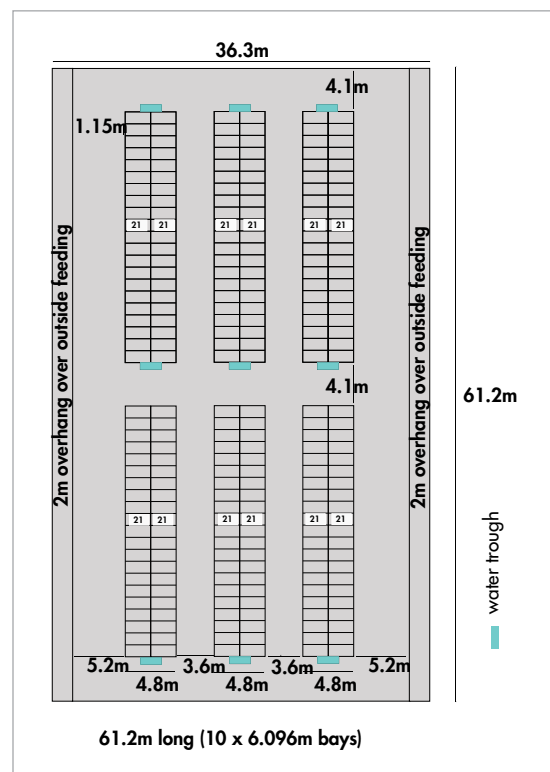


Figure 7.c – A three-row system with outdoor perimeter feeding, with 2m overhang. 252 cubicles either in one or two groups. Suitable to house 240 cows (5% additional cubicles).



Typically, a three-row system has a 25% reduction in passage dimensions when compared with a two-row system. It should be noted that the loafing area in a three-row system will be reduced in size, although there may be sufficient loafing space to comply with the varying standards and codes of practice, there will be other considerations such as cow behaviour, aggression and feed intake.

Two row cubicle system



Each animal generates a similar amount of slurry in a 24-hour period. A two-row system has 20% more surface area than a three-row system, this means that the accumulated slurry is distributed over a larger surface area helping to reduce the depth of the accumulated waste.

A critical component of any environmental mastitis programme is the requirement to keep cows standing on clean concrete for 30 minutes after milking, to allow sufficient time for the teat orifice to close. Although this can be achieved with a three-row system, it requires the use of electric fences or other moveable barriers to prevent cows accessing the cubicles which are adjacent to the feed face. Two-row systems utilising perimeter feeding and two sets of head-to-head cubicles (Figure 7.e) may also have the issue of keeping cows from lying down in the cubicles directly after milking.

Example layouts for a two-row system are illustrated in Figures 7.d and 7.e.

Figure 7.d – Two-row system with a central feed passage, 170 cubicles in two groups of 85. Suitable to house 162 cows (5% additional cubicles)

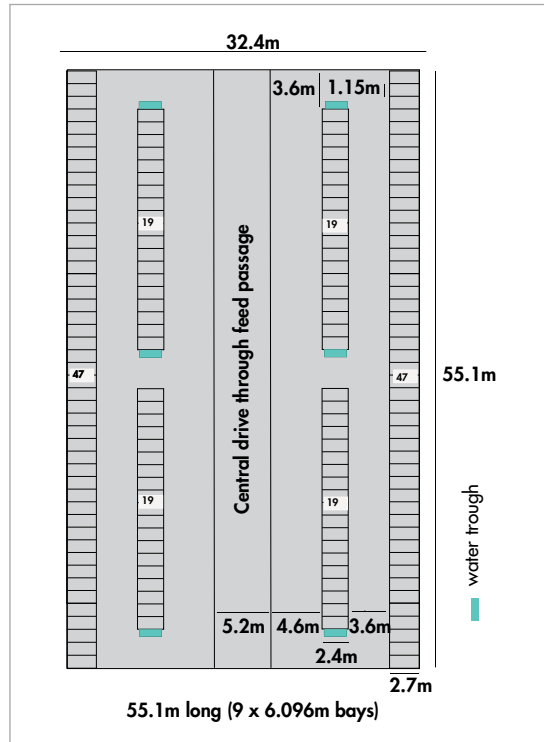
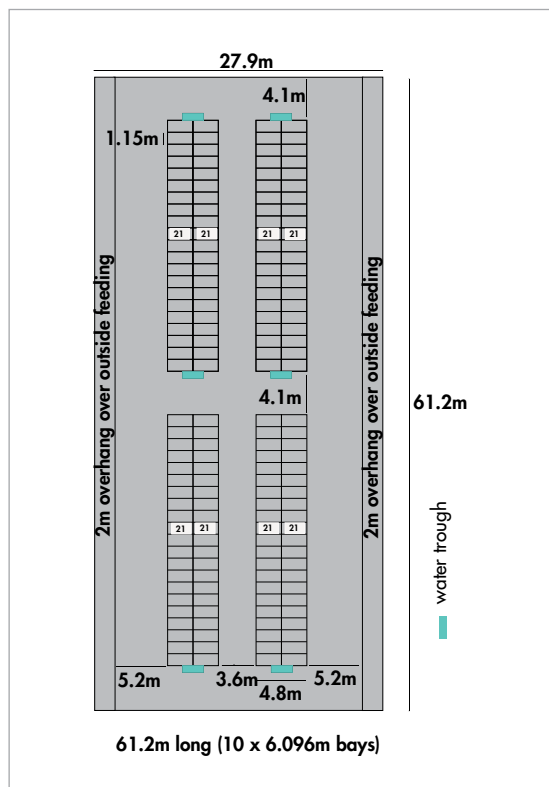


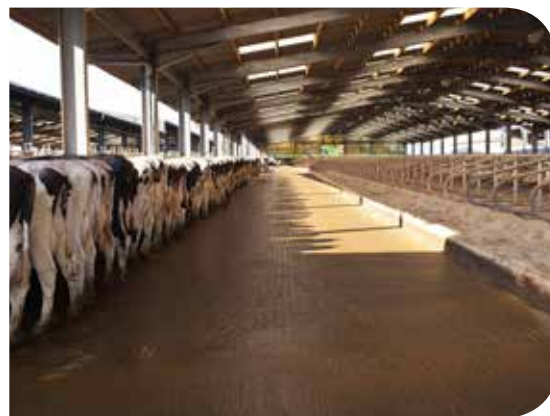
Figure 7.e – Two-row system with outdoor perimeter feeding, with 2m overhang. 168 cubicles in one group. Suitable to house 160 cows (5% additional cubicles).



4. Feed passage in a three-row system where one row of cows are backing out of cubicles onto the feed passage should be at least 5.2m wide
5. Feed passage in a two-row system should be at least 4.6m wide

Wide passages increase loafing area and can improve positive social interactions and reduce negative aggression interactions between cows. In hot weather, wide passages can be difficult to scrape as slurry is spread over a wider area and can dry out more quickly.

5.2m wide feed passage



7.4 Passage widths and layout

Typically, the main types of passages in a cow house are the feed passage, cubicle passage and cross-over passages. The purpose of a passage within a cubicle building is to facilitate cow movement, allow the cows to loaf and exhibit social interaction as well as allow the removal of slurry. All passages should be designed to ensure that there are no dead ends where a dominant cow can interact aggressively with a subordinate cow.

The Red Tractor Farm Assurance Dairy Scheme requires an adequate loafing area of at least 120% of the cubicle lying area. To achieve this figure within the confines of a feed/sleep building, the following passage widths are required:

1. Passage between rows of cubicles should be a minimum of 3.0m with an ideal width of 3.6m
2. Cross-over passages without a water trough should be 2.4m wide
3. Cross-over passages with a water trough should be 3.6m wide

Cross over passages should be installed at the end of every row of cubicles to remove dead ends. A cross over passage should also be located at approximately every 20 cubicle places, depending on building layout and size. It is recommended that there should be no more than 25 cubicles without a cross over passage. The cross over passages should be constructed to the same height as the surrounding cubicle beds to promote ease of cleaning.

! Think about

In order to provide uninterrupted cow flow, an intermediate cross over passage without water troughs should be at least 2.4m wide, when a drinking trough is installed in the cross over passage, the width should be increased to a minimum of 3.6m to allow cows to pass behind other animals who are drinking.

Cross-passage with drinking trough



Feed passages also have to facilitate vehicle movement. In particular, farms that rely on forage boxes/complete diet feeders, need to ensure that the machine can enter the building and work easily once inside. As the capacity of these trailed feed dispensers increases, the dimensions also increase and consideration should be given to possible future requirements.

It is also important to take account of the driving skills of the operator. Minimising all building dimensions to reduce costs may appear prudent. However, if these tight dimensions are marginal, not only will the time taken for the tasks to be carried out increase, but damage could occur to staff, cows or machinery.

7.5 Cubicle dimensions

The required dimensions of a cubicle are dependent on the size of the cow. Previously this has been best-estimated using body weight, although cubicle partition design can affect this.

The body weight of an animal can be estimated by measuring the chest girth and the diagonal body length. This is demonstrated in Table 7.a.

Table 7.a – Relationship between chest girth, diagonal body length and weight.

Cow body weight (kg)	Chest girth (m)	Diagonal body length (m)
375	1.68	1.36
425	1.75	1.41
475	1.81	1.46
525	1.87	1.50
575	1.93	1.54
625	1.98	1.58
675	2.04	1.62
725	2.09	1.65
775	2.14	1.68
825	2.18	1.72

Research has concluded that cubicle usage increases with increased cubicle size. However, the dimensions required for a cubicle will depend on the cubicle location (eg against an outside wall, open front facing a feed passage or head-to-head facing another cow).

7.6 Cubicle length

The total length of the cubicle should provide body space, headspace and lunging space.

Cubicles which are open front (either facing a feed passage or head-to-head) allow a cow to extend past the cubicle perimeter when rising, either by placing her head in the adjacent cubicle in a head-to-head arrangement or by utilising the extra space available in the feed passage.

Open fronted cubicles



Cubicles which are closed at the front have some type of barrier which prevents the cow from lunging outside the perimeter of the cubicle. These are often the outside cubicles facing a wall.

When rising naturally, a cow will choose to lunge forward. When a cow can lunge forward, she will lie straighter in the cubicle. Cows which are forced, by inadequate cubicle length, to lunge to the side will often lie at an angle in the cubicle.

If a closed front cubicle is too short, the cow may respond by lunging to the side or rising in a dog/horse fashion. Selecting a cubicle partition which allows this sideways lunging action can be helpful, although this can encourage cows to lie diagonally. When cows lie diagonally, they are more likely to soil the rear of the cubicle which results in dirtier cows.

Cow rising in dog/horse fashion



A study in Canada examined the rising pattern of cows and reported that when cows were housed in a cubicle bed with a closed front which was 2.4m long, they lunged diagonally 68% of the time. When the fronts were removed to allow straight lunging, the percentage of cows lunging diagonally fell to 44%.

In a UK survey carried out in 1995, the researchers concluded that a Friesian/Holstein cow at pasture required a lying space approximately 2.4m long and 1.2m wide. They suggested that a cow required an additional 0.6m length to facilitate lunging. When these parameters were considered, it was reported that 87% of cubicles in the study were too short and

50% either too wide or too narrow. However, cow size has increased in the intervening period and such dimensions would now be considered too small. More up-to-date research is required in this area.

It is critical that the length of the cubicle bed is correct. The difference in required bed length when cows have either an open or closed front cubicle is demonstrated in Table 7.b.

Table 7.b – Guidelines on cubicle length

Weight of cow (kg)	Total length of bed (m)		
	open front	closed front	Head to head
550	2.10	2.40	4.20
700	2.30	2.55	4.60
800	2.40	2.70	4.80

Think about

- As the length of the bed increases, it is important that the length of the partition increases. There should be around 0.35m from the back of the partition to the cubicle kerb. If this distance is greater, cows may walk along the back of the cubicle or try and reverse into the bed.

The assertion has been that with head-to-head cubicles, the length of each cubicle can be somewhat reduced due to the potential of cows sharing the common lunging space, studies have shown that this leads to bobbing action by both cows, causing the cow opposite to rise as well.

One cubicle size does not fit all cows and, therefore, a compromise has to be reached where cow groups include animals of various size and parity.

7.7 Cubicle width

It is important that a cubicle is wide enough to allow the cow to recline and rise easily. If the cubicle width is excessive, cows will tend to lie at an angle in the cubicle or some smaller cows may lie backwards in the cubicle. Both will lead to an increase in faecal soiling of the bed. The main cause of cows lying at an angle with wide cubicle dimensions is thought to

be insufficient cubicle length. If the cubicle length is correct then cows will lie straight.

The width of the cubicle will be determined in part by the choice of cubicle partition. If the partition fitted has a rear support leg, the partition should be installed with a clear distance between partitions of 1.2m.

Think about

EFSA states that cubicle width should be at least 1.8 times cow hip width (hook bones).

A diagram showing how hip width should be measured



7.8 Partition design

There are numerous types of cubicle partitions currently available on the market. The overall requirement of any partition is to provide the cow with maximum comfort, while ensuring that she is correctly positioned. The partition also needs to impart a degree of protection to prevent injury from neighbouring animals but not cause any discomfort or injury to the cow herself.

Many of the traditional designs have partition sections which impinge on the area on which the cow may choose to lie. Lower rails (often installed 400mm above the bed surface) could lead to cows becoming trapped and many partitions with a rear support leg can cause damage to the cow's hock and pelvis.

Suspended partitions (eg Cantilever) with very little restrictions to interfere with the cow at rest continue to be very popular. Although variations of suspended cantilever divisions remain a popular choice, there is little evidence to compare their performance with other

partitions. Manufacturers make small design changes but there is little independent evidence-based science to support these adaptations.

Suspended cantilever partition



Table 7.c – Occupancy rates for a range of partition designs.

Partition Design	% Occupancy/cubicle	
	Lying	Lying and standing
Newton Rigg	30	43
Dorsdun	31	46
Dutch Comfort	33	50
Dutch Cantilever	39	64
Super Dutch Comfort	51	71

A recent development has seen the emergence of a simple partition design incorporating a flexible pole. It is, however, important to ensure they are the correct dimensions for your cows.

One of the advantages of several designs of the cantilever type of partition is that both height and width can be adjusted, allowing small changes to be made with significant implications, for example, for cubicle occupancy, cleanliness and standing position.

Farmers who have installed the flexible pole partition report animals walking along the front of the beds and the manufacturer has subsequently released an updated version of this partition which includes a horizontal rail from the partition to the front of the bed.

7.10 Slope

Cows prefer to lie facing uphill so cubicle beds should be installed with a slight fall from the front to the rear. The fall will also help drain any liquids (eg milk and urine), where the cubicle base has an impermeable finish, which could otherwise contaminate the bed.

Think about

A consistent fall of 2-3% across the length of the cubicle bed is satisfactory, any steeper than this and the bedding becomes hard to retain.

7.11 Kerbstone

Kerb height and degree of slope are important design considerations. Cows tend to prefer lying uphill and this will also allow urine and leaked milk to flow down and away from the cow.

The height of the kerbstone should be between 15-20cm. The final height of the kerb will be dictated by the method of slurry removal, although cow comfort should always be the main consideration. Although concerns have been raised about excessive kerb height, with adverse affects on foot health as a result of prolonged perching. This concern is minimised if overall dimensions are correct and cows can comfortably stand with all four feet in the cubicle.

Scraped passages may require a slightly higher kerb to prevent faecal soiling of the beds when the passage is scraped. Slatted passages will allow the kerb to be reduced in height. The kerb height should not be reduced below 15cm, as this can encourage some cows to lie partly in and partly out of the cubicle.

Think about

When fitting mats or mattresses, it is important that their height is included in the kerb height calculation. This will help ensure that the kerb stone does not protrude above the mattress causing discomfort to the cow, on the other hand, sufficient kerb height is required to prevent mattress movement or slippage.

7.12 Cubicle lying surface

The challenge is to provide an optimal cubicle surface that provides thermal insulation, softness, traction, low risk of abrasion, easily maintained, easy to clean and cost-effective to initially install.

If comfortable cubicle base and bedding, along with the correct cubicle dimensions are used, then cows will be encouraged to spend time lying. This will have a direct bearing on rumination and the condition of their feet and the incidence of lameness.

Constructing a cubicle bed from concrete is a common practice. However, bare concrete is not an acceptable surface and, to ensure cows spend time lying in the cubicle, it should be covered with bedding. There are many bedding options available and each have advantages and disadvantages.

Some choices are:

- Straw (chopped or long straw)
- Sawdust
- Shavings
- Wood ash

In many cases, the choice of cubicle bedding is dictated not by the requirements of the cow but by the requirements of the farm's existing slurry handling system. Numerous studies have demonstrated that when concrete cubicle beds are compared with softer alternatives, the cow will show a preference for the softer alternative.

Think about

- Bare concrete or hard rubber mats without bedding are unacceptable cubicle surfaces. The softer the bedded surface, the more acceptable the cubicle will be to the cow.

To reduce the depth (amount) of bedding, there are numerous cubicle base types which can be used (eg mat, mattresses, waterbeds). Suggested initial cost of a mattress in GB is around £55-70/cow and they have a life expectancy of between 6-10 years. Cubicles with either mats or mattresses require a small amount of some type of absorbent bedding material applied to them to help keep the beds dry, the cows clean and prevent hock and knee abrasions.

The quantity of bedding material is an important factor to cubicle comfort, for example, cows spend over an hour longer lying on heavily bedded mattresses with 7.5kg sawdust and 1.3 hours longer on 7kg chopped straw compared to 1kg. Several studies have reported an increase in hock lesions on rubber mats compared to mattresses, however, more hock lesions were observed on mattresses compared to deep bedded sand.

It would be typical to use in the region of 1.0kg of kiln-dried sawdust each day on a mattress.

Sand-bedded cubicles have become very popular in GB. Producers who opt to use sand accept that there is an ongoing labour requirement to keep the beds raked clean and replenished with fresh sand. Ideally, the sand bed should be filled to kerb height. Piles of sand stored in the front of the cubicle are obstructions to lying, rising and resting behaviours and should be raked and flattened out daily. Sand level is important for lying time, when the depth of sand begins to decline, occupancy and lying times also decline. As sand level drops below the kerb, cows spend less time lying in the cubicles. When the sand beds became pitted (defined as a drop below the kerb height of 13cm) the lying times declined by 2.33 hours/day. Lying time decreases by 10 minutes for every 1cm decrease in sand level below the kerb. Deep sand-bedded cubicles have been shown to decrease lameness prevalence by half in comparison to rubber mats and mattresses with little or no bedding. Sand decreases hock lesions and their severity when compared with mattresses.

Cow cleanliness is not improved on sand but sand has a lower bacteria count compared to sawdust or straw but no effect on somatic cell count has been demonstrated. Although the initial investment with sand-based cubicles is low, the labour associated with filling and maintaining the beds and the adverse effects that sand can have on waste handling systems need to be considered.

When occupancy was observed, deep bedded sand and rubber filled mattresses consistently showed the highest occupancy while concrete and rubber mats consistently showed the lowest occupancy. The results can be seen in Table 7.d.

Table 7.d – Cow preference for different cubicle bases

Cubicle base	% cubicles occupied
Rubber filled mattress	89
Deep bedded sand	79
Mat	65
Bare concrete	39

Not all mattresses are equally attractive to cows and it has been demonstrated that some mattresses have a higher occupancy than other mattresses.

Regardless of the type of cubicle base or bedding used, cubicles should be routinely bedded and raked out.

Think about

- It is important to observe your cows' legs, particularly the hocks and knees for signs of severe hair loss, abrasions or swelling as this may indicate insufficient cubicle comfort.

Although a considerable amount of work has been done looking at the features of different lying surfaces, in general, researchers have failed to demonstrate a financial benefit from investing in one technology or another. However, the majority of the studies have demonstrated improvements in cow comfort and lying times and a reduction in physical damage which will indirectly influence cow longevity and welfare and may be the driving force from milk buyers and consumers for such investments.

Further reading

- M von Keyserlingk and D Weary. 2009. Improving the Welfare of Dairy Cattle: Implications of Free Cubicle Housing on Behaviour & Health. Proc. Western Dairy Management Conference, pp 43-52.
- Nordlund, K.V. 2004. Behavioural needs of the dairy cow and considerations for facility design. Vet. Clin. Food Anim. 20 495-520.
- Leonard, F.C. 1996. Effect of Overcrowding on Claw Health in Friesian Heifers. Br.Vet.J.152:459-472.
- Wierenga, H.K. 1990. The significance of cubicles for the behaviour of dairy cows. Appl. Anim. Behav. Sci. 26:309-337.
- Miller, K. and Wood-Gush, D.G.M. (1991). Some Effects of Housing on the Social Behaviour of Dairy Cows. Anim. Prod. 53:271-278.
- Cook, N.B. (2009). Big sand cubicles: best thing ever or bad idea? Proc National Mastitis Council, Charlotte, pp10-24.