DairyNZ

Dairy cow housing

A good practice guide for dairy cow housing in New Zealand

For more information visit **dairynz.co.nz**

DairyNZ
Corner Ruakura and Morrinsville Roads
Private Bag 3221
Hamilton 3240

Version 3 - 04/2025 DNZ50 – 007

The development of this good practice guide was funded by DairyNZ and the Ministry for Primary Industries through the 'Transforming the dairy value chain primary growth partnership'.

Note
All dairy farm operators must comply with the MPI Animal Products (Dairy Processing) specifications for milking and animal health as set out in the registered Risk Management Programme covering their operation. If you alter the farm system by adding a housed facility, talk to your milk supply company about any additional milk supply requirements.

Contents

This guide provides information on the design aspects, factors for cow comfort, good management principles, future-proofing options, and the relevant Code of Welfare minimum standards for dairy cow housing. This guide will help assist you in maintaining and achieving good management practices for cow housing facilities. In this guide, a housed cow is defined as a cow that spends a significant portion of her day or year in a housed cow unit.

We recommend seeking professional advice from reputable sources before making any significant changes or investments in your farming system. Proper guidance can ensure that your housing facility meets all necessary standards and improves cow comfort and productivity.

If you are considering integrating a robotic milking system within your housing facility, talk to your milk supply company about specific supply requirements.

This booklet does not include uncovered stand-off pads and feed pads. For information on these topics, and for further cow housing resources, visit **dairynz.co.nz**

Minimum standard – Code of Welfare

These boxes state the minimum standards from the Dairy Cattle Code of Welfare.

Future proof

These boxes show future proof pointers to make sure you can stay flexible.

Good practice

These boxes highlight key facts and figures in good practice.

1 Cow Comfort

Globally, our understanding of animal welfare has evolved. Instead of thinking only about health and production, we now take a broader perspective that includes behaviour and affective state, which considers an animal's experiences and mood. A successful off-paddock system will take the cows' experience into account alongside the environmental, financial and practical aspects of housing.

Dairy Cow Housing should be designed to allow cows to demonstrate natural behaviours and promote their overall wellbeing. Cows are social animals and will establish a hierarchy through their behaviours and interactions with one another.

Lying is an important behaviour for cows. If the surface is suitable, they'll spend 10-12 hours a day lying down, to rest and ruminate. The ability to perform natural behaviours like grooming, feeding and lying are influenced by the design and stocking density of the housing system. When planning your off-paddock system, think about what a cow needs to be content and comfortable.

1.1 Animal welfare

The Animal Welfare Act 1999 places the responsibility on all owners and people in charge of animals to ensure that they meet the physical, health and behavioural needs of the animals.

The Act does not define what the needs are or how to meet them for every situation. This is left to the codes of welfare issued under the Act. Codes of welfare establish minimum standards and recommended best practices. They have legal effect, and failure to meet a minimum standard in a code of welfare can be used as evidence to support a prosecution for an offence under the Act. Conversely, meeting a minimum standard can be used as a defence against a prosecution under the Act.

Look out for the blue boxes throughout this guide which highlight minimum standards.

Minimum standard – Code of Welfare

No.9 – Managing Dairy Cattle in Off-Paddock Facilities

- Buildings and facilities for managing dairy cattle off-paddock, and all fittings and internal surfaces, including entry races and adjoining yards, must be designed, constructed and maintained so as not to cause injury and to meet the health and welfare needs of the dairy cattle.
  - Automated systems, including for feeding, water reticulation, cleaning and milking, must be checked daily and provisions must be made to safeguard animal welfare in case these systems fail.
  - A contingency plan, containing fire prevention measures, emergency evacuation procedures, and pest and disease management plans, must be in place.
- Must be inspected at least once a day and timely preventative or remedial action taken to address identified problems.
- Stocking rate must allow a minimum of one free-stall per animal housed. The design and size of the free-stalls must allow all dairy cows in the facility to lie without the body extending outside or overhanging the end of the free-stalls.

1.2 Cow comfort factors

All aspects of cow comfort should be achieved to provide an environment for optimum welfare, health and production.

Behavioural needs

Cows need to move freely from area to area, turn around, and move in and out of stalls easily. Cows must be given the correct space and environment to be able to pass each other easily, socialise and groom. Cows need to walk confidently on non-slip, reasonably clean flooring.

Ventilation and shade

Cows need infrastructure that supplies good quality air through an effective ventilation system and provides shade to reduce the impact of heat stress. Cows need uniform distribution of light to make best use of lying areas and cow traffic areas.

Lying surfaces

Cows need to lie down comfortably on compressible, dry and clean bedding. The bedding should provide stability for cows to easily get up and lie down, and allow them to spend long periods resting comfortably.

Feed and water

Because herds or groups of cows have a social hierarchy with higher and lower rankings it is important that the correct feed face and trough space is provided at the right height dimensions. Cows will be most settled if there is minimal competition for space, feed and water.

Fitting cow brushes in any barn is beneficial. Grooming is very important, due to the health and wellbeing benefits it provides.

2 Defining and considering systems

The design and management of a housing system is influenced by how long the cows will use it, e.g., whether it's all winter, or just for shorter periods of the day. Irrespective of how the facility is integrated into your farm system, it must provide a clean, dry, and comfortable environment that does not compromise cow health, welfare, comfort, or production.

If the facility is expected to house cows for longer periods of time, the greater the consideration for key factors like structural robustness, effluent management, and cost. The level of design detail required when housing cows for long periods should not be underestimated.

When selecting a housing option, it is important to be clear on the purpose of the facility. There are many factors to consider. Each of the following points is covered in more detail in this guide:

- The suitability of the facility to house lactating and/or dry cows.
- The local climate requirements for housing during hot and/or wet periods.
- Access to resources such as water and a sustainable supply of bedding material.
- Construction costs of building the facility.
- Long-term costs associated with maintaining and managing the facility.
- Animal health and welfare implications.
- Effluent management and storage systems and intended use for old bedding, effluent, and potentially separated effluent.
- Building lifespan and how it fits with long-term farm plans.
- Regulatory requirements specific to your regional and district council.
- Future proofing, with the allowance of future potential expansions or changes in farming practices.

2.1. Making an informed decision

To ensure you are operating your farm as efficiently as possible, the decision to invest needs to be based on a robust analysis of the farm business.

Do your homework

- Make sure any changes you want to make will solve the problem you want to address and align with your goals.
- Confirm proposed changes with independent, qualified people.
- Use proper financial tools: use capital investment tools like net present value to assess the viability of your investment.
- Remember that ancillary costs (e.g. effluent, labour, machinery) can add 30%-100% to the build cost.
- Understand the risks and skills associated with running a system with off-paddock facilities.
- Use benchmarking to identify areas where efficiency can be gained and apply practices that minimise wastage.
- Make infrastructure adjustments to address environmental challenges effectively.
- Consider the impact of expensive imported feed sources.

2.2 Designing your system

Ensure your choice of housed facility meets the needs of your system. Consider how your new facility will integrate with existing infrastructure. Think about how transitions in and out of the facility will occur and whether there will be any bottlenecks or unintended consequences.

Farm system considerations

- If the infrastructure will be used for feeding lactating cows, access and proximity to the milking shed is important.
- Allow enough room around the loafing and feed pad areas for auxiliary structures like turning circles, stone traps, weeping walls, effluent tanks, and silage bunkers. A further consideration is flush tanks that may have to be raised above the highest point of the flood wash surface.
- Consider cow flow from existing races into and out of the structure, as well as farm lanes for heavy vehicles during construction and when the structure is in use.
- Plan how rainwater from the roof will be captured and removed or reused.
- Understand site suitability such as the soil layers and how deep you need to cut to reach stable sub-soil; this can significantly impact cut-and-fill costs.
- Ensure the facility can accommodate the size of the tractor, wagon and other machinery required to manage the facility efficiently. A turnaround area may be necessary, and the tractor laneway should be at least four metres wide.
- Determine if large areas of concrete will be used for holding cows during the winter, how these surfaces will be cleaned and their contribution to effluent storage.
- Efficiently place silage bunkers/stacks to minimise loading and transporting time. Plan for the containment of silage leachate and any additional infrastructure required.

2.3 Area allocation

Getting the area allocation per cow right is essential for maintaining cow health, welfare, productivity and overall wellbeing.

- Maintaining optimal allocated area per cow, allows staff to easily monitor individual cows, ensuring timely detection of illness, distress, and behavioural changes.
- Providing ample space between animals can help minimise the spread of pathogens and parasites leading to healthier herds.
- Sufficient space reduces competition for resources (bedding and feeding face), fostering a more peaceful and stress-free environment for cows.
- Ensuring adequate ventilation can prevent the buildup of ammonia gases, promoting better air quality and respiratory health.

Required space allowances for cow comfort

	Loose housed systems		Freestall system
	Integrated paddock and housed systems	Wintering system or other long-term use	
Loafing space allowance per adult cow	6 – 8m^2	9 – 11m^2	Refer to required design specifications including: stall, passageways and feed alleys to determine total stocking rate. There must be one freestall per animal housed.

2.4 Lying areas

Housed cows need to lie down comfortably on compressible, dry bedding for ideally 10-12 hours (minimum of 8 hours) per day to optimise health and welfare.

Minimum standard – Code of Welfare

No.6 – Providing for behavioural needs

- Dairy cattle must be able to walk, turn around, lie in a natural position, lie down and rise freely, and express normal feeding behaviour and appropriate social interactions.
- Dairy cattle must be able to lie and rest comfortably for sufficient periods to meet their behavioural needs.

No.9 – Managing Dairy Cattle in Off-Paddock Facilities

- Dairy cattle must be provided with a well-drained lying area with a compressible soft surface or bedding that is maintained to avoid manure accumulation, and artificial or natural shelter or other means of minimising the effects of exposure to the weather.

Good practice

Knee test A. Drop to your knees from standing on the bedding to test how comfortable it is. Two thirds of a cow's weight is on her front knees when she goes to lie down.

Compressible bedding

Cows housed on hard surfaces, such as concrete, solid or slatted floors, and river stones, experience increased lameness, stiffness, and agitated behaviour. They also have decreased lying times, reduced dry matter intakes, and lower body condition scores. To create a comfortable lying surface, additional bedding material must be added to these hard floors.

Rubber overlays can be used to improve comfort for standing and lying. However, it is important to think about how you will maintain the rubber, as it can become slippery when wet and unhygienic as it deteriorates. Not all rubber will increase cow comfort, so select wisely.

For information on field testing of lying surfaces conducted by DairyNZ, see section 3.2.

Key considerations for lying areas

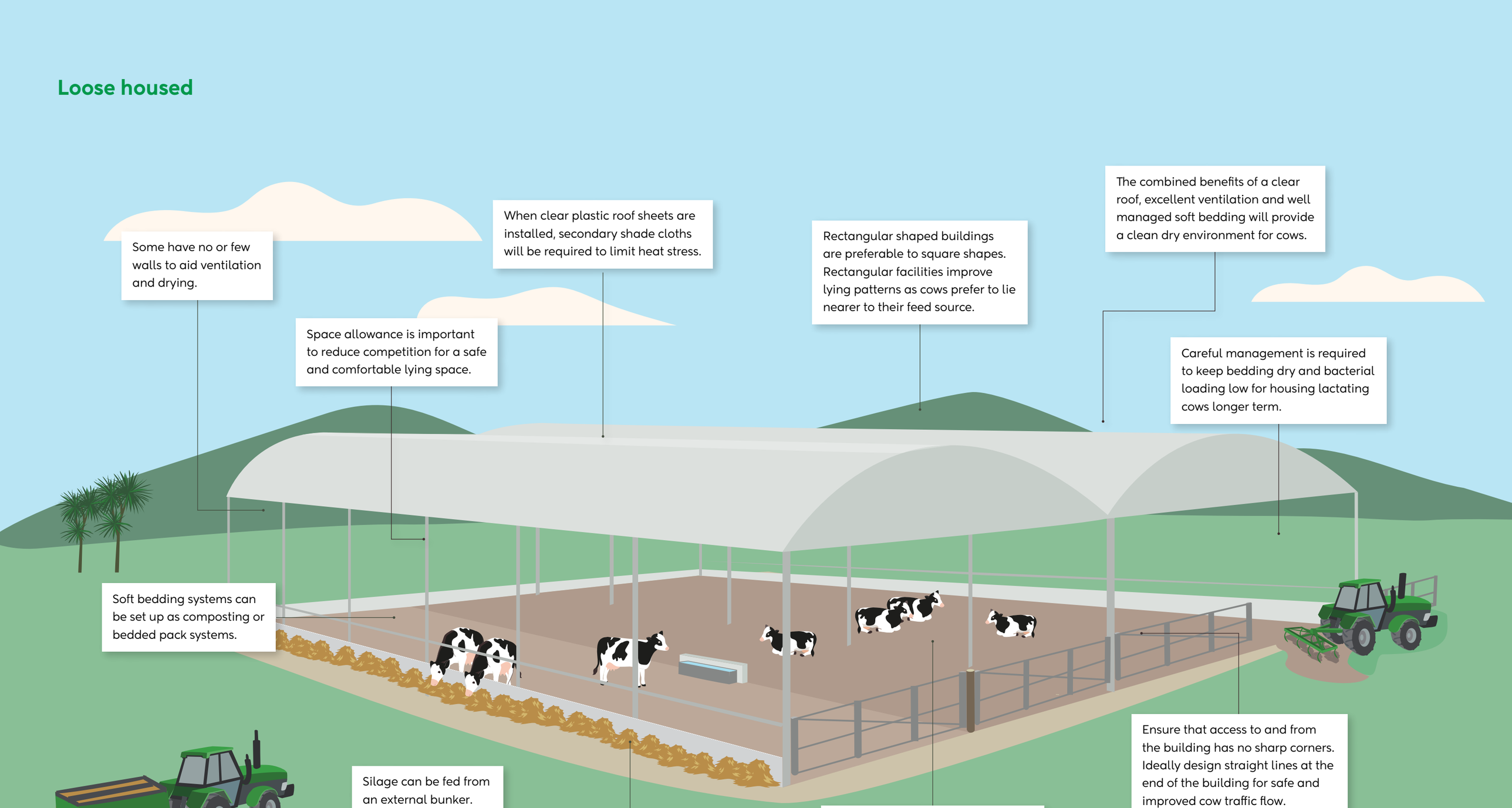
Keeping the lying area dry and clean is essential for comfort and animal health, particularly for calving cows. Good design of the lying area, proper area allocation, effective drainage, management of the lying surface, and adequate ventilation all contribute to maintaining dry and clean lying surfaces.

- Use compressible materials like woodchip, sawdust, sand, straw, or appropriate matting to provide a soft and comfortable lying surface.
- Regularly add fresh bedding and remove solid material to ensure cleanliness and comfort.
- Ensure the lying area has proper drainage to prevent moisture build up.
- Provide adequate ventilation to keep the lying area dry and reduce the risk of respiratory issues.
- Invest time and effort to ensure effective composting for a warm, dry bedding surface.

Good practice

Knee test B. Try kneeling on the lying surface for 10 seconds and see how wet and dirty your knees get. Wet knees mean you should assess some of the factors that influence dry and clean beds. In an integrated system cows spend time inside and outside every day. If cows are not comfortable inside, they will lie down when let out to pasture in preference to grazing, potentially resulting in underfeeding. There is a direct link between lying time and production.

Loose housed



Some have no or few walls to aid ventilation and drying.

When clear plastic roof sheets are installed, secondary shade cloths will be required to limit heat stress.

Rectangular shaped buildings are preferable to square shapes. Rectangular facilities improve lying patterns as cows prefer to lie nearer to their feed source.

The combined benefits of a clear roof, excellent ventilation and well managed soft bedding will provide a clean dry environment for cows.

Space allowance is important to reduce competition for a safe and comfortable lying space.

Careful management is required to keep bedding dry and bacterial loading low for housing lactating cows longer term.

Soft bedding systems can be set up as composting or bedded pack systems.

Ensure that access to and from the building has no sharp corners. Ideally design straight lines at the end of the building for safe and improved cow traffic flow.

Silage can be fed from an external bunker.

Cows lie in a designated lying area in a similar pattern to pasture cows. There are some options for bedding material and each will achieve varying degrees of cow comfort.

Feed tables can be located around the perimeter, centrally within the building, or outside.

Effluent management will vary, but most systems rely on effluent draining through the bedding to a drainage system and Into an effluent collection system.

3 Loose housed system designs

There are a few basic designs of loose housed systems, primarily based on the position and type of feed passage. Proper design is important to ensure cow comfort, ease of management, and efficient use of space.

Design option one: Feed table accessed from the inside with soft-bedded feed passage

In this design, cows access the feed table from inside the barn, and the feed passage is bedded with soft material to enhance cow comfort. To achieve the right stocking rate, calculate the lying area. Do this by removing the section shaded green from the total barn area. Allow at least two metres for the length of each cow and multiply this by the total feed table length.

Lying area for loose housed system housing 150 cows

a) Calculate total barn area
70m x 25m = 1500m²

b) Calculate feeding area
65m x 2m= 130m²

c) Subtract feeding area from total area
1500 - 130 = 1372m²

d) Divide by the maximum number of cows that will use the barn to give space allowance per cow.
1372m² / 150cow = 9.1 m²/cow

Design option two: Feed table accessed from the inside with scraped concrete passage

In this design, cows access the feed table from inside the barn, and the feed passage is made of concrete that is regularly scraped or flood washed. Ensure the distance from the feeding area to the centre of the bedding area (if feeding along both sides) doesn't exceed 10 metres to improve the lying pattern and even distribution of cows. Make feed access passageways 4.5 metres wide to allow cows to pass behind others that are feeding.

There should be open access along all sides of the bedding area to the feed passage to prevent congestion, pugging and reduced bedding space. Place a drain behind the feeding area to handle high traffic and the accumulation of dung and urine. If using flood washing to clean the passage, minimise spray drift into the bedding area.

Provide wide entry and exit points for good cow flow.

Design option three: Feed table accessed from the outside with scraped concrete feed passage

In this design, cows access the feed table from outside the facility, and the feed passage is concrete that is regularly scraped or flood-washed. Design the building so cows can be removed from the feeding area and closed onto the bedded area, allowing the passage to be cleaned once or twice a day. This can be managed with a reel and standards. Position a nib wall between the bedding pack and the feed passage to prevent water runoff from the feed passage into the bedded area and to contain the bedding material. Ensure the concrete feed table is more than 1.2 metres wide to reduce feed wastage. Include rainwater entering the effluent system in the calculations for effluent storage.

Additional considerations are wider concrete feed tables (1.2-1.5 metres) and durable machinery tracks to reduce feed wastage and pugging. See feed barrier section for the best design to suit the cows.

Woodchips can be placed just inside the doors, rather than sawdust. Woodchips are more durable in high traffic areas and less likely to be carried outside on cows' hooves.

Consider wider concrete feed tables (1.2 - 1.5 metres) and durable machinery tracks to reduce feed wastage and pugging. See feed barrier (section 5, page 34) for the best design.

3.1 Loose housed bedding materials

Wood products

By-products from the timber industry are commonly used as bedding for cows. Wood products typically do not require daily or weekly topping up, as cow traffic helps to stir up the material. However, weekly maintenance (or daily for some systems) is required.

- Use a tractor with implements such as grubbers, tines, or rippers, to aerate the surface. This helps break down faecal matter and promote composting.
- Do regular checks to ensure there is at least 50cm of soft, dry bedding, adding more if necessary.

There are many types of wood products available, with some being more suitable for bedding than others.

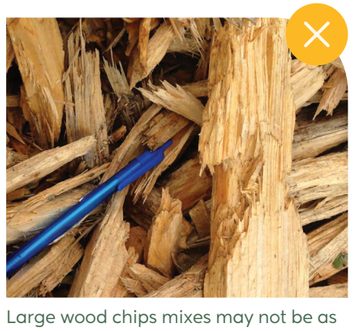
- Square chips provide good drainage and comfort. Avoid chips that are too small and soft or contain a lot of fine dusty material (fines) as these can clog and restrict drainage. Conversely, chips that are too large can be uncomfortable and create a poor walking surface.
- Ensure woodchip is from untreated timber to avoid toxicity to livestock.
- Avoid macrocarpa chippings as this tree has been linked to late-stage abortions.
- Avoid recycled wood product chips as these may contain nails and staples.
- The drier the woodchips are before use, the longer they will last, as they have a higher capacity to absorb moisture. Kiln dried woodchips are available.
- Keep woodchips in covered storage to maintain dryness.

To extend the lifespan of woodchip in loafing areas, reduce the dung load by minimising the time cows spend on this surface. Remember, cows need 10-13 hours of lying time per day and access to water at all times. Automated gates can help control access on and off loafing and feeding surfaces.

"We have found by running over the bed every day with a set of tines, our bedding surface is so much better; I wish we had done this from the first winter we used it."

Use pine or a timber type that chips square and not stringy.

Some mixes can contain sharp parts that could cause discomfort and injury for cows.



Large wood chips mixes may not be as comfortable for the cow.

Straw

If straw is used for bedding, it will require more frequent topping up than woodchip. Additionally, straw can be relatively difficult to source in large volumes in many areas of New Zealand.

Compost systems

Composting systems can be set up in loose-housed facilities. When managed correctly, a composting system provides dry bedding that needs little extra composting after removal and only occasional topping up throughout the year. These beds are built using fine wood chipping or sawdust with a moisture content of 45–55% and a minimum depth of 45-60cm. The bedding pack builds up over time and needs to reach temperatures between 43 to 60°C for proper composting and to remain dry. The top 20cm of material is cultivated twice a day to incorporate urine and faecal matter and aerate the top layer. This aids the composting process and should be done when cows are out of the barn.

The bacteria levels in compost bedding packs are very high. Maintaining a dry lying surface is critical to minimise material sticking to the cow or its udder. Moisture from the bedding is removed by natural evaporation, facilitated by internal compost temperatures of approximately 55°C and dry matter (DM) content of at least 50%. The external compost temperature provides a comfortable resting surface, with compost typically replaced once per year. Milk quality risks can exist in poorly managed composting systems due to the high levels of bacteria that may contact the cow's udder. Starting a composting pack well can reduce the need for frequent top-ups but be prepared to top up if required. Well-managed systems may only need topping up every eight weeks, while poorly managed packs may require weekly top-ups.

Bedding material sources, consistency of cow dung (25% DM or higher), labour requirements for pack management and stocking density are all important considerations when planning to build this type of system.

3.2 Artificial bedding surfaces

Choosing an artificial bedding surface for housing facilities requires careful consideration. You need to balance the needs of the cow with a surface that performs well. The surface should provide cows with comfort to enable natural resting behaviour and good traction to allow natural movements and prevent slipping. You can test the comfort levels of surfaces using the knee drop test. The surface should be easy to clean, environmentally friendly, durable and sustainable.

Interlocking rubber matting on concrete.

Experimental pour-in-place rubber surface prior to adhesion of a geotextile top surface.

Field testing of surfaces

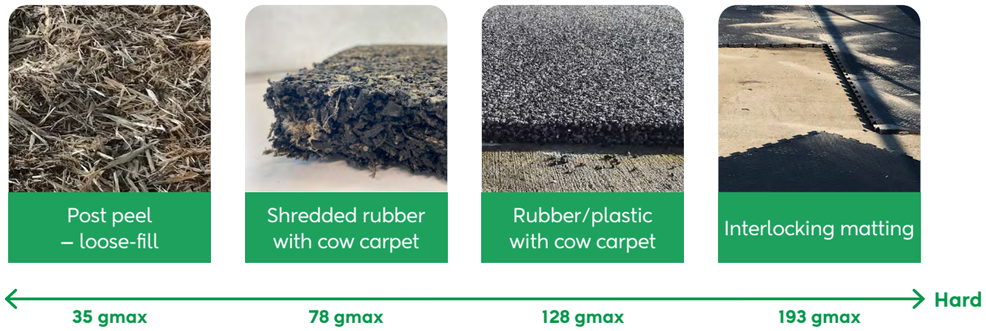
Information on the performance of artificial surfaces is mostly subjective, making it difficult to gauge differences in on-farm performance between options. DairyNZ has investigated objective field-testing methods to assess the performance of existing and new loafing surfaces and sub-base combinations under normal farming conditions. Comfort levels were corelated with cow lying duration and bouts.

Dairy cow lying times for tested surfaces

The comfort (compressibility) performance of rubber matting is influenced mostly by material density, thickness, and the structured pattern under the mat that allows deformation rather than just compression. The surface pattern and compressibility affect slip resistance. A higher profile surface pattern provides more grip but may be uncomfortable for cows and cause abrasions.

A 2.25kg Clegg Hammer, an accelerometer-based device used internationally to measure the firmness of sports fields, was used to measure the 'comfort' of loafing surface materials with a range of firmness values. The results, shown as Gmax values, quantify the hardness of a surface where the higher Gmax values are associated with firmer surfaces and shorter lying times. The Turf Clegg Hammer results show a clear range from the least firm post peelings to the firmest rubber matting.

DairyNZ conducted a trial on different lying surfaces.
Surfaces were tested for firmness with a Clegg Hammer.
Results show a range of firmness values (Gmax) aross the 4 products.



Gmax results for firmness using the Turf Clegg Hammer for four loafing surfaces

- Post peelings: 32
- 50mm shredded rubber (SustainPor, NUMAT) with Cow Carpet: 72
- 25mm rubber/plastic chip (Ecocept, Tiger Turf) with Cow Carpet: 122
- 23mm interlocking rubber matting (Double Stud, NUMAT): 187

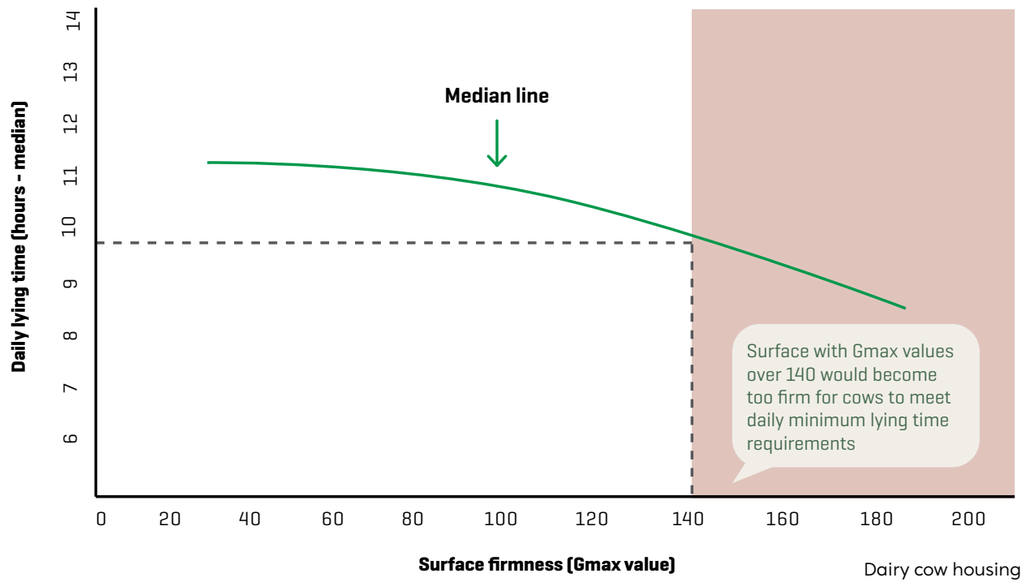
Additional Gmax values

- Woodchip for calf pens: 49
- Soft condition paddock: 58
- 25mm Rubber mix (SustainPor, NUMAT): 104
- 30mm Comfy Cow interlocking rubber matting: 140
- 25mm Kura (NUMAT) interlocking rubber matting: 182

The Clegg Hammer results showed a strong negative relationship with lying times, with higher Gmax values associated with lower lying times.

Consider cow comfort by using the Gmax value of lying surfaces

Consider the products firmness and how it will impact your daily lying time requirements for cows. The median line below shows the relationship between the firmness of the surface and the daily lying time. Ideally cows should get 10-12 hours per day.



3.3 Flood washing surfaces

Flood washing can be used to clean artificial surfaces for feeding or loafing. This method involves releasing a large volume of water in a short time span, creating enough force to dislodge dung on the surface and wash dung, urine and feed waste into a receiving sump or drain. The key to success is the volume of water and the slope of the surface, which together create enough force to dislodge dung.

Generally, cows are not too concerned by the flood wash water but will move out of the way in their own time once they are used to it, as observed during an on-farm trial in Southland in 2022. During the trial, the flood wash was used every three days, depending on the amount of dung. If left for too long, cow dung can become very sticky on the surface, and one flood wash event may not remove it. Minimise any obstacles in the flood wash path, as manure will accumulate on the downslope side of these obstacles, requiring extra labour and time to clean.

Conditions for flood washing

- The surface has a slope of at least 2% (a 2m fall per 100m distance) with collection drains/sumps at the end.
- Used wash water can be treated to remove most solids so that it can be recycled (green wash).
- Suitable for roofed and unroofed structures, concrete or rubber surfaces.
- To reduce labour requirements.
- Can be used in combination with light scraping on geotextile carpet surfaces over shredded rubber.
- Good drainage is required underneath permeable surfaces like shredded rubber with a geotextile overlay and rubber matting.
- Flood wash water will seep through permeable surfaces and must be channelled away to prevent stagnation and bacterial growth.
- Flood wash drainage can be achieved by diagonal grooves in concrete that direct water to the sides of the structure.
- Effluent from flood washing surfaces must be collected and effectively managed.

The surface should be boxed (concrete nib or timber joist between flood wash and other surfaces) to avoid open edges. A natural slope will substantially reduce your construction costs if you are considering flood washing as a cleaning system. If there is no existing slope, this must be created by cut and fill, and costs can quickly escalate. If you use imported gravel fill for constructing a slope, this can be very expensive. Ensure any components purchased for the flood wash system are fit for purpose.

Effluent from surfaces needs to be collected. Flood wash is usually collected in drainage channels and pumped to the storage area. Rain and yard wash water should go into a storage tank or pond to dilute the greenwash, otherwise it may thicken through repeated use.

Green water exiting the risers and flowing from top to bottom in this picture.

Water pressure and flow

Pressure needs to be created by the volume of water and height. For example, two 30,000 L flush tanks raised 1-1.25m above the highest point of the flood wash surface can create sufficient pressure. Nib walls should be high enough to contain bow waves created by scrapers if being used. Release valves should be large enough to release the required volume in a short time. One basic approach is rising pipes opening from below in the concrete surface. There are special release valves on the market designed to release large volumes of water.

Flood wash risers imbedded in the concrete. Water flows from right to left.

Scraping while washing

Scraping certain surfaces can improve the efficiency of cleaning with flood wash. Scraping a concrete surface with a rubber blade attached to a quad bike can be very effective, especially when the blade is pushed upslope against the flow of water, creating a bow wave that disturbs the water and helps remove the dung. However, scraping should be done with care on a surface like geotextile carpet covering a shredded rubber underlay. The blade can still be used but should be raised a few centimetres above the surface to avoid rumpling and loosening the carpet from the rubber underlay.

3.4 Drainage

Poor drainage is a major contributing factor to bedding pack failure. While the type of bedding material used can influence drainage effectiveness, a good drainage system must be installed under the bedding material to ensure that liquid effluent is removed from the bedding pack. The surface below the bedding material should be impermeable and meet your regional environmental standards.

Installing drains in exit ways will minimise the amount of muck brought onto the bedding area. All liquid effluent should be captured on a sealed surface and drained to the effluent system. Some composting barns are now being built without any drainage, utilising up to 1m of bedding material. Consult with your regional council and barn supplier for more information.

Stay informed

If the barn is used for housing the milking herd it is important to ensure the cows remain standing for a minimum of 30 minutes after milking to give the teat canal time to close to reduce the likelihood of mastitis. This can be achieved by providing fresh feed after milking and enough feed space per cow so that all cows can feed comfortably at the same time.

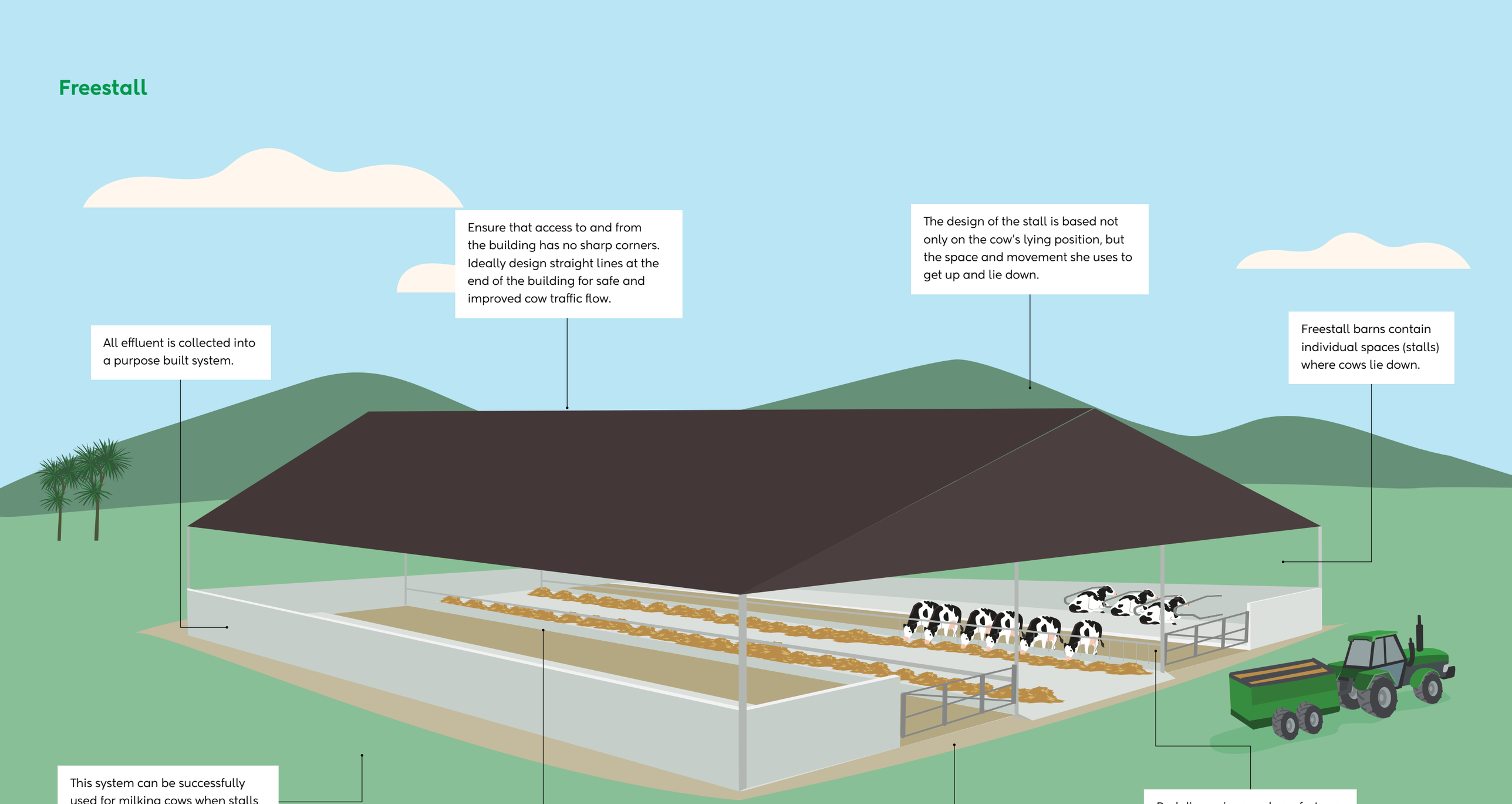
Freestall

Ensure that access to and from the building has no sharp corners. Ideally design straight lines at the end of the building for safe and improved cow traffic flow.

The design of the stall is based not only on the cow's lying position, but the space and movement she uses to get up and lie down.

Freestall barns contain individual spaces (stalls) where cows lie down.

All effluent is collected into a purpose built system.



This system can be successfully used for milking cows when stalls and lanes are managed correctly.

Feed tables are commonly located centrally within the building.

Undiluted effluent is designed to drain into the concrete cow traffic lanes and is either scraped or flood washed at regular intervals.

Bed dimensions and comfort are essential to a well-run freestall barn that maximises lying time, productivity and welfare.

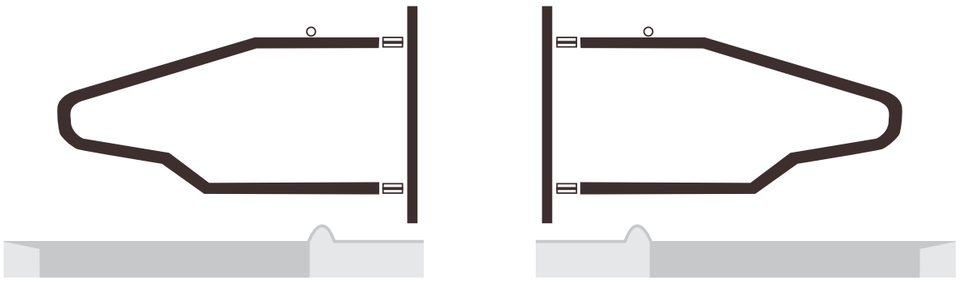
4 Freestall design

A freestall building designed according to the needs and size of the herd provides flexibility for separating specific mobs of cows based on age or stage of lactation. It also allows for differential feeding using dividers (gates) to partition the building. Ensure design and management comply with the requirements in the Dairy Cattle Code of Welfare.

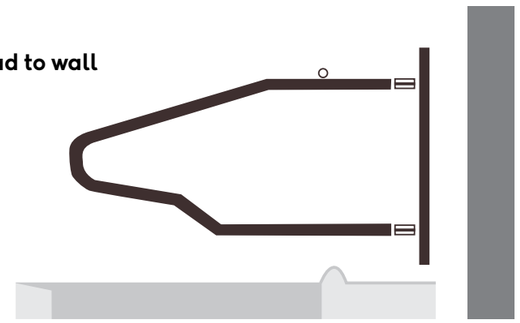
A conventional design with a central feed passage typically includes multiple rows of stalls on each side of the lane. The layout should be matched to herd size, building use, and feed space per cow. Keeping cows clean and passageways free of effluent build up is critical to achieving optimal performance.

Stalls may either face the outer walls/outside or be arranged head-to-head. Dimensions are important for both configurations.

Head to head



Head to wall



There should be no dead ends in the building to facilitate cow traffic and easy access to feed and water. Ultimately, the feed space per cow drives the length of the building. For example, 70cm per crossbred cow with 100 stalls on each side equates to a 70m barn in length (70cm per cow x 100 cows = 70m). The total width of the barn is driven by the number of rows of stalls and the width of the passageways.

4.1 Cow uniformity

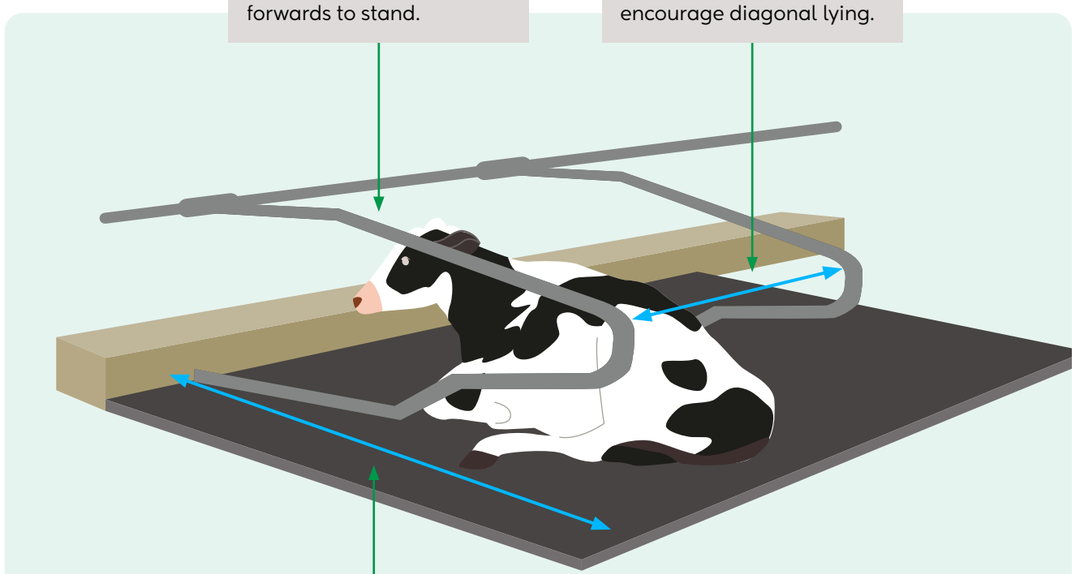
The dilemma for any farmer moving from an open lying area i.e. pasture or loose housed system, to a freestall design, is the issue of herd size uniformity. While achieving uniformity for the entire herd is unlikely, and heifers will always make up around 20% of the herd, some improvements in uniformity can be made.

Consider future production and genetics goals, as these will influence the size of your cows and the appropriate stall dimensions. Focus on the appropriate stall size and lunge space for the larger cows, accepting that beds for smaller cows and heifers will need more cleaning. Check if overseas specifications for larger cows are relevant for your herd.

Cow size and stall design outcomes

The brisket bar must allow sufficient space for the cow to lie straight and lunge forwards to stand.

The stall should be wide enough to allow correct lying position but not encourage diagonal lying.



The length of the stall is considered too short if the cow is defecatng on the mattress/bedding. The cows' tail or legs should not overhang into the passage way, this could cause injuries from scrapers and other cows walking past.

4.2 Passageways

Passageways and crossover passages provide escape routes for submissive cows, turning spaces, areas for social interaction, and improved cow traffic flow.

- Crossovers should be located every 20–25 stalls.
- All passageways and crossovers should be scraped or washed regularly.
- Passageways must provide adequate turning room and a non-slip floor to reduce the risk of falling or pushing.

Determine width based on traffic; auto-scraper width may influence passageway width. If narrower than 5m, more frequent cleaning is required.

A feeding cow takes up 2m in length. The minimum width of any scraped passage should be 3m, consider increasing the width if cows are exiting stalls into the passageway. Stalls that exit onto a feed face passageway have high levels of cow traffic. These stalls are at the greatest risk of splashing from effluent and soiling of bedding, so the adjacent feed face passageway should be 5.0-5.2m wide. To ensure good cow traffic flow, a crossover should be at least 3m wide. When a drinking trough is installed in the crossover, the width should be increased to 4.3m to allow cows to pass behind others drinking. Provide even more space where a grooming brush is located at the crossover.

Consider placing slatted cross channels or grates in longer scraped passages to deposit accumulated effluent before it builds up in front of the blade. For manual scraping, a cross-passage drain will speed up the process and limit effluent overflow onto beds. Dry matter content of feed affects the dung which in turn affects how well these drains will work.

Central passage

Feed lane passages facilitate machinery movement. The machinery used is likely to be a mixer feeder wagon.

- Ensure machinery can enter the building easily and operate effectively inside.
- Provide adequate space outside at either end of the feed passage for turning areas.
- Ensure sufficient height clearance for transporting downer cows and dead stock.
- Match floor strength to machinery weights.
- Consider the width of the feed table when deciding on the central passage width. Cows should not walk within the tractor turnaround as a biosecurity precaution.

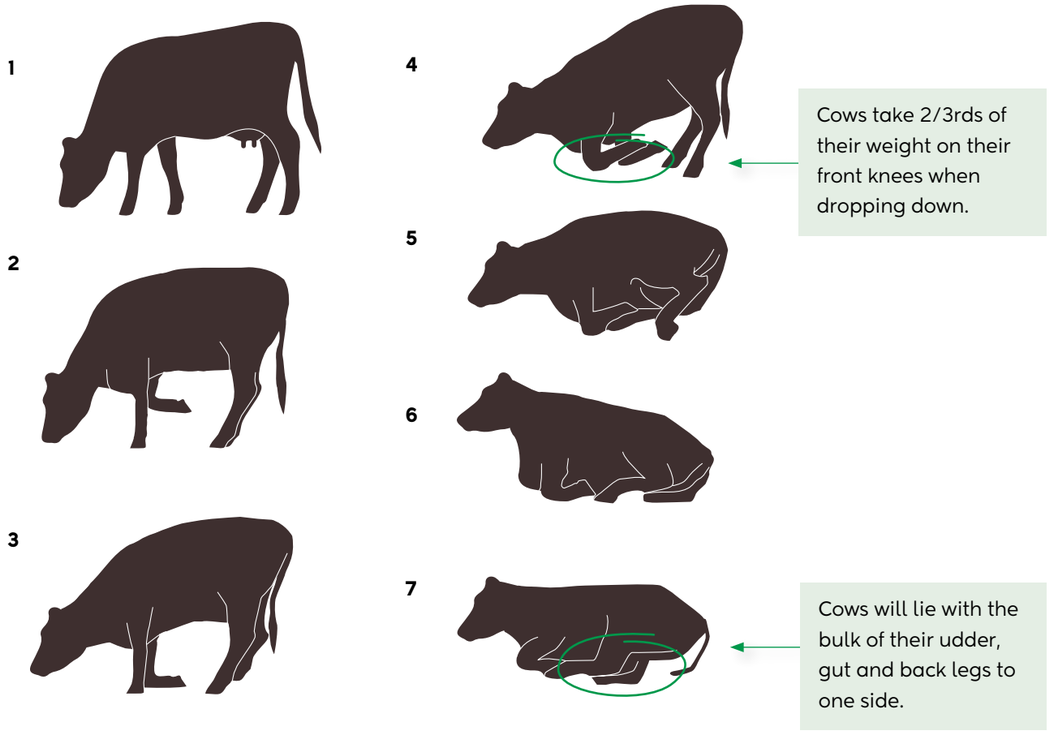
Stay flexible

As the size and capacity of tractors and feeder wagons increases, the central passageway dimensions may also need to allow for this. Think about possible future requirements.

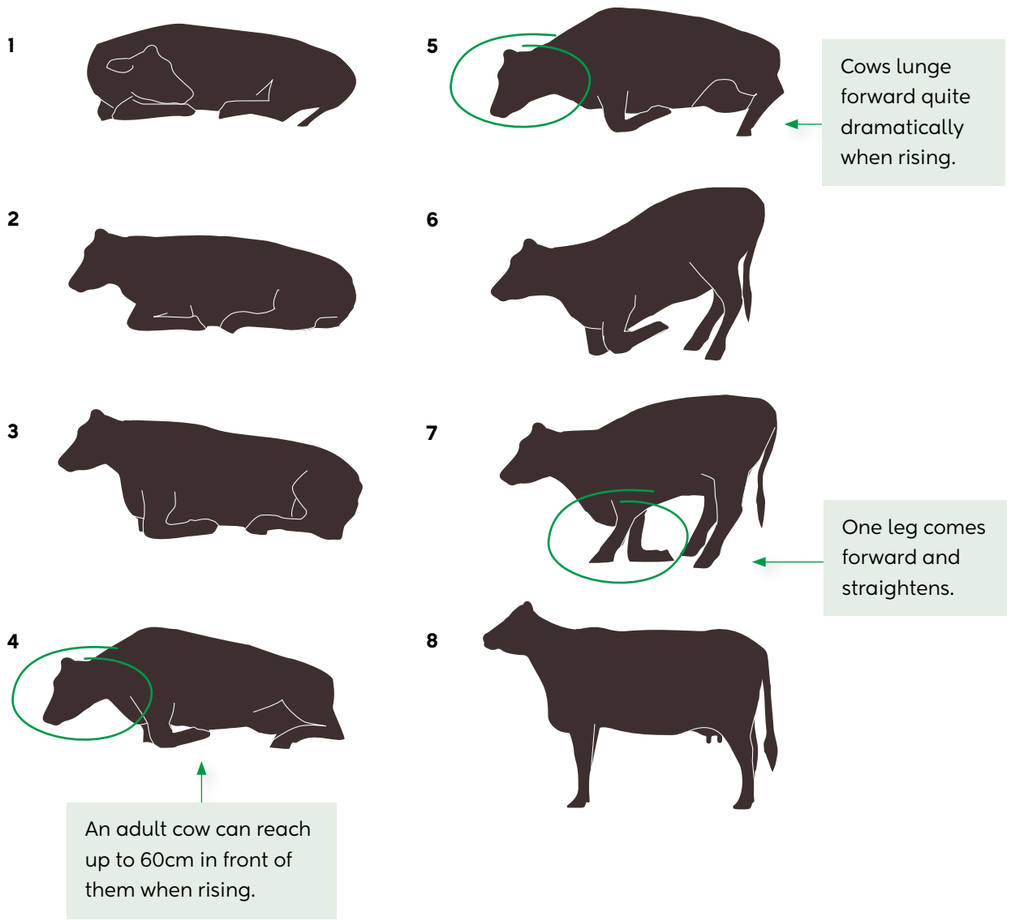
4.3 Stall design factors

The dimensions of a freestall depend on the size of the cow. It is important to understand the space requirements of a cow when she lies down, rises and rests.

The stages of lying down



The stage of rising



Stall design factors affect use and cow comfort.

Bed length – the area the cow has to place most of her body, excluding the lunging space.

Lunge space – the space the cow has to lunge forward into when getting up. Stalls located too close to a wall have little or no lunging space, making it difficult for cows to stand up. This compromises the lunging space, reduces stall use and lying time, and forces cows to lie diagonally.

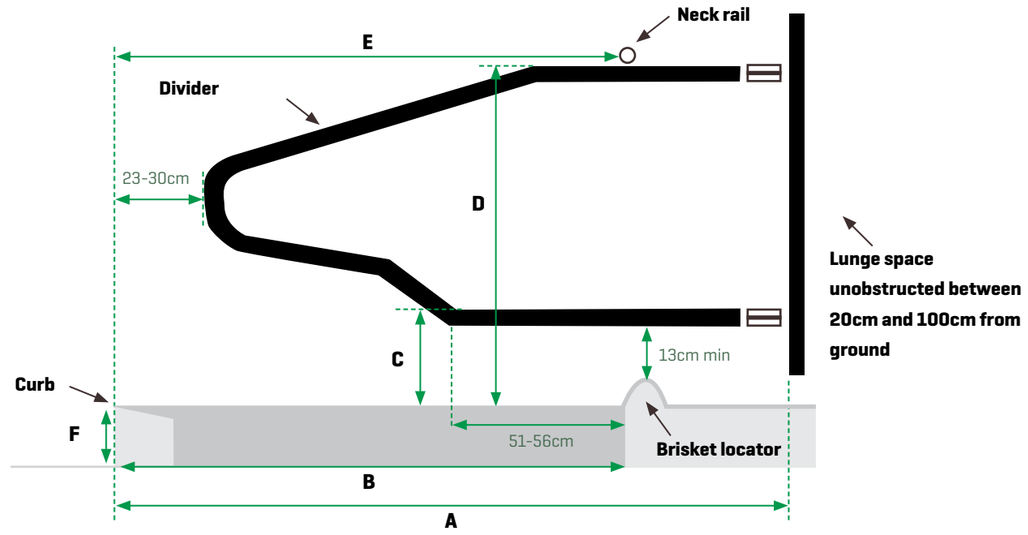
Head space – the space at the front of the cow when she is lying down, also referred to as the lunge space. Cows do not normally sit head-to-head. They need room to ensure they do not intrude into each other's 'threat' or personal space. Cows do not like a wall blocking their natural head position or extension and will lie diagonally when there is not enough head space.

Freestall length – the combined length of the stall; bed length plus headspace/ lunge space.

Brisket locator – this raised area helps the cow locate herself in the correct position within the stall.

4.4 Freestall dimensions

These measurements are guidelines. It is good practice to fit stalls that can be adjusted to allow some movement once cows are in the barn and you have assessed their comfort levels. Always start the design process by measuring your cows and considering how much bigger they may get on a different diet or with any changes in breeding strategy.



Stall Dimensions for Mattress Stalls	Body Weight Estimate (kg)			
	455	545	636	727
Total stall length facing a wall **(A)**	244	244	274	305
Full length of head to head stall	488	488	518	518
Rear kerb to rear of brisket locator **(B)**	163	168	173	178
Stall width (centre to centre)	112	117	122	127
Height of upper edge of bottom stall divider rail from bed **(C)**	28	28	30	30
Height of neck rail above mattress surface **(D)**	112	117	122	127
Horizontal Distance between rear edge of neck rail and rear kerb (mattress stall) **(E)**	163	168	173	178
Rear kerb height (F) Not including mattress thickness.	20	20	20	20

Adapted from The Dairyland Initiative, University of Wisconsin, Madison – Freestall Dimensions.

There should be 23–30cm from the back of the divider to the kerb. If this distance is longer than 30cm, cows may walk or lie along the back of the bed.

Freestall width

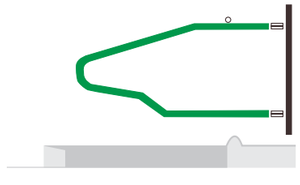
The stall should be wide enough to allow the cow to recline and rise easily without banging her hip bones on the dividers.

Stall width is determined by the width of the gut of a fully fed cow lying down, with extra allowance for late pregnancy and breed. Work with your barn supplier to determine the ideal stall width for your herd.

Divisions that allow horizontal adjustment help ensure appropriate stall widths. Keep an eye out for shiny rub marks on the dividers, your stalls may be too small.

Freestall division

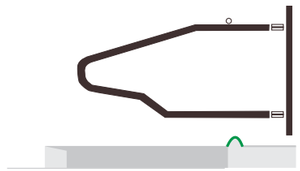
There are many freestall divider designs. The overall requirement of any divider is to ensure the cow is correctly positioned while not causing any discomfort or injury. Dividers must not catch the legs while moving in and out of the stall. The rear of the divider should not be attached to the ground to avoid obstructing rear legs, tail or udder, as lying cows naturally extend their back legs away from their bodies. The front end of the divider must be designed to minimise front legs getting caught in positions that restrict rising or cause injury, while keeping the cow positioned correctly.



Conventional dividers are metal but other materials and designs are available. Ensure the design you choose provides cow comfort, minimises injury and increases lying time in the correct position. Talk to other farmers when looking into options.

Brisket locator

The purpose of the brisket locator is to position the cow correctly when she lies down. When the brisket locator is correctly positioned, it prevents the cow lying too far forward or creeping forward when lying. If a cow lies too far forward, it leads to bed soiling, causes difficulty when rising and can interrupt the lunge space of the opposite cow in any head-to-head stalls.

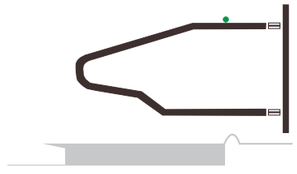


The height of the brisket locator is important as the cow will swing her front leg forward before rising; 10cm provides the cow with easy clearance, 8cm is more suitable for smaller cows.

The brisket locator should be rounded and have no sharp edges to allow for the natural shape of the cow's leg. Many brisket locator designs are available, and thick pipes are an inexpensive option.

Neck rail

The purpose of the neck rail is to position the cow when she enters the stall, before she lies down. The position of the neck rail needs to be correct both horizontally and vertically. It is difficult to get a neck rail in the right place without compromising either the standing cow or the rising cow, especially if the herd contains cows of varying size. Fitting adjustable neck rails is a sensible choice.



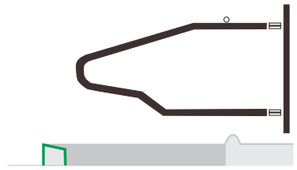
A neck rail too far back will limit the occupancy of the stall and lead to cows perching (two feet on the stall and two feet in the passage) or avoid the stalls and stand in passageways.

A neck rail that is too low can cause injury to the cow when she reclines and rises and also reduces stall occupancy.

Increasingly, neck rails are being moved right forward or removed completely as they are difficult to position correctly. If neck rails are removed, the structural integrity of the dividers can be reduced, so the design and strength of the dividers needs to be considered before neck rails are removed.

Kerb

The kerb is the drop between the back of the bed and the cow passageway and keeps effluent off the stalls. Height will depend on the scraper type, floor type and length of passageway. Long scrape passages may require a slightly higher kerb e.g. 200mm to prevent effluent soiling the beds, while fully slatted passages will allow the kerb to be reduced in height e.g. 150mm.

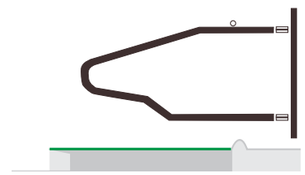


If mattresses are fitted, their height should be considered when calculating kerb depth. It is important for the cow exiting the stall that the kerb is not too high as the pressure on her back legs increases when she backs out.

As with all aspects of stall design, kerbs should not have sharp edges, be slippery or be too wide to prevent cows' hocks resting or rubbing on the kerb when lying down.

Slope of bed

Stall beds should be installed with a slight slope of 1–2% from the front to the rear to provide cow comfort and drainage. Well-designed mattresses incorporate slope and grooving to draw fluid away from the cow.



Where the slope is greater than 3%, there can be problems retaining secondary soft bedding in the stall.

Future proof

Think about fitting freestalls that are either adjustable or do not have designated widths to allow for change and expansion.

4.5 Freestall lying surface

All lying surfaces, including the stall bed, must be clean, dry, comfortable and safe. They should provide sufficient grip and be made from resilient and durable material.

Various bedding options can be used alone or in combination, usually on top of a concrete or stone base.

Bedding options

- Foam or rubber mattresses are usually encased in an impermeable synthetic envelope. Not all rubber matting is created equally; refer to the results of a DairyNZ field trial section 3.2.
- Waterbeds require internal baffles or divisions to be successful. Cows may take longer to get used to waterbeds than other bed options, especially if they are not well stabilised.
- Sand offers the highest comfort and cleanliness for cows but requires daily grooming and replacement. Sand can also be separated, washed, dried and reused. It provides traction for cows in walking alleys but requires careful management to prevent sand from entering the effluent system and increase wear on manure pumps.
- Additional bedding material on top of rubber mattresses/mats can improve cow comfort, keep beds drier, encourage cows to lie down and make stall scraping easier.
- Drying powders are often used on top of freestall mattresses or additional bedding. Even with drying powders, daily scraping of faecal matter from the back of stalls is necessary.

Sand reduces pressure or abrasion points for lying cows and provides high levels of leg and hoof health.

Ask farmers who have built barns and used them for 3-5 years what they would do differently."

The essentials of any bedding choice are that it:

- provides a soft, comfortable surface that does not cause abrasions or pressure points
- supports the cow's weight evenly
- is made of a material capable of being kept dry and hygienic
- ensures cows have secure footing, allowing them to feel confident when lying down and rising.

Ensure you choose a reputable supplier to guarantee the lifespan of the product. Reputable suppliers offer lengthy guarantees on the durability of their products, backed by research.

Good practice

Could you sleep on it? Drop to your knees from standing or kneel on it for long periods, would you be comfortable?

4.6 Managing scraped passages

The busiest loafing areas or passageways (usually the feeding passageway) are the dirtiest. Continuous exposure of cows' feet to faecal material and the pathogens contained within it is highly likely to increase the prevalence of lameness, weakening of the hoof, or digital dermatitis.

Unlike the UK, Europe, and the USA, digital dermatitis is not common in New Zealand. Good management of housing systems will reduce the risk of increasing incidences.

A higher stocking density will require more frequent scraping or washing. Keeping the building and the cows as clean as possible is essential.

Floor slope can aid drainage but interfere with scraper systems, which need both solid and liquid parts to work properly. Cows prefer standing on flat surfaces, which are particularly important in feeding lanes where cows stand for longer periods.

The scraper needs reasonable levels of liquid to ensure good scraping, so in hot weather or when stocking densities are low, scraping systems may not work as efficiently. Sand from beds can end up in areas being scraped and enter the effluent systems, creating extra wear and tear on transfer pumps and other machinery. Large bow waves of effluent in front of the scraper blade are an indicator that the scraping routine needs to be altered.

Ensure scrapers run regularly enough to stop effluent pooling. You will need to adjust the scraping routine depending on the length of time the barn is used.

Ensure the scraper runs frequently enough to keep the volume of scraped slurry from overflowing onto the beds.

Freestall flood washing

An alternative to scraping is flood washing. The floor should be laid with a 2–3% fall, and 10mm wide groves should be cut in the floor in the direction of the water flow. Bedding material pulled off the beds can be difficult to move with flood-wash water. Flood washes are not as common as scrapers, and it is better if the barn is empty when the washing occurs. The volume of water required depends on the floor slope and the width of the passage. Seek expert advice to get this system right. The slope required for flood wash is not suitable to convert successfully to a scraped system without changing concrete levels.

4.7 Flooring

Proper flooring in freestall systems is essential for cow comfort, safety, and overall health. Flooring design is complex, and professional advice should be obtained.

Effective flooring should:

- provide a non-slip surface for secure footing
- enable confident and natural walking
- support stable three-legged stances for grooming
- allow for natural oestrus expression
- minimise the risk of injury
- be durable and long lasting.

Concrete flooring

On concrete slatted floors, the gap width between slats is critical. Cattle slats are typically spaced 40mm apart; larger gaps can cause issues for cows when they walk, while smaller gaps can create drainage issues. The edges of the slats should be rounded to prevent hoof injuries.

"We tried brushed concrete to start with but quickly went over the grooved concrete scraper lanes, we found too many problems with cows slipping on the brushed concrete."

Improving traction on concrete surfaces

There are many options available to provide anti-slip flooring for cows. If the direction of cow flow is known, i.e. on access passageways, parallel grooves can be formed in the concrete to provide extra grip.. Consider the scraping system that will be installed and the effect the grooving might have on the scraping ability. If using straight-line grooves, ensure they run in the direction of the scraper.

For detailed information on concrete surfacing, refer to IPENZ Practice Note 27 (PN27), Part 4, Section 7.2 (pages 122- 123). The durability and abrasion resistance of the concrete need to be considered in the specification for a feed passage floor.

Rubber matting on passage floors

Installing rubber matting on passage floors reduces pressure on cows' feet. However, rubber matting is expensive, and cows should lie in designated lying areas and not be encouraged to stand or lie in passageways. Rubber can become very slippery when wet, and bacteria can grow in cracked, worn rubber.

There are different thicknesses of rubber available, with some thinner mats providing no extra cushioning. Select a material with a proven design from a reputable company. Ensure the contractor has experience in laying rubber matting, as there can be issues with long-term fixing to the floor.

DairyNZ completed a field trial testing the comfort levels of different artificial surfaces. See the results in Section 3.2 Artificial Bedding Surfaces for more details.

5 Feeding

The feeding area should be designed to provide easy and comfortable access to feed, while minimising waste and preventing contamination from weather and pests. It should also offer a safe environment that reduces the risk of injuries, while ensuring feeding out is easy for farm staff.

Minimum standard – Code of Welfare

No.2 – Food
Dairy cattle of all ages must receive sufficient quantities of food and nutrients to enable each animal to:

- Maintain good health.
- Meet their physiological requirements.
- Minimise metabolic and nutritional disorders.
- Feeding must be managed so that any injury and/or conditions resulting in ill health, as a consequence of the food or feeding methods, are minimised.

5.1 Feed barrier dimensions

A well-designed barrier supports a cow's natural grazing stance, ensuring comfortable and efficient feeding. The following examples highlight effective design solutions.

This heap of feed will need pushing up toward the cows to allow them to eat it.

The cow's reach and eating action will depend on the height of the feed table and the design of the feed barrier.

How the feed table height affects feed utilisation

Height of the feed table above cows feet	Reach of the cow	Outcome
0cm	60cm	Feed will be pushed away by cows trying to eat which increases the risk of wastage, and requires more regular "push up".
10cm	90cm	Good muscular action and salivary production will be achieved.

Feed face per cow

The correct space per cow is essential for stress-free feeding, proper feed intake, and ensuring cows remain on their feet for 30 minutes after milking. The width through the gut of a fully fed pregnant cow determines the ideal feed face space, along with timing of use and diet type. It is good practice to allow enough space for all cows to feed simultaneously, especially after milking and when fresh feed is delivered.

When calculating your feed face per cow, check if there are any obstacles like nib wall or roof poles that will restrict the feed face space allowance. The diameter of such obstacles should be removed from the calculations of space per cow.

These dimensions are guidelines; measuring your own herd will provide more accurate measurements.

How to calculate available feed face per cow

1. Measure the complete length of the feed face.
   e.g. 56m
2. Measure the width of any poles along the feed face.
   e.g. 40cm
3. Multiply the width of the pole by the number of poles.
   e.g. 40cm x 10 poles = 4m
   - Remember to only add half the width of the end poles (if you have them) as cows can only eat to one side of these poles.
4. Minus the total length of the poles from the total length of the feed face. This gives you your total available feed face.
   e.g. 56m – 4m = 52m
5. To calculate the feed face per cow, divide the length of the available feed face by the number of cows in the facility.
   e.g. 52m / 73 = 0.7m
   - It is recommended to have at least 0.7m per cow. This helps reduce competition and injuries from reaching around poles.

Weight of animal	Width of feed face per cow
450-500kg	70cm
>500kg	1m

Feed bins per cow

The feed bin/table length should allow approximately 0.7m of feed face per cow for a 450-500kg cow. Increase this to a 1m feed face for >500kg cow when all cows are feeding at the same time.

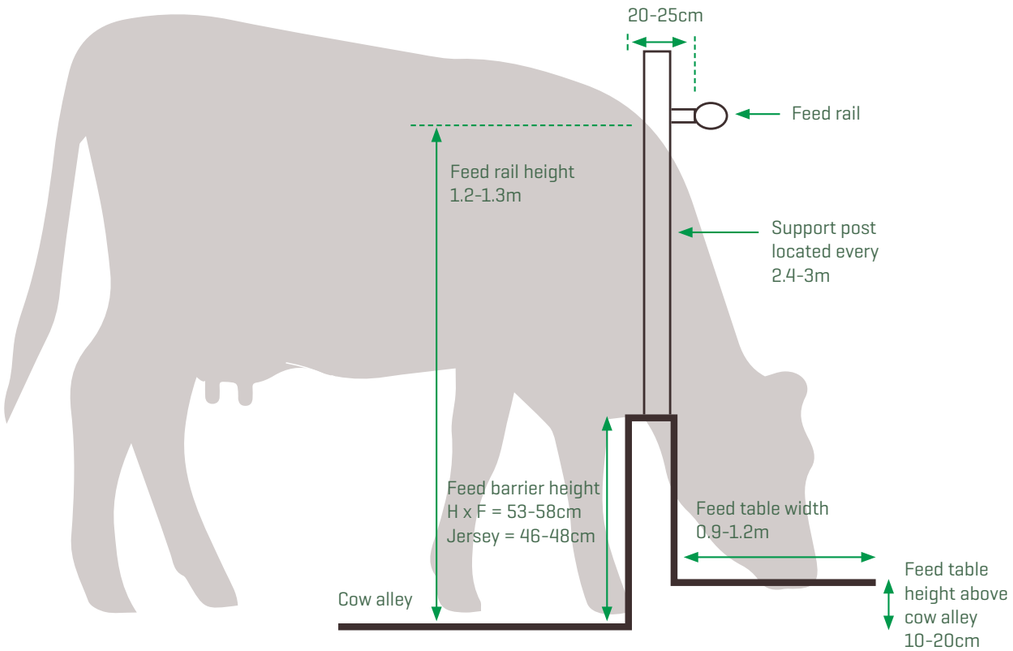
The eating surface should be as smooth as possible to facilitate licking the feed table clean, eliminate tongue abrasion, prevent old feed spoiling on rough surfaces and withstand wear and abrasion from acidic feeds.

Many farmers are using a sealant on the feed table to reduce concrete damage. Corners that collect feed should be covered or rounded.

The feed barrier must be high enough to stop any effluent being splashed onto feed, stop cows escaping, and to stop cows standing with their front feet in the feed. The feed barrier must not be too high that it puts pressure onto the bottom of the throat or neck of the cow when eating. Make sure any dividers are smooth edged to reduce discomfort.

Feed barrier height can be affected in a loose housed system by levels of soft bedding. Ensure that excessive build-up or reduction of soft bedding does not occur on the cow side of the feed face. If cows are on their knees at the feed face, the feed rail is too low, or the feed table is too low because the soft bedding has built up.

To achieve the correct feeding stance the feed rail should be mounted on the feed table side to allow the cow maximum reach with minimum rail contact. If you notice bald areas on the neck area, it is an indicator that the feed rail is in the wrong position and/or the feed is not getting regularly pushed up.

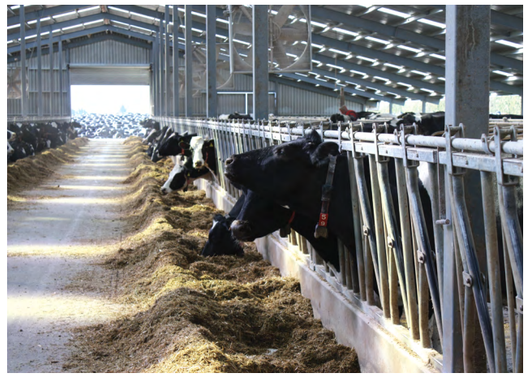


5.2 Feed barrier designs

A well-designed barrier supports a cow's natural grazing stance, ensuring comfortable and efficient feeding. The following examples highlight effective design solutions.

Post and rail barriers: relatively inexpensive; can be adjustable.

Individual metal feed spaces: check the width of the individual spaces before purchasing; ensure they are fitted at an angle to provide better feeding position.



Self-locking yokes: expensive; varied opinions on the negative or positive outcomes for feeding cows.

It is possible to install a few locking yokes at the end of the feed face to provide a cow handling area. Alternatively consider including a vet race in the building design.

It is better to have a few smaller cows that will put their feet through the feed barrier than to cause bigger cows to rub their necks or disrupt their access to feed.

In the absence of any division, cows can disturb each other when feed space is restricted or there is not enough available feed spread along the entire length of the feed table.

Nib wall

A well-designed nib wall will be comfortable for cows to lean over to feed and enable easy cleaning of surfaces. There are a couple of options to consider for placement and diameter of the roof posts.

Wide timber posts on the feed table side provide an easier reach for cows with minimal shoulder rubbing on the wooden posts but makes flood washing the feed table area difficult.

Posts on feed passage side allow for easier scraping of unused feed from the feed table but increase shoulder rub risk and create awkward corners around the posts where the flood wash will dump solids because of the slower flow in the corners and around posts that require extra cleaning effort.

Consider the areas you will be cleaning frequently and how animals will access their feed over the nib wall when deciding on post placement.

5.4 Managing the feed face

Pushing up feed that cows cannot reach is necessary because cows tend to push the feed around over a large area when eating. Regular pushing up increases the likelihood of submissive cows getting a better opportunity to feed. If the time from feeding to first push-up is too long (e.g. 2 hours) dominant cows will return to the feed first, unless all cows have adequate space to eat all their fill at once.

An alternative to a standard feed table is a trough which eliminates the need for pushing up feed. However, trough design and sizing are important. Troughs should not be too wide to ensure cows can reach all the feed. Troughs are labour-intensive as they require manual cleaning, which can be difficult due to corners.

Reducing feed waste

Correct feeding levels are the first step to minimising wastage and keeping the feed table clean. Outside uncovered feed tables are prone to higher wastage and contamination due to weather conditions. Consider the extra cost of covered feed tables to protect feed from rain and wind. Central feed lanes and feed tables are typically covered by location, offering inherent protection against the elements. Self-feed silage bunkers can be wasteful if not managed correctly. Run-off from the feed table needs to be contained in the farm effluent system to prevent environmental contamination.

6 Water requirements

Providing enough water for cows is just as important as managing their feed. It is important to get professional assistance with stock water design to ensure fitting choices, pipe sizes and installation are correct. A system that does not meet demand may cause queuing around the troughs, limit intake, and be costly to rectify once the system is in place. Depending on the water source and restrictions, consents may be required to meet council regulations.

Water system considerations:

- future expansion
- feed type
- in-line water dispenser use
- hose points for shed cleaning
- DM% of mixed rations and supplementary feeding
- milk yield goals.

Minimum standard – Code of Welfare

No.5 – Water

- All dairy cows must have access to a daily supply of drinking water sufficient for their needs and that is not harmful to their health.
- The water delivery systems must be reliable and maintained to meet daily demand.
- In the event of a water delivery system failure remedial action must be taken to ensure that daily water requirements are met.

Future proof

Set the water system up to cope with the highest potential seasonal demand. Make it easy for the water system to be checked daily and any problems fixed quickly.

6.1 Drinking water requirements

Dairy cows typically spend less than 30 minutes a day drinking, and intakes vary depending on diet, stage of production, temperature, and humidity. Roughly 1kg of dry matter utilises up to 5 litres of drinking water. Since the dry matter content of mixed rations is higher than that of pasture, cows will need to drink more water. Housed cow intake has been measured between 76 to 114 litres per cow per day, with higher producing cows needing more. Cows need at least 3 litres of water to produce one litre of milk.

Access to water in dairy housing is challenging as cows are sociable and drinking is a herd behaviour, especially after milking and around sunset, when up to 50% of the cow's daily requirement can be consumed. It is essential that enough space is provided to allow for this, and the water supply rate is at least 10 litres per minute (aim for 20 litres per minute). Modern high-pressure valves can easily achieve this flow rate. Because cows drink large volumes of water, the supply needs to be replaced quickly enough for the next cow. It is not only the total water consumed per day, but the rate of consumption at peak times that needs to be considered.

Cows can start feeling heat stress at temperatures above 20°C. You might notice your cows breathe faster, eat less and drink more. Heat stress occurs when cows have more heat than they can get rid of. This can lead to discomfort and lower milk production.

Provide at least 10cm of accessible trough perimeter per cow, with at least two watering locations per group. Consider the proximity of fresh water and electricity sources.

How many troughs do I need?

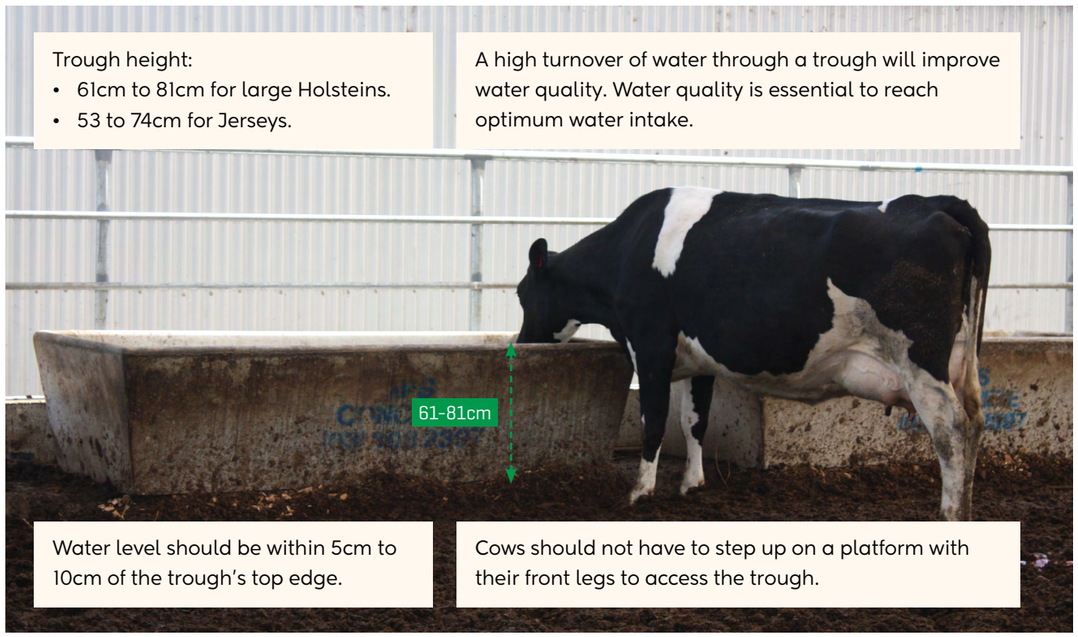
Example calculation for 600 cows

Each trough is 4m long x 0.5m wide

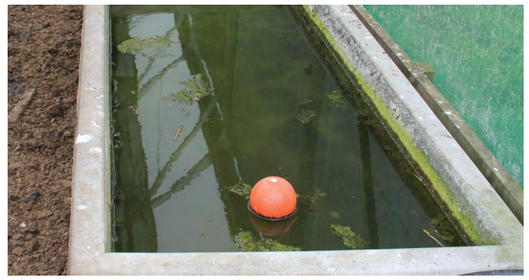
Accessible perimeter is 400cm + 50cm + 50cm = 500cm

500cm/10cm = 50. Therefore 50 cows could drink from this one trough.

Therefore 600 cows require 12 troughs of this size.



Keep water troughs clean by regular checking and have an effective and easy cleaning policy. Seeing the bottom of the trough is a good sign the water is clean.
Troughs can quickly become dirty when cows are housed. Dry feed sticks to cow muzzles and falls into the trough.



Would you drink this water? Plugs can be positioned in the bottom or side of the troughs so that they can be quickly drained and cleaned regularly.

Watch out for pugging from leaks and over full troughs.

Tipping troughs provide a quick and easy solution to cleaning. The tipped water can help clean the passageways in freestall systems. Make sure the tipped water drains away from the bedded area.

Future proof

Consider your region, climate and the need for frost protected pipes.
High producing cows will have higher water requirements. Consider your genetic and production direction to ensure the highest water requirement is met.

6.2 Location of water troughs

Loose housed systems: Troughs should be located around the perimeter and available on at least two sides of the building. Position the troughs well outside the bedded area to prevent contamination of the water and wetting of the bedding material.

Freestall systems: Most troughs are located on the crossovers, allowing three sides of the trough to be utilised and shared by cows from two adjacent passageways. Ensure generous trough size to fill the crossover and increase water availability.

Water troughs should be out of the way of flood washing. Tipping water troughs work well for this purpose. For 125 cows, 12.5m of water trough space is needed (see calculation on page 40).

Good practice

Placing water troughs at the exit race of the milking shed will improve availability and potential intake, as cows have their highest water intake after milking, especially afternoon milking.

7 Ventilation and shade

Ventilation is an air exchange process that brings fresh air into the building through planned inlets. It mixes incoming and inside air, and removes warm, moist, contaminated air from the building, maximising comfort and health.

Minimum standard – Code of Welfare

No.9 – Managing Dairy Cattle in Off-Paddock Facilities

- Natural or artificial ventilation must be sufficient to maintain temperature and humidity at levels that do not cause the dairy cattle heat or cold stress, that prevent direct draught onto animals and the build-up of harmful concentrations of dust or noxious gases.
- If ammonia levels of 25ppm or more are detected at animal level, immediate action must be taken to reduce ammonia levels.

As a guide, a level of 10–15 ppm of ammonia in the air can be detected by smell and an ammonia level over 25 ppm may cause eye and nasal irritation in people. Ammonia levels should not consistently exceed levels of 10 – 15 ppm. Such levels compromise animal welfare and may predispose dairy cattle to respiratory disease and reduced performance.

Correct building design is critical to ensure adequate ventilation that maintains air quality and temperature year-round, regardless of outside weather conditions.

Proper ventilation maximises cow comfort and health by removing excess heat and water vapour (from respiration and sweat) and reduces the effects of humidity. It also removes microorganisms, dust, and gases, especially ammonia, while providing uniform air distribution and minimising draughts at stock height.

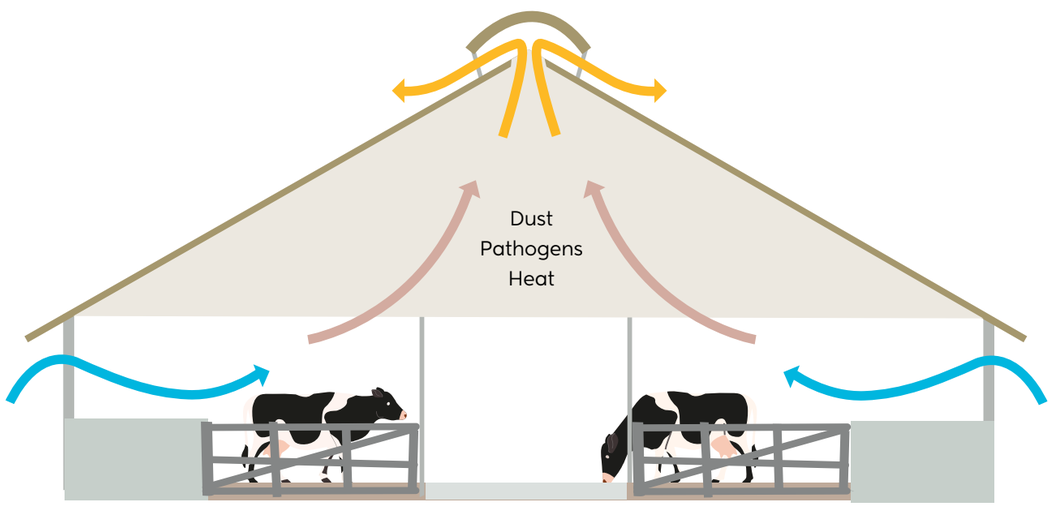
Passive or natural ventilation relies on external wind speeds and the design of inlets and outlets. Active or forced ventilation uses internal and external fans, sometimes in conjunction with natural ventilation, and requires an energy source.

Buildings naturally ventilate best when situated at right angles to the prevailing wind direction, with no wind disruption from obstacles such as buildings or tree lines and have adequate eave height and roof design.

Consider natural windbreaks and the predominant direction of driving rain when positioning the roofed structure. Avoid aligning main openings of the roofed area with the predominant wind and rain direction.

Chimney effect using a central ridge outlet

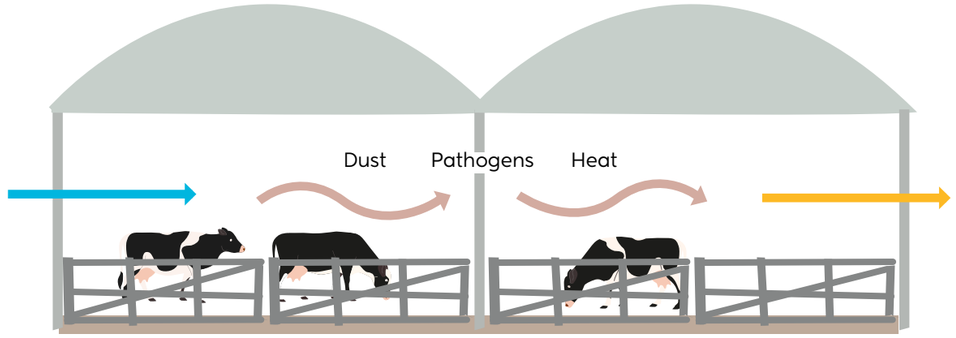
The chimney, or stack effect, occurs in a livestock building when warm air from the cows rises and escapes through an outlet, pulling in cool air from the sides. For efficient chimney effect, there must be a suitable balance between air inlet and air outlet and adequate roof pitch.



Basic cross-ventilation in an open sided building

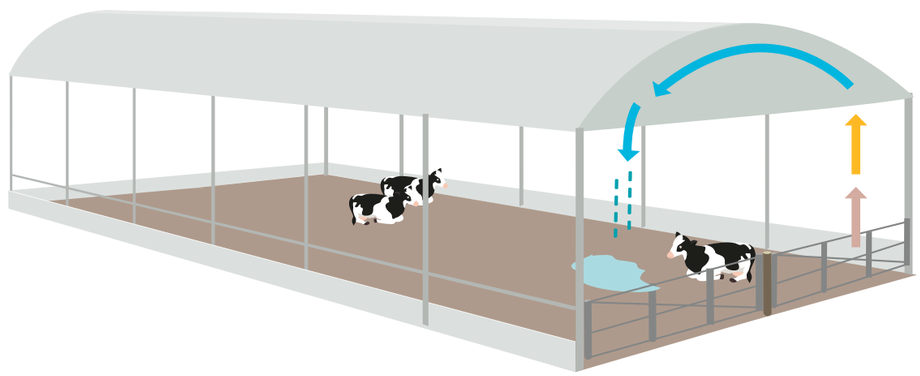
Passive ventilation systems typically feature open sides with minimal walls and use windbreak curtains. When cows access a building with a central ridge outlet only briefly for feeding, cross-ventilation may be the primary airflow mechanism. This is because the short duration of occupancy does not generate enough heat to drive convective airflow through the ridgeline.

A height restriction may be applied by some local councils. If height is restricted, find a resolution to ensure that ventilation is not affected. Seek expert advice in this area. Detailed information of ventilation options is available in the IPENZ practice Note 29 and should be a key discussion point with your builder and housing supplier.



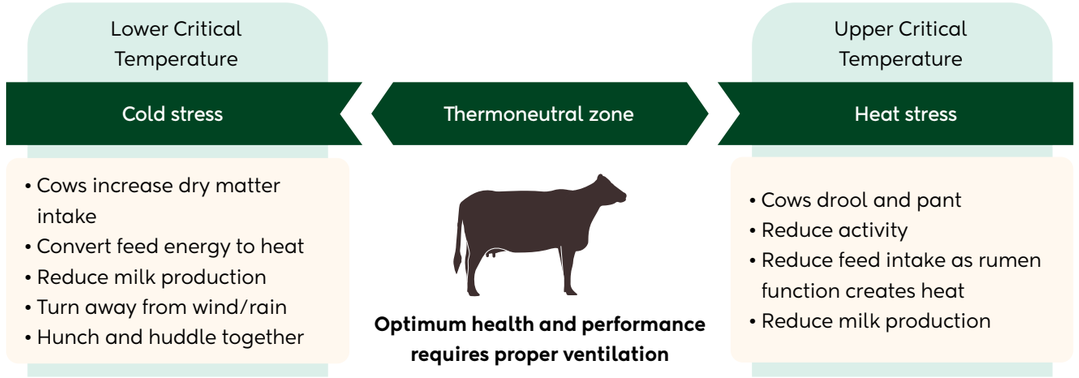
Condensation

Condensation forms when warm moist air rises and has no way of escaping. It collects under the cooler roof surface and forms droplets that fall onto the bedding. Droplets on lying areas increase the risk of pathogen growth and make some areas less appealing for cows to lie on. Good ventilation reduces the risk of condensation.



7.1 Temperature requirements

The comfort zone, or thermoneutral zone, for a dairy cow varies depending on breed, production levels, and health. The coldest temperatures a cow can tolerate before needing to utilise additional energy to keep warm is called the Lower Critical Temperature (LCT). The Upper Critical Temperature (UCT) is the temperature at which a cow begins to experience heat stress. The thermoneutral zone for a cow will feel uncomfortably cool to people.



7.2 Shade

Providing adequate shade is essential for cow comfort, particularly in warm weather conditions. Cows prefer shade that provides at least a 50% blockage of solar radiation. Provision of shade under a clear plastic roof will reduce the solar radiation but care needs to be taken to avoid shadows. You must provide enough shade to cover the entire lying area to ensure that all cows can lie under shade.

Consider the path of the sun and how shade from the roofed area can reduce drying time of unroofed surfaces. Consider sun for the cows when they loaf during daytime.

8 Stockmanship

Managing off-paddock systems requires strong skills in stockmanship, feeding, welfare, and hygiene to ensure both animal wellbeing and operational efficiency.

A high level of stockmanship helps to maintain safety for both people and animals. Observant and proactive management is essential, including checking cows daily, assessing facility safety and functionality, and acting quickly on recorded observations to prevent issues before they escalate.

Key health indicators to look out for in housed systems include lameness, mastitis, cow cleanliness, variation in cow body condition score (BCS), rub marks and patches of hair loss, injuries, and digital dermatitis. Many of these can be managed by ensuring cows have sufficient space, clean and dry environments and comfortable resting areas that promote optimal lying times.

Feeding must be managed correctly, and cows should have access to good quality water. Any 'at risk' cows should be removed from the housing system and treated promptly.

Clearly defining roles and responsibilities ensures a well-managed system, healthier cows, and better overall farm performance.

Minimum standard – Code of Welfare

No.9 – Managing Dairy Cattle in Off-Paddock Facilities

All off-paddock facilities where dairy cattle are being kept must comply with the following:

- Natural and/or artificial lighting levels must be at least 50 lux during the light phase, for a minimum of nine continuous hours and a maximum of 18 hours each day, so that the dairy cattle can see each other and their surroundings.
- Automated systems, including for feeding, water reticulation, cleaning and milking, must be checked daily and provisions must be made to safeguard animal welfare in case these systems fail.
- A contingency plan, containing fire prevention measures, emergency evacuation procedures, and pest and disease management plans, must be in place.

Where dairy cattle, except calves are kept in off-paddock facilities for more than 16 hours a day for more than three consecutive days:

- They must be trained or allowed to adapt to an off-paddock facility before being confined to it, and dairy cattle that do not adjust must be provided with alternative management.

Where dairy cows are held in any off-paddock facility for more than 16 hours a day for more than three consecutive days, the following apply:

- The stocking density and facility design and management must allow dairy cows to separate themselves for calving, or they must be separated to another area for calving.
- Calving areas must be clean, well-drained and have an anti-slip surface.
- Dairy cows must be provided with clean and dry bedding, including, but not limited to, rubber matting or deep straw, when calving on hard surfaces or on slats.
- Where free-stalls are provided within the off-paddock facility:
  - Dairy cows must not calve in free-stalls.

Good practice

Measuring health indicators (e.g. lameness) before housing cows provides a benchmark from which to monitor.

Exercise

Integrated systems provide access to the outdoors or grazing for some periods of the production cycle. Some farmers have designed systems that allow cows to exit and enter the barn at will during certain times of the day. Providing outdoor access for exercise can result in more settled cows, better foot health, improved cow observation by farm staff, better calving outcomes, and a reduction in ketosis.

Future proof

It is likely that in the future, some countries or milk supply companies will require cows to have some outside access for exercise or grazing. Consider this when designing a system.

8.1 Introducing cows to a facility

In a well-managed system with good cow comfort, cows will easily find food, water, and desirable lying places. Simpler systems require less time for cows to adjust. Daily observations are essential, and these should be increased in frequency when introducing cows into any facility.

Introducing cows as transition cows (e.g. springers or newly calved) can increase cow stress. Introduce cows in late lactation or early dry period, initially using the barn for just 3-4 hours a day as a feed pad. If cows cannot be introduced slowly, introduce them in smaller groups. In-calf heifers should be introduced at least eight weeks before calving.

Introducing stock to a freestall building

Young stock

Keep young animals inside for a few hours a day for two to three weeks to ease later introduction. Understand where lying areas are, even if correct lying behaviour is not yet achieved. You may notice some stalls, such as those located by the feed area are always occupied first.

All stock

Create a plan for all stock being introduced to the building for the first time.

- Cows lying in passageways continuously for three days should return to the paddocks and be reintroduced later.
- Use palatable feed, such as silage or molasses-rich concentrate, in the head space of the stalls to encourage entry and lying.
- Introduce small groups to ensure ample space.
- Position neck rails as far forward as possible to encourage cows into the stalls.
- Older cows can train younger cows, but all-heifer pens can also be effective.
- Run the scraper regularly so they get used to it and prevent cows from lying in passageways.

Setting targets

- 90% of cows should be using stalls within one week of introduction.
- One third to half of the herd should be lying down four to six hours after feeding.

Warning signs that indicate cows are unsettled and not adapting well

- Increased standing/reduced lying
- A general increase in movement i.e. agitated
- Arched backs
- Lying down in the paddock when let out to graze
- Stressed or unconfident looking cows (e.g. flighty, head low, tail tucked)

8.2 Calving

Calving area requirements for all types of housed systems should be the same. Cows should calve in designated areas, such as clean paddocks, dedicated calving pens, or areas of loose-housed soft bedding material, and be moved to these areas at least 2 weeks before calving.

The calving space required will depend on the expected calving rate and should allow at least 10m^2 per cow of area. Separate feeding areas (using barriers/gates) for calving cows may be necessary due to different feeding needs. Facilities that have flexibility to split the loafing/feeding areas to accommodate different herds are useful. Some areas may need to be fenced so that calves cannot escape.

A good calving area should allow cows to remove themselves from the group to calve. Lowering stocking rates can help achieve this. Ensure calving areas are clean with dry bedding, well drained, and well-ventilated.

Ensure good tractor access for downer cows and removal of dead stock, with facilities such as vet races nearby. Keep a 'calving cupboard' for easy access to necessary supplies.

Avoid calving cows on rubber or concrete slats as calves can get their legs stuck between the slats. All hard surfaces including rubber matting must have a layer of bedding, such as straw or woodchip, over the top to create comfort and an anti-slip surface for cow, calf and staff. It is not acceptable to calve cows in freestalls.

It is not acceptable to calve cows on concrete, in scraper lanes, or on slatted floors. Soft bedding material should be placed on top of hard surfaces.

Calving cows need space and should still be within sight of their herd mates and have free access to feed and waste.

Animal care facilities

All housed facilities must contain or be near locking yokes or a vet race for treating cows and assisting calving.

Ensure the design provides for correct downer cow lifting and removal. Each farm must have a downer cow policy which includes the provision for correct lifting and equipment and moving and treating downer cows e.g. slings.

Design soft bedded pens for treatment cows.

8.3 Lighting

Lighting plays a crucial role in housed cow facilities, influencing various aspects of cow behaviour and management. Proper lighting can alter calving patterns in enclosed barns, extend lactation, encourage feed intake, facilitate cow movement, and prevent shadows that disrupt cow flow. Additionally, good lighting makes it easier to observe cows on dull days or at night, especially in loafing areas, and aids in accurate record-keeping.

Measure your levels of illumination with a lux meter. At 0.9m above the stall surface, the illumination should be between 160 to 215 lux. Night lights or dim red lights (15W) can be used to facilitate observation of cows by staff at key times of the year. Fit timer switches to standardise your lighting routine and reduce energy costs.

Ideal ratio of dark to daylight hours

- Lactating cows: 16 hours of light, 8 hours of dark
- Dry cows: 8 hours of light, 16 hours of dark

8.4 Mastitis

Housed cows are in closer contact with faecal material, increasing the risk of dirty teats between milkings. Housed cows may also be fed more supplements, which can raise the starch content of their diet and increase E. coli bacteria in dung. More contamination of teats with such bacteria can lead to acute forms of environmental mastitis, such as coliform mastitis. Maintaining clean and healthy teat skin is vital for preventing this acute form of mastitis. For more information see **dairynz.co.nz/mastitis**

Thermoduric bacteria can survive pasteurisation and grow in pasteurised milk. These bacteria are found in silage, bedding, and faeces. Poor management of lying areas, ineffective effluent removal, and poor silage quality can increase the risk. Seek expert advice from your veterinarian on mastitis monitoring and control in housed systems.

8.5 Lameness

Monitoring lameness before and after transitioning systems allows for proactive issue management. Increased vigilance is essential if factors such as walking distance, time off-pasture, and standing in effluent increase.

Consider contacting a certified hoof trimmer and your farm veterinarian to develop a lameness policy. Train staff to recognise lameness in housed and pasture-based systems and plan facilities needed for hoof inspection and trimming.

Continuous exposure to effluent can affect hoof health.

Future proof

Consider adding a footbath to the facility.
This will provide an easy treatment point for any future foot problems.

8.6 Cleaning policy

A cleaning policy and procedure is essential to ensure good hygiene in the barn and keep cows healthy. Daily routines should include scraping the backs of the beds; ensuring the scraper systems are set correctly by visually checking effluent levels in the passageways and manually scraping crossovers. Weekly routines should include cleaning water troughs.

Depending on barn usage, it may be good practice to carry out a deep clean at appropriate times during the year. This also helps with maintenance and equipment checks. For soft bed systems, it is practical to combine this with total bed removal. If the barn becomes very dirty very quickly, investigate the causes and implement management practices or design changes to reduce the need for annual deep cleans.

Check that the products you use in the cleaning process are fit for purpose. Check with your chemical representative. There is a risk that some cleaning residue may be left behind and could lead to contamination.

Bed scraping is essential.

Avoid this by investing in bird proofing or a regular cleaning policy.

8.7 Emergency policies

A contingency plan should enable procedures to be put in place immediately once issues arise to minimise impact. All farm staff members should be familiar with contingency plans and procedures.

Emergency plans should outline procedures for dealing with power outages, fires, floods, and extreme weather conditions. First aid kits should be easily accessible and fully stocked. The kit should provide information on first aid measures for both cows and staff.

Have a list of emergency contacts available, including veterinarians, local authorities, and emergency services.

9 Biosecurity

Biosecurity is the set of measures to prevent the entry, establishment, and spread of pests and diseases on a farm (or country). A biosecurity plan should be implemented on every dairy farm, as it not only protects and benefits the health and welfare of livestock but also the wellbeing of staff.

Anyone entering the farm is stepping into your farm's 'bubble' and may pose a risk. To reduce these risks, it is important to establish some simple controls on your farm.

Steps to reduce the risk

- Ensure there is one clear entry and exit point and your biosecurity signage is clear for visitors.
- Set up cleaning and disinfection points to prevent the spread of diseases and weeds.
- Offer hand washing facilities to staff and visitors to reduce the risk of diseases that can be spread between animals and people.
- Have a policy for where visitors are allowed on farm and communicate this effectively.
- Store bagged and bulk feed appropriately, as per the manufacturer's instructions. Ensure feed is kept dry, covered, and free from pests and vermin.
- Ensure all spilt or uneaten feed is removed to reduce vermin. Take time to ensure all new staff and contractors are aware of the biosecurity policies.
- Consider a visitors' book to track visitors to the farm.
- Control pests and vermin such as possums, birds, rodents, wild cats and flies, which can spread diseases such as tuberculosis, salmonella and leptospirosis directly to cattle, or by contaminating feed and water supplies. Update your biosecurity policy in conjunction with your vet if there is a change to disease risk in the local area, or if your facilities change.
- Inspect stock on a regular basis to check their general health. Take notice of feet, dung consistency, eye and nose discharge and incidence of coughing.
- Consult your vet when looking at purchasing new stock to join your herd to minimise risk of disease entering your herd. Follow quarantine and testing procedures for new animals before integrating them into the herd.

For more information on biosecurity, visit **dairynz.co.nz/biosecurity**

10 Effluent from housed facilities

Managing effluent from off-paddock facilities involves capturing, storing, applying and managing both solids and liquids as part of the whole farm system.

There may be significant additional costs involved depending on the type of housing selected. Care must be taken when applying captured effluent to land to ensure compliance with district and regional council rules, particularly regarding paddock selection for solids application, timing, odour management, and nutrient budgets.

Existing effluent systems from the farm dairy could incorporate the effluent from the housing system if there is sufficient storage capacity and enough land area to apply the additional volume. Different feed sources may change the composition of the effluent, so consider how to manage solid and liquid (green waste) effluent. Alternatively, a stand-alone system may be designed to manage the additional effluent captured from an off-paddock system.

A significant volume of effluent is captured when housing dairy cows. This volume varies based on frequency of use, dry and lactating stages, and diet composition. Below is a table that describes likely volumes generated in off-paddock facilities.

Use the DairyNZ Dairy Effluent Spreading Calculator to help you estimate nutrient loadings and application rates from different sources of effluent. Visit **dairynz.co.nz/tools**

Animal	Heifer		Mixed age cow	
Status	Dry	Lactating	Dry	Lactating
Weight	400kg	400kg	500kg	500kg
Effluent generated, per hour(L) Approx kgDM/day	2.3 (12kgDM)	3.0 (16kgDM)	2.6 (14kgDM)	3.4 (18kgDM)
Effluent generated, per day(L)	55	72	62	82

Example:

A 500 mixed age cow herd housed all day in a freestall barn for 90 days could produce up to 3,672,000L or 3,672m^3 of effluent.

This captured effluent at an average nutrient concentration of 5kgN/m^3 will need to be spread over 122 hectares to avoid breaching the 150kg/ha/yr rule.

10.1 Consents and regulations

Resource consents permit certain activities to manage their environmental impact. Permits are granted under a set of regulatory and compliance rules set out under the National Environmental Standards. Compliance with both the national regulations and your regional/district council regulations is required. The need for resource consents or permits will vary between councils, and some cases may require more than one consent or permit.

Most regional councils have nitrogen loading restrictions from farm dairy effluent, necessitating significant land area to irrigate/spread the effluent captured.

A dairy effluent storge calculator (DESC) will be required to determine the volume of effluent storage needed for the off-paddock facility. Final calculations should be completed by a qualified person. Dairy effluent WOF assessors and accredited effluent system designers can help. Using a qualified person provides validation of accurate calculations and may offer suggestions for system efficiencies, reducing total storage requirements. Go to **dairynz.co.nz/effluent** for more information.

Effluent from off-paddock facilities should be tested three to four times a year to calculate nutrient loading accurately. Nutrients could vary from your pasture system. A nutrient budget will estimate the area needed to meet nutrient loadings, including nitrogen (N), phosphorus (P), potassium (K) and selenium (S). It will also determine how much effluent is captured and the likely land area required. This will help determine the cost, the whole farm effluent and manure management strategy, and any upgrade requirements.

10.2 Effluent management

There are a range of factors that need to be considered for managing effluent from housed facilities. Effluent is commonly grouped into three broad categories based on DM content: liquids (0–5%), slurries (5–15%) and solids (>15%).

If effluent from infrastructure facilities is not regularly irrigated to land, solids separation is strongly recommended. Unseparated solids can cause significant odour issues, especially if stored for extended periods when soils are too saturated to apply to land.

Mechanical solids separation systems are generally recommended, but weeping wall systems may be considered. Weeping wall systems need multiple beds and deeper bunkers to cope with the thicker consistency of effluent from off-paddock systems. Lined storage pond/tanks should be regularly stirred which helps reduce potential odour issues, whether solids are separated or not.

Spreading effluent solids requires specialist machinery suited to the type of effluent being spread. Vehicle spreading provides flexibility to apply effluent in areas outside the farm dairy effluent irrigation zone. It can also be used for nutrient boosts prior to sowing crops or on silage and hay paddocks. Effluent solids are commonly characterised by their physical consistency. There is some variation in how solids can be handled based on the size of the solid particles and the solids percentage. Effluent between 15-20% solids is generally the most difficult to handle with loading equipment and requires a sealed muck spreader.

Effluent solids have a higher nutrient content than liquid effluent. Application rates need to be lower, and a mixed sample should be tested to determine exact nutrient loading. As a guide, nutrient concentration ranges from 0.5kgN/m^3 to 5kgN/m^3 and 0.06kgP/m^3 to 2kgP/m^3.

Effluent contains many nutrients and can be used on a range of pasture and crops, which has economic benefits. Application of effluent will need to match herd grazing rotations to ensure paddock withholding periods don't interrupt feeding schedules.

When planning or designing effluent systems, consider sensitive areas like neighbouring properties, waterways, drains, differing soil types, and calving paddocks that need to be protected from the site of the effluent system. An effluent system should be designed based on your management resources and limitations. For more information see **dairynz.co.nz/effluent**

11 Assumptions

Dairy cow weight assumptions

Dimensions for space requirements and building design in dairy cow housing are closely related to the weight of the cows.

Use your herds median weight when designing your system. Variations in cow weights need to be accounted for to create a flexible and accommodating environment. By accounting for weight variations, housing facilities can be designed to cater to the needs of all cows in the herd, enhancing their comfort and welfare.

To accurately determine the median herd live weight, it is recommended to weigh at least 20% of the herd, ensuring a cross-section of cow ages. This approach provides a more representative median weight, which can be used as a baseline for design considerations. The best time to weigh your animals for an accurate representation is mid lactation. Take some height and width measurements to get a good understanding of the size of cows you will need to provide for, especially if planning a freestall system.

Although weight is a good indication of size, the actual dimensions of the cow are the most important factor. Lighter and heavier cows are often perceived as smaller and larger, respectively. These cows may not be adequately provided for when average dimensions are used.

Weight gain and increased condition normally go hand in hand with a higher feed input system. Therefore, most housed cows will gain condition due to changes in diet, feed utilisation, and protection from adverse weather conditions.

Production point	Min kg	Max kg
Dry	308	790
Peak Lactation	294	796
Late Lactation	345	770

Source: Lye, Scott and WTARS Research Farms

See DairyNZ's Facts and Figures for standard assumptions on weights of cows based on breed at **dairynz.co.nz/ff-chapter4**

I talked to other farmers to get an idea of how condition, weight or size changed when they housed their herd"

12 Glossary

Bedded pack	Deep layers of organic material (i.e. woodchips, straw, sawdust) that form a bed and pack down over time.
Bedding	Organic or inorganic material or manufactured products used to provide a comfortable laying space to improve animal health and welfare. Bedding materials include sand, composted manure, woodchips, sawdust, straw and rubber mats.
Natural behaviour	The practice of providing animals under managed care with environmental stimuli to improve quality of life.
Brisket locator	A device at the front of stalls to assist the position of the cow when lying, preventing her from lying too far forward in the stall.
Bund	Watertight wall or embankment designed to prevent liquid entering and/or exiting an area.
Compost	A humus-rich soil conditioner produced by composting manure and bedding material.
Compost bedded pack	A bedding system where an active composting process is maintained in the base of the bedding pack to promote a clean, dry, comfortable bedding surface.
Composting	A natural biological decomposition process that takes place under controlled self-heating and aerobic conditions.
Controlled drainage area	An area that collects and contains runoff from the dairy complex while excluding stormwater inflows.
Cow barrier	Structures used to prevent cows from standing in or on the feeding table. Common structures include elevated troughs, fences, hot wires, steel cables, head locks, neck rails and stanchions.
Cow brush	Rotating cylinder with hard bristles that cows can scratch themselves against.
Cross over	In a freestall, a walkway that joins two alleys.
Cross ventilation	A negative pressure mechanical exhaust system that provides forced air movement laterally across the housing from side to side.
Deep litter pack	A bedding system where new bedding material is continuously layered on top of the old bedding material to keep the surface clean and dry.
Effluent	See manure.
Erosion	The wearing away of the land surface by rainwater, water-flow or wind, removing soil from one point to another e.g. gully, rill or sheet erosion.
Effluent reuse	The application of manure and recycled effluent onto land.
Feed alley	The alleys occupied by cows when they are accessing feed. These alleys are located parallel to the feeding table.

Feed table	The surface on which feed is placed when feeding cows on feedpads and in contained housing facilities.
Freestall	A type of contained housing facility where cattle are allocated bedded cubicles (stalls), which they are free to enter to lie down as they please. They are used for long-term housing of cattle and may be an open-air, partially or fully enclosed structure, with or without an additional loafing area for cattle to stand to utilise or occupy.
Leaching	The process whereby soluble nutrients (e.g. nitrogen) are carried by water down through the soil profile.
Loafing area	A formed surface adjacent to a feedpad, or within the contained housing facility. Its primary purpose is to provide a separate section away from the feeding passageway for cattle to stand, lie, ruminate or idle.
Longitudinal slope	The slope along the length of the feedpad, or contained housing facility, to facilitate drainage particularly for flushing alleys.
Loose housing	A type of off-paddock facility where there is a large open bedding area, without individual stalls. These facilities are typically categorised by their management of the bedded area as a: • Compost bedded pack that is mechanically tilled at least twice daily; or • Deep litter pack where absorbent organic bedding is added regularly to the bedded area, but there is no mechanical tilling.
Manure	Livestock faecal and urinary excreta in a liquid, slurry, semi-solid and solid form. It can also include waste feed, bedding and soil. Liquid manure is typically referred to as effluent. Effluent is produced by cleaning the dairy shed and holding yards with water. Effluent may also include stormwater, residual milk and chemicals from cleaning dairy plant and equipment. Effluent may be recycled (i.e. recycled effluent) and used for washing manure from areas such as holding yards, alleys and off paddock facilities, or applied to land.
Natural ventilation	The provision of fresh air into a building space using natural air flow movements.
Neck rail	A rail to assist the position of cows in a stall so they have enough forward lunging space when they lie down.
Nib wall	A small concrete wall constructed along the perimeter of the feed alley/ passageway to prevent manure from leaving the off paddock facility or entering the feeding table.
Off-paddock facility	Any structure, with or without a roof designed to hold, house or feed animals.
Partial mixed ration (PMR)	A method of feeding where feedstuffs, supplementary to what the cows will graze, are combined as a single mixed ration and fed in between bouts of grazing, so the mixed ration makes up only part of the cows' diet.
Recirculation fans	Fans used to create fast air movement above cow resting places to promote cooling.

Side slope	The slope in the feed alley that directs manure and runoff away from the feeding table. The slope direction runs perpendicular to the feeding table. This is usually only associated with earthen feedpads.
Stall alley	In a freestall, these are walkways to enable the cows to access the stalls.
Stall divider	A looped rail that defines the width of the freestall and facilitates the lying direction of the cow.
Stall kerb	A small concrete barrier at the back of a stall used to prevent manure from the alley contaminating the bedding.
Stalls	Individual resting spaces or beds in a freestall which cows are free to enter and leave as they please.
Stocking density	Feedpad: space per cow. Freestall: number of cows per stall. Loose housing: square metres per cow of bedded area.
Stormwater	Rainfall runoff from building roofs, other hard surfaces and land.
Thermoneutral zone	The ambient temperature range across which an animal is comfortable and doesn't need to expend energy to maintain its normal body temperature. For healthy cattle this is generally 0°C to 25°C.
Total mixed ration (TMR)	A method of feeding which involves mixing all diet ingredients together into a single ration so that, in theory, each mouthful the animal eats is nutritionally balanced.
Transition period	The period from four weeks pre-calving to four weeks post-calving, which is characterised by an increased risk of metabolic disease for the cow due to the physiological changes that are happening.
Tunnel ventilation	A negative pressure mechanical exhaust system that provides forced air movement longitudinally through the housing from end to end.

DairyNZ

dairynz.co.nz