Composting Barn guide

A Practical Guide to planning, design and management for New Zealand Dairy Farmers

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

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Image credit: Michael Phillips

1 Overview

A composting barn is a covered structure where cows can rest on a deep bedding pack. The fundamental principle that differentiates composting barns from other dairy housing structures is the composting process that occurs within the loafing area. Over time, dung and urine from the cows, combined with regular tilling and airflow, support a natural composting process. When the system is designed and managed well, the bedding stays warm, dry, and comfortable, helping support both cow comfort and barn performance.

This guide is designed to help New Zealand farmers work through the key decisions involved in planning, building, and operating a composting barn within a pasture-based system. It draws on the experience of New Zealand farmers currently using these systems, alongside relevant international research.

The technical success of a composting barn comes down to balance. The amount of dung and urine going into the bedding must be matched by the system's ability to evaporate moisture and maintain microbial activity. This means regular monitoring and active management are essential.

A note on the New Zealand evidence base

Composting barns are still an emerging system in New Zealand. Most of what we currently know comes from commercial farm experience, on-farm observations, and collaboration between farmers, rural professionals, and industry specialists. There is still plenty to learn, and farmers sharing both successes and challenges continues to strengthen understanding across the sector.

② Composting barns as part of your whole-farm system

A composting barn should be viewed as a whole-farm system change. How the barn is designed, how the bedding is managed, and how cows move through the system will all influence farm performance and profit.

Before making design or investment decisions, be clear on why you are considering a composting barn.

Farmers choose these systems for different reasons, including:

- Improving animal welfare by providing shade in summer, shelter and a dry lying surface during winter, adverse weather and through calving.
- Reducing environmental footprint (particularly winter nitrogen leaching).
- Improving feed utilisation and efficiency.
- Protecting pasture by minimising soil damage during periods of saturated soils, summer dry or adverse weather events.
- Supporting better transition cow management and body condition score gain.
- Improving system resilience and farmer wellbeing during adverse weather.

These outcomes do not happen automatically. They depend on good design, consistent management, and how well the barn is integrated into the wider farm system.

How will you use the barn?

Early planning decisions will influence stocking density, bedding requirements, airflow design, and ongoing management. Consider the following questions before committing to a build:

- Which stock will use the barn? (milking cows, springers, dry cows, young stock, calves)
- How many animals will be housed at any one time?
- When will the barn be used during the year?
- Will the barn be used for wintering only, or year-round for multiple purposes?
- Will cows be housed full-time, or will they continue to access pasture or crops?
- Will the barn be used to reduce pasture damage, urinary loading, or heat stress?
- How will cows transition in and out of the barn across the season?
- Will feeding be ad-lib or controlled?
- What feeds will be used, and how might diet dry matter or crude protein affect composting performance?

You don't need definitive answers to all of these at the outset, but having a working plan will help inform any capital decisions. Do your research as to what type of infrastructure best suits your system and compare the range of options available.

Explore existing resources that compare off-paddock options at **dairynz.co.nz/off-paddock**

Image credit: Smartshelters

Animal welfare

Cows need to lie down comfortably to meet their health and wellbeing needs. If the surface is suitable, they'll spend 10-12 hours a day lying down, resting and ruminating. The ability to perform natural behaviours like grooming, feeding and lying are influenced by the design and stocking density of the barn. These are important considerations when planning your barn design.

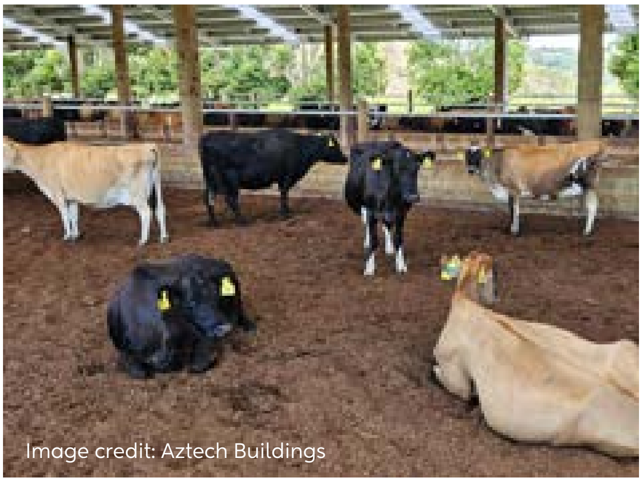


Image credit: Aztech Buildings

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.

Learn more about the Dairy Cattle code of welfare at **mpi.govt.nz/dmsdocument/46024-Code-of-Welfare-Dairy-cattle**

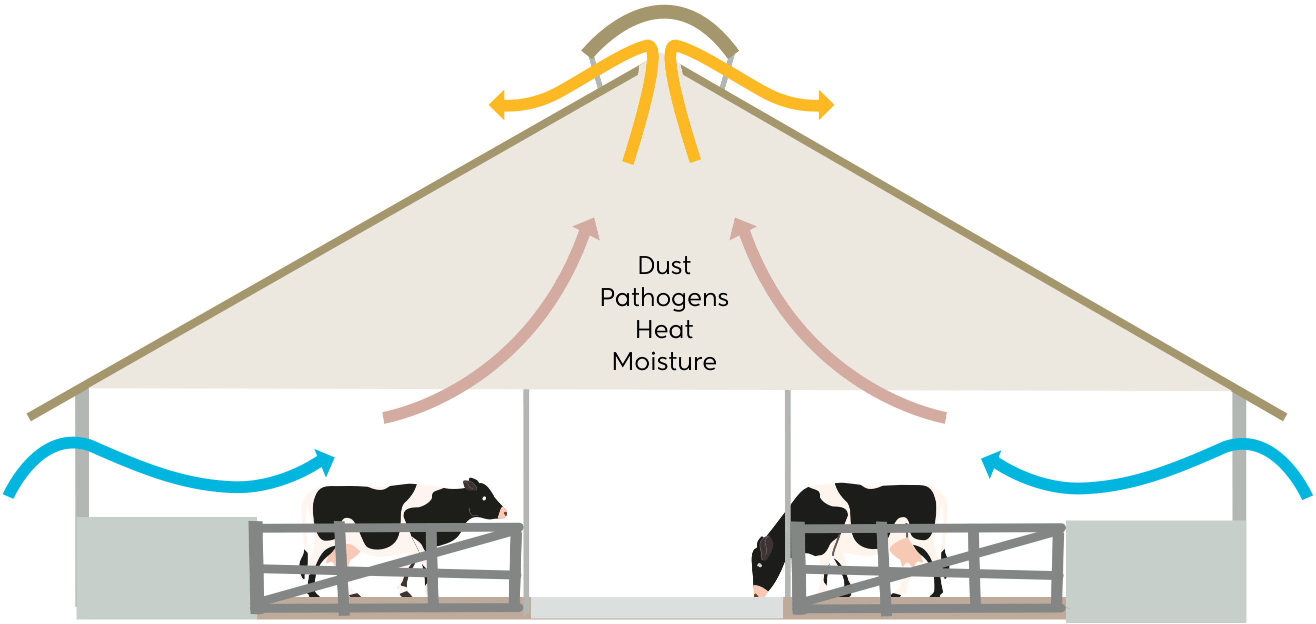
③ Design process

Good design helps you manage the barn effectively. The design needs to give you sufficient control over air movement, temperature, and evaporation.

Key design question: Will this structure allow you to remove moisture efficiently year-round?

Design factors that influence this include:

- Side-wall height and the presence or absence of retractable side-curtains.
- Orientation in relation to prevailing winds.
- The climatic region of the farm.
- Stocking density and hours of use.
- A roof apex venting system to create a chimney effect (venturi effect) for moisture removal.
- Roof slope/pitch (affects chimney effect).
- Tunnel roof height and width (alongside sufficient air movement).



Positioning the barn

Where possible, locate the barn close to existing infrastructure, particularly the milking shed (ensuring the proximity meets supply and consenting requirements). A common approach is to run the long sides of the barn parallel to prevailing wind and rain, with the short ends facing into the weather. The barn's dimensions (length and width) will affect how much sun reaches the bedding. Longer, narrower structures may allow more sun onto the bedding than wider builds. Consider how driving rain could reach the bedding pack, and how positioning can help reduce this risk.

"

Alongside orientation to the prevailing wind, consider cow flow when siting the barn so cow traffic splits evenly to other parts of the farm, with access at both ends. This lets different mobs come and go on their own and gives real operational flexibility."

Numat Agri


Image credit: Smartshelters


Image credit: Michael Phillips


Image credit: Aztech Buildings


Image credit: Numat Agri

Types of barns


Image credit: Smartshelters

Tunnel/hoop barns

Tunnel or hoop barns use curved metal frames covered with translucent fabric. They're generally lighter and lower cost than gable-roof structures. They are best suited to smaller herds or may require multiple structures for larger herds.

Key considerations for hoop barns

- Hoop barns often don't include vents, as they can naturally ventilate when built at the right height. Air movement through the structure helps remove moisture.
- Recent experience in New Zealand systems has shown roof heights over 5m improve air movement and ventilation and prevent condensation from reaching the roof. This is important if the barn does not contain a vent. Lower heights may reduce ventilation and increase condensation risk.
- Hoop structures are widely available and typically lower capital cost than other options.
- The best fabric to use is opaque white. It allows natural light through to give cows the feeling they are outside, while reducing heat penetration and heat stress. It may also reduce the need for artificial lighting.
- If translucent or clear fabric is used, shade cloth may be needed under the fabric to reduce sun exposure, in addition to a vent in the structure for removing the extra heat, especially in summer. These barns often provide more warmth in winter due to sunlight exposure.
- Hoop structures are typically clear span (no internal support columns or posts). This can make it easier to till the composting bedding.
- It's important to understand the structural requirements (snow and wind loading), expected fabric lifespan, and how the fabric will be cleaned as these all influence the ongoing operational costs.
- It's worth seeking advice on the cost and frequency of replacing the fabric roof, and factoring this into ongoing costs. Long-life (e.g. 15-20 years) fabric options are available from reputable suppliers.


Image credit: Smartshelters

Hear from farmers using a tunnel hoop composting barn: **bit.ly/readalefarm**

Gable roof barns

Gable-roof barns offer greater design flexibility. They're often well suited to composting systems because they provide excellent summer shade, and with a roof vent, can compost well year-round when managed well.

Key considerations for gable roof barns

- **Roof gap at the apex:** 1–2% of roof width
- **Rain cap**: include this over the roof gap
- **Roof slope**: at least 18 degrees to support airflow (check this with your designer)
- **Layout options:** central roofed laneway or outer laneways, with feeding on both sides
- **Eave overhang:** wide enough to keep out driving rain

More on what to consider when designing a gable roof barn here **numatagri.co.nz/cb**

Image credit: Aztech Buildings

Hear from farmers operating a gable roof barn here **aztechbuildings.co.nz/animal-housing/composting-barns?last_source=DairyNZ&last_campaign=composting-barns-guide-dairynz**

Central laneway – yes or no?

Without a central laneway, construction constraints can limit barn width to around 26–32 metres due to span widths (depending on design and materials). A central laneway allows wider spans but requires internal poles alongside the laneway, which need to be factored into costs and tilling plans. Including a central lane can also double the available feed face. When making this decision, consider the total barn size, dimensions and your herd size.

Speak to your building company for options. Extending shed spans by incorporating support poles into the loafing area may make tilling more challenging and time-consuming.

> *Feeding lane access is a consideration; roof height can limit the tractor's ability to feed to the side of shed feed lanes. You need to consider whether the feed will be kept dry or exposed to the weather, and how the feed will be managed, including the use of feed pushers.*

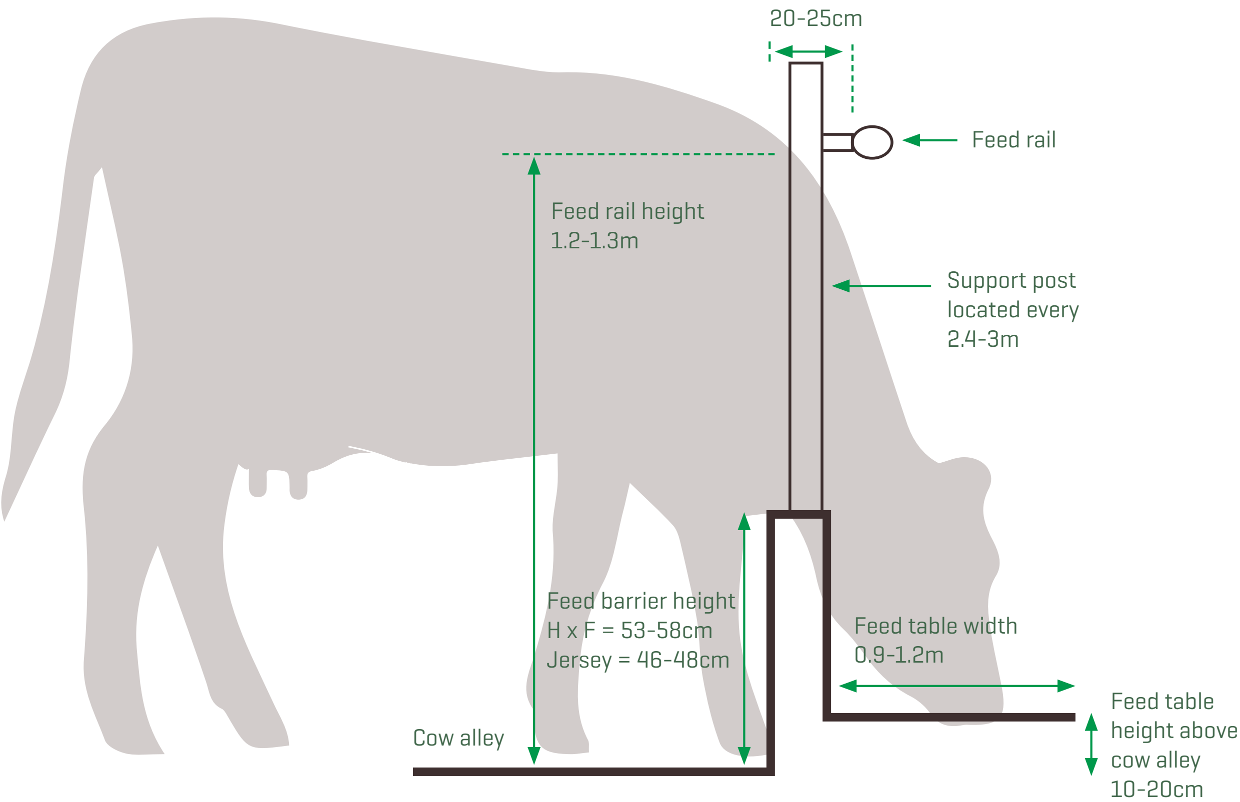
John Faulkner,
Lockerbie Farms


Image credit: Numat Agri

Feed space per cow

Feed-face per animal is an important early design decision. For controlled feeding, or when using the shelter as a feed pad, you'll need more feed-face per cow than for ad-lib feeding. As a guide, allow 75–90 cm per animal depending on cow size, assuming all animals are at the feed face simultaneously. Allow for space lost to poles if necessary, which can be up to 40-50cm per pole. Feed-face requirements will influence the shelter's length, width, and number of feed lanes needed.

Image credit: Smartshelters



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
4. 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.
5. Subtract 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
6. 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 / 70 = 0.74m
7. It is recommended to have at least 0.75m per cow. This helps reduce competition and injuries from reaching around poles.

Flooring under the compost

A range of base flooring options are used in composting barns, including compacted clay and cement-stabilised pit shingle. The base beneath the compost pack may be subject to regional council requirements, which can vary between regions and sites. For this reason, it's worth engaging with your local authorities early in the design process to understand any requirements. In some cases, councils may require impermeable surfaces and/or inspection points, depending on local conditions and regulations.

Feed and water structures

The three most common feeding options are:

1. **Internal central laneway** (roofed)
2. **Along the exterior sides** of the loafing area
3. **Separate feeding area** (e.g. external feed pad).

Each option has trade-offs, so think about what will work best for your setup and how you manage cows day-to-day. Feeding along the outside of the barn onto a concrete surface, with a roof overhang, is a common and practical option. When designing this, consider:

- **Machinery access**: allow enough space to safely feed out
- **Roof overhang**: allow enough height and width to protect feed from weather, but also reduce the risk of machinery damage to the structure
- **Concrete finish**: smooth to avoid tongue wear
- **Feed management**: you'll need a system to push feed up – from manual methods through to robotic options.

Water supply is very important. Your requirements will vary depending on whether animals are lactating and the dry matter content of their feed, so design for the peak stocking scenario.

Position and design water troughs carefully:

- Place them away from bedding areas to keep the space dry
- Ensure they are bunded, so spills/overflows don't enter the bedding
- Provide enough capacity and access points for your stocking density
- Locate them where they won't interfere with bedding management (e.g. tilling or emptying).

Image credit: Aztech Buildings

Image credit: Aztech Buildings

Image credit: Numat Agri

Loafing area per cow

Bedding area per cow has a significant influence on composting performance. Higher stocking densities increase nutrient and moisture loading. They can also lead to greater bedding compaction, reducing oxygen availability.

As a rule of thumb, more space per cow provides greater tolerance for management and design errors and makes it easier to maintain effective composting under challenging conditions.

The compost area required (m^2/cow) will depend on the system and how the barn is designed and managed. The longer the usage (hours and days), the more area per cow is recommended for successful composting.

Allocations of 8-10m^2/cow minimum are recommended, but there is no universal standard. Larger areas may be required for lactating cows, bigger breeds (e.g. Holsteins), high stocking density, or frequent use. Cows need enough space to lie comfortably in a natural posture.

Whether you plan for 9m^2 or 12m^2/cow, it's important that your design and management factors support good composting, and that you have a contingency plan if the bedding deteriorates. Allowing additional space can provide more management flexibility and future-proofing where the farm system or budget allow.

Cows typically do not lie in the feeding area. When calculating loafing area, allow for the feed-face and exclude the feeding area (e.g. around 2m width x length of the barn).

Image credit: Numat Agri

④ Choosing your bedding material

Bedding choice has a strong influence on how well your composting system performs. The key component in bedding is carbon, particularly from materials containing lignin. Lignin is a complex carbon compound that decomposes slowly and is the part of a plant that gives it structure. In composting bedding, it helps prevent the bedding pack from becoming wet and mushy. It also provides the energy microbes need to break down bedding, urine and dung into compost.

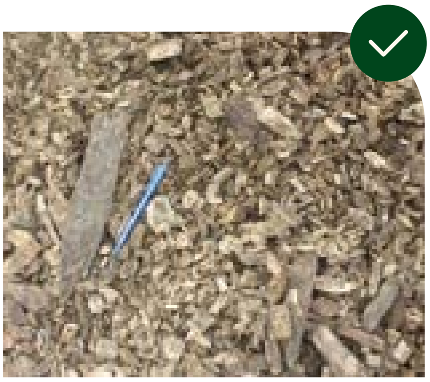
Wood-based bedding

Choose a bedding material that's high in lignin. Common options include:

- Wood shavings
- Sawdust
- Small woodchips

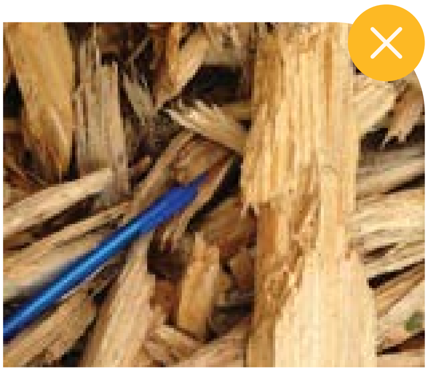
All timber types contain lignin, but hardwoods generally have more than softwoods. In New Zealand, pinus radiata is widely available and works well.

Wood-based bedding can vary widely in its carbon-to-nitrogen (C:N) ratio – typically 100:1 to 500:1 depending on the source. A high C:N indicates the bedding is rich in carbon, which helps balance the nitrogen (and moisture) added through manure and urine.



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.

Getting the right particle size

Particle size affects how much your bedding drains, compacts and composts.

- **Fine material (sawdust, fine shavings)**

  Breaks down quickly, and can compact if too fine, reducing airflow

- **Medium woodchips (around 10-50 mm)**

  Provide good structure and airflow – a good balance for most systems.

- **Large chips**

  Last longer but compost more slowly and can affect cow comfort if oversized

Very fine material can lead to poor airflow and anaerobic (low oxygen) conditions, which slows composting. On the other hand, overly large chips don't break down well and can increase the risk of lameness.

Moisture matters

Freshly milled timber is often too wet to use straight away. Where possible:

- Source bedding that is already dry, or,
- Allow it to dry before or after processing.

Aim for at least 60% dry matter (DM) at the start of the composting process to get the best results.

Straw

Wheat and barley straw are lower in lignin than wood-based bedding, so they break down quickly into wet, mushy bedding when used as a major component. Straw can be used as part of a bedding mix, but it generally breaks down faster than wood-based materials and may need more frequent topping up.

Miscanthus

Miscanthus is showing promise as an alternative bedding material in New Zealand. Some farms are already using it successfully, although supply and local experience are still limited. It's best harvested in September or early October when dry matter is around 85%, then chopped and/or baled for use. Miscanthus could be a useful bedding option where soil type and climate are suitable, but its use in New Zealand remains constrained by limited rhizome supply, slow vegetative propagation, high establishment costs, and relatively limited on-farm experience.

Buying bedding

Bedding is often priced by volume, which can make it hard to compare value. What really matters for composting is the carbon you're getting, so comparing cost per tonne of dry matter gives a more useful picture. Most composting barns start with around 60-80 cm of bedding depth. Some begin at 40 cm and add material through the season.

When sourcing bedding, ask your supplier for the bulk density (kgDM/m^3) of the product. Products with a higher bulk density contain more dry matter per cubic metre, so more bedding can be transported in each load. This can reduce transport costs and help you get better value for your money.

> *Having dedicated storage for both fresh bedding material and compost extracted from the barn has been key for us in keeping our composting system running efficiently. It means we can top up bedding when we need to and avoid getting bottlenecked waiting on contractors."*

Mike Phillips,
Waka Dairies

⑤ Managing your compost

Aerobic composting is a process where microbes consume oxygen and carbon and produce carbon dioxide, heat and moisture.

Composting is a biological process driven by microbial activity. It's influenced by moisture, oxygen and temperature, which are closely linked. When one shifts, it affects the others. Many composting barns in New Zealand struggle to maintain the correct temperature. This is often a sign of management or design gaps that are worth addressing early.

Active composting layer
(hot & aerobic)

Uncomposted material layer

Impermeable layer
(Concrete, Liner or compacted clay)

Starting with bedding as dry as possible is critical. Dry bedding has more capacity to absorb urine and dung, providing the right conditions for composting.

When bedding becomes too wet:

- Moisture fills the pore spaces
- Airflow is reduced
- Microbial activity slows down

This leads to less heat production, which in turn reduces moisture evaporation. As a result, bedding becomes even wetter and composting performance drops.

Once this cycle starts, conditions can deteriorate quickly – which is why early intervention is important.

Compost should run at 50–60°C at 15–30 cm depth before tilling.

Good composting relies on the right balance of carbon, nitrogen and oxygen:

- High-lignin bedding provides the carbon
- Dung and urine supply nitrogen for microbial growth
- Tilling introduces oxygen to keep the process aerobic

Getting the compost started

If your barn is mainly used for wintering, introduce a group of animals from around mid-April. Even bringing cows in at night or for a couple of hours after milking can help. This lead-in time allows the microbial population to build and begin composting before full stocking. It reduces the risk of adding too much nitrogen (from urine and dung) too quickly.

Tilling the compost

Tilling (or ripping) the bedding pack at least once a day is recommended. For cows housed 24/7, twice daily tilling may be required.

Tilling helps:

- Mix urine and dung through the bedding, supplying nitrogen to microbes and keeping the surface cleaner for cows
- Introduce oxygen to maintain aerobic conditions
- Release moisture from the pack

This supports microbial activity, generating heat and helping keep the bedding drier for longer.

Without enough oxygen, composting becomes anaerobic, leading to wet bedding, odour and poor composting.

Evaporation is crucial to remove moisture, so tilling needs to work alongside good airflow.

Image credit: Aztech Buildings

When you till active compost, you should see steam rising from the bed. This moisture should be exiting through the roof vent. If there's no steam, the compost temperature is too low.

Design considerations

How your barn is set up will affect how the bedding performs.

Feeding on the pack
The area of the bedding pack where cows stand to feed often becomes wetter than the other areas of the pack. These "standing" areas may need additional tilling, levelling, more frequent top-ups, or in some cases, a concrete surface.

Concrete feed lanes
When concrete feed lanes are installed, make sure you have a practical system for cleaning and managing effluent. Keep bedding material out of the system and avoid wash water soaking into the pack, as extra moisture can reduce pack performance.

Cow movement in and out of the barn
Entry and exit points can become wet and churned up. Using coarse woodchip or similar material in these areas can help maintain pack structure. Wet weather can also increase the amount of moisture cows bring into the barn, so these areas may need more closer monitoring or more frequent top-ups.

> *"Understanding the technicalities of a composting barn is vital. Now we have learnt them, the process is really quite simple. For us, with housing autumn-calved milking cows, it requires regular aeration, regular feeding of carbon, and vaccinating our cows."*

Mike Phillips,
Waka Dairies


Image credit: Michael Phillips

Equipment choices

Choose equipment that matches your bedding type and current conditions:

- Tyne-based equipment tends to perform better than rotary discs, which can create a hard layer (particularly in wood shavings or sawdust)
- Mechanical spaders or aerators can improve lift and aeration
- Ensure equipment can achieve depth of aeration for effective mixing
- Front-end loaders are useful for redistributing material from high-traffic areas, such as feed lanes
- Tilling while animals are in the barn is possible but requires considerable care. Where practical, move animals to a holding area or onto the feed lanes first
- Using tilling equipment narrower than the tractor will reduce the risk of damage to the structure during use.

Image credit: Smartshelters

See more about this ripper design here:
bit.ly/smart-ripper

Moisture management

Start with bedding as dry as possible. For ongoing composting, optimal moisture sits between 40–60% (dry matter content of 60-40%).

Moisture thresholds

- 40–60% moisture – compost is generally performing well
- Around 65% moisture – the pack is becoming overloaded and needs attention
- 70%+ moisture – the system is under pressure and action is essential

Image credit: Michael Phillips

How moisture affects the bedding pack

Moisture level of compost during use	What It means	Action required
40–60%	Optimal range	Continue normal management.
65%	Warning – conditions are trending away from the optimal range	Review stocking density (it could be too high), consider adding fresh bedding, increase tilling frequency, assess ventilation and review dietary DM.
70%+	System under stress	Reduce stocking density immediately or add fresh bedding. Wheat straw can help as a short-term recovery option. Increase tilling frequency and review dietary DM.
Moisture can be squeezed from bedding and/or bedding sticks to cows	Composting system has broken down	Immediate intervention is required.

Signs the pack is getting too wet include:

- Bedding sticking to cows
- Bedding building up on boots or machinery
- Ammonia smell
- Reduced heat or no visible steam when tilling

If these signs occur, review stocking density, tilling depth and frequency, ventilation, bedding supply, and dietary dry matter.

What to do if composting has stopped

When composting slows significantly or stops altogether, the system has usually lost one or more of the key requirements for composting: carbon, appropriate moisture levels, oxygen, or an active microbial population. There are practical steps to take to diagnose the problem and restart composting. Refer to the Compost barn pack recovery check guide for a step-by-step decision process.

Compost barn pack recovery check

Step 1

Is the pack responding well to aeration?

Aerate the pack right through to full depth, then check:

- Is it warming up down to 30cm depth?
- Can you see steam rising?
- Does it feel loose and open when you walk across after aerating?
- Is there an ammonia smell? If yes, go to Step 2

Yes → Keep doing what you're doing and monitor as normal.

No → Go to Step 2

Step 2

What is the pack moisture status?

Do a squeeze test with a handful of pack material:

Note: If you've recently added fresh woodchip, it may be too dry to form a ball during the squeeze test. In this case, the test may not accurately reflect the pack's moisture status, so do this test after the bedding has been mixed in and used.

Too dry (<40%)	About right (40–60%)	Getting wet (60–65%)	Too wet (>65%)
• Falls apart straight away • No dampness in your hand	• Holds together in a ball • Feels slightly damp • No water squeezing out	• Holds shape firmly • Feels noticeably wet or sticky	• Water squeezes out • Feels greasy or heavy • Pack is starting to seal over • Wet lying areas • Dirty cows
Action Add moisture to assist composting • Increase stocking density • Review DM in feed • Reassess	**Action** Moisture is likely okay – go to Step 3.	**Action** Reduce moisture load • Increase tilling • Reduce stocking density • Improve airflow	**Action** Address moisture ASAP • Add bedding • Reduce stocking density – Improve airflow

Step 3

Has the pack closed up or become compacted?

Check for:

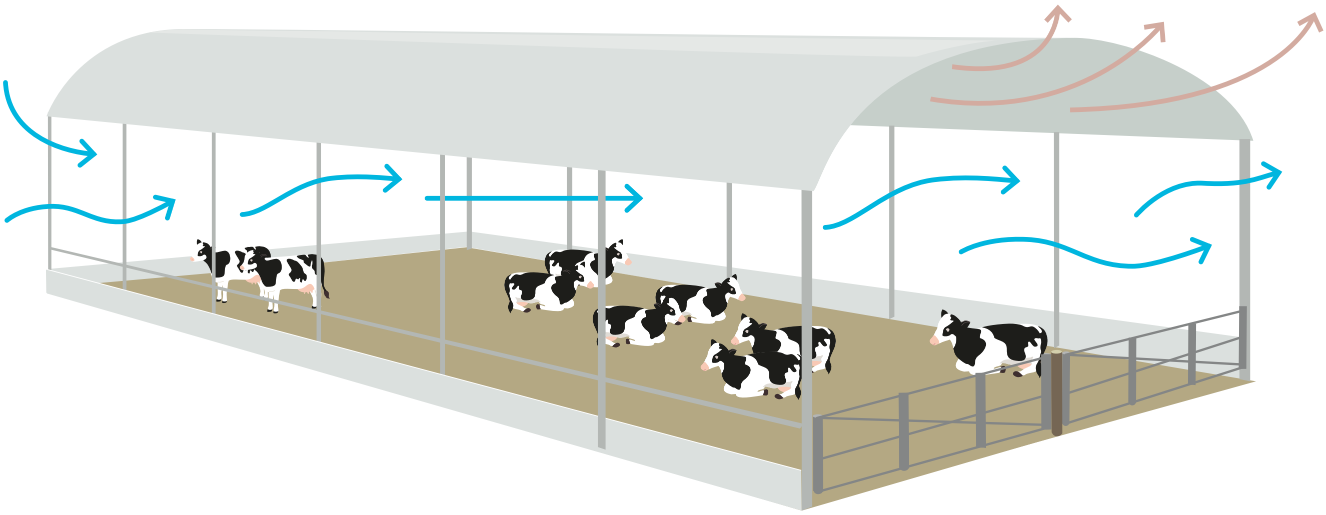
- Hard or dense areas?
- Sticky or greasy texture?
- Air not moving through the pack?

Yes →

- Increase tilling frequency.
- Monitor moisture and temperature to ensure pack is returning to effective composting - steam coming off - no strong ammonia smell.
- Consider equipment being used for tilling and the bedding type used - is it compacting rather than aerating?

Last resort: only remove and replace the pack if you can't get air, moisture, and pack structure back into balance.

Managing air flow and temperature



Air temperature management inside the barn has a significant effect on both compost performance and animal wellbeing.

Too cold: Evaporation and composting slow as heat is lost from the bedding. Feed requirements increase.

Too warm: If ventilation is inadequate, heat can build up in the barn. Cows have limited ability to sweat and rely on respiration for cooling, increasing their risk of heat stress. This is more likely to be a problem if the barn is used to provide shade in warmer seasons.

The ideal air temperature at around one metre of height is 11–15°C, with low humidity.

Shed design has a big impact on how well a barn manages air temperature and airflow. An appropriately sized ridge vent, along with side curtains or end wall closures that allow controlled air entry, can strongly influence ventilation effectiveness. Solid roofs tend to have lower risk for accumulating heat in the barn compared to fabric roofs.

Tunnel or hoop barns tend to have a higher condensation risk than gable roof barns. However, good design can minimise this risk. Extra roof height, open sidewalls and a high ridge outlet all help. Warm, moist air from cows and the compost pack rises and escapes before it can condense on the roof and drip back onto the bedding. Generous sidewall heights and open ridge ventilation is needed to support this airflow.

Retractable side-curtains can improve evaporation and cow comfort. While they're not common in New Zealand barns, they're worth considering - especially on the windward side to have greater control of airflow and reduce rain reaching the bedding.

A narrow ridge vent can create a venturi effect (where wind speeds up as it passes through a tight space). This helps draw warm, moist air up and out of the barn. Refer to the section on shed design for more information.

Image credit: Numat Agri

Image credit: Aztech Buildings

⑥ Monitoring your system

Consistent monitoring is what keeps a composting barn performing well over time.
Focus on two key variables: temperature and dry matter.

Temperature

For at least the first two years, measure compost temperature weekly using a compost thermometer.

- Take readings from at least six locations
- Measure at 15–30 cm depth before tilling
- Record results – trends matter as much as individual readings

What to look for

- Well-managed compost is 50-60°C
- Below 45°C at 30 cm: something is not right - investigate
- Low temperature at depth but normal near the surface: the upper layer is doing the work; the compost may need turning to depth.

After corrective action, temperature should rise gradually over several days.

You'll know composting is active when:

- Temperatures sit between 50-60°C
- You see steam when the pack is disturbed.

Image credit: Smartshelters

Compost thermometers

Compost thermometers are built for high temperatures and have:

- **A long stainless-steel probe** (40- 90cm) that allows you to reach the center of large compost piles.
- **A dial or digital display** reading from 0-120°C.

Moisture / dry matter

An oven and kitchen scales at the barn is a low-cost way to measure dry matter on roughly one-litre samples. Commercial lab testing is the alternative.

- 35% dry matter (65% moisture): orange warning – take action
- 30% dry matter (70% moisture): red alert - act immediately

A simple field check: take a handful of bedding and squeeze it:

- If moisture drips out: serious problem
- Good bedding: slightly damp to touch and doesn't stick to boots

Image credit: Smartshelters

Carbon-to-nitrogen ratio (C:N)

Wood-based bedding typically starts at around 100:1 C:N (range 100:1-500:1).

Over time, as urine and dung is added to the bedding, the nitrogen content increases.

Use the C:N ratio to track when the compost is approaching replacement point:

- A C:N ratio of 25:1 means about half the nitrogen-absorbing capacity of the bedding is used
- A C:N ratio of 15:1 means the nitrogen-absorbing capacity is used up and it is time to replace the bedding

Most soil-testing laboratories can analyse the C:N ratio. However, be aware that samples are usually ground before analysis to create an evenly mixed sample for testing. If the pack still contains large amounts of large, undecomposed wood chips, the test result on the sample may not accurately reflect the amount of unutilised carbon still in the pack. In some situations, farmers use a sieve-like attachment on a digger so that only the fine material is removed from the barn, and the remaining larger chunks are retained for further composting.

Visual checks

Don't underestimate simple observation. If cows have dung/bedding building up on their legs and flank, something isn't working. Act early before it compounds.

When to replace the compost

Bedding is a significant cost, so it pays to get the most out of it. In barns used mainly for wintering dry cows, well-managed bedding can last multiple years before it needs to be replaced.

> In a well-managed barn, the technical trigger for replacement is the carbon to nitrogen (C:N) ratio. Replace when C:N ratio drops to approximately 15:1.

In practice, many New Zealand farms are replacing compost at higher C:N ratios, around 25:1 or more because the compost has become too wet. This is a management outcome rather than a carbon limitation issue. Replacing bedding while carbon levels are still high means you're not getting full value from the bedding.

What's happening

Composting microbes do

Moisture

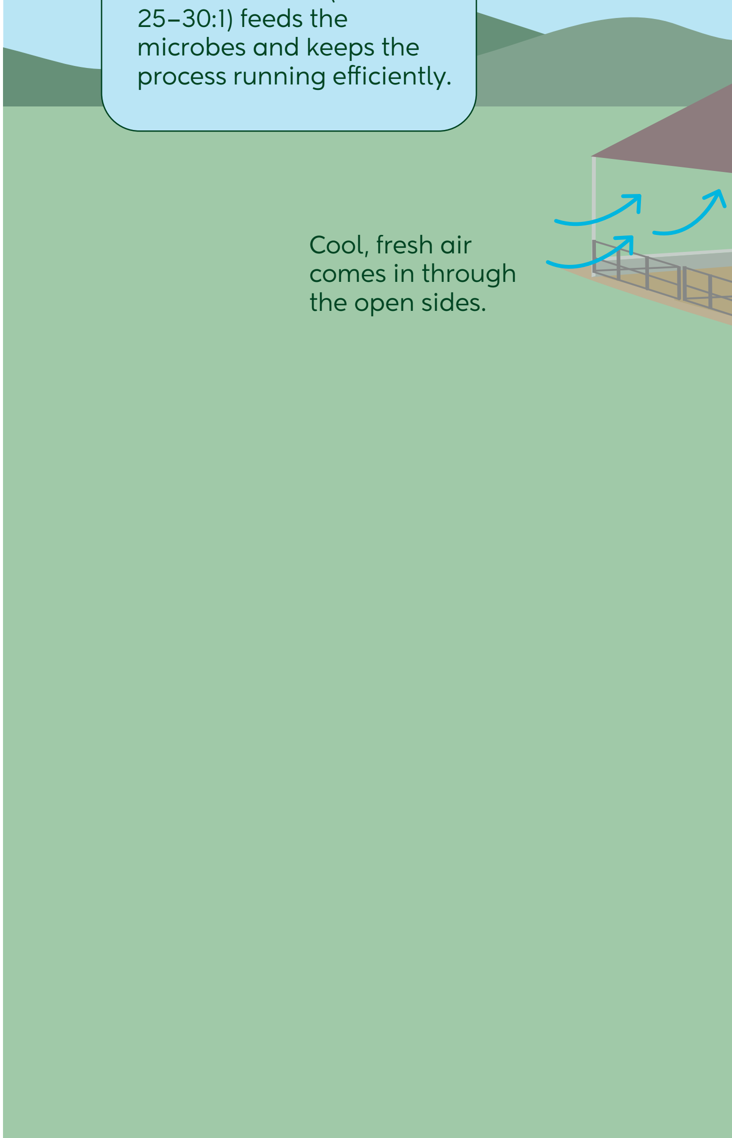
Bedding pack feels warm and slightly damp, like a wrung-out sponge. Perfect for microbes.

Temperature

Microbes generate heat. Bedding stays hot and stable at 50–60°C.

C:N ratio

A balanced mix (about 25–30:1) feeds the microbes and keeps the process running efficiently.



inside the barn

the work

Tilling we add the air

Evaporation

Tilling releases excess moisture as steam, helping bring moisture back to the ideal range.

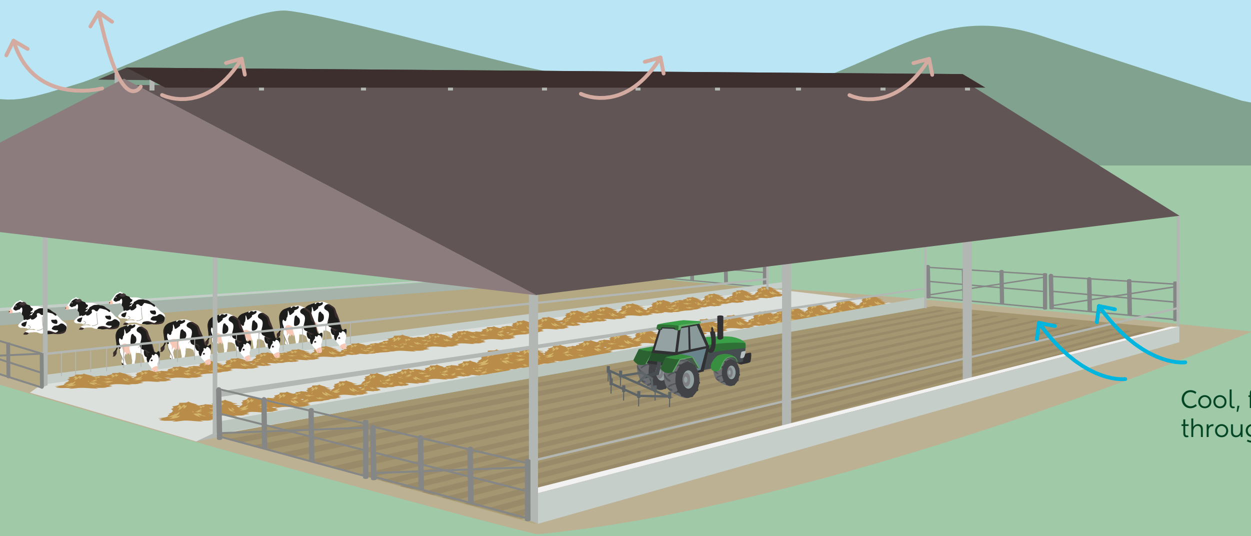
Temperature

A brief cool-down often happens after tilling, but the pile heats back up quickly with good moisture and the right C:N.

Aeration

Tilling pulls oxygen deep into the bedding, speeding up microbial activity and keeping things healthy.

Warm, moist air rises and leaves through the ridge vent.



Cool, fresh air comes in through the open sides.

The compost cycle

1 Cows
Add nitrogen and moisture (mainly through urine)

2 Bedding
Provides lying surface for the cows and carbon for microbes

3 Microbes
Utilise the nitrogen to feed on and breakdown the carbon generating heat

4 Tilling
Mixes the urine/dung with the bedding, adds oxygen and removes moisture.

5 Rest & repeat

Nutrient value of the compost

Compost has real nutrient value and can reduce fertiliser costs. Key nutrients include nitrogen, phosphorus, potassium, sulphur, magnesium and trace elements.

The specific value depends on:

- Nutrient content of the feed
- Nitrogen content of the bedding product
- Dry matter content of the compost

Putting a confident dollar value on the compost requires laboratory analysis and knowledge of your specific farm system. It's worth doing this calculation as part of your financial assessment.

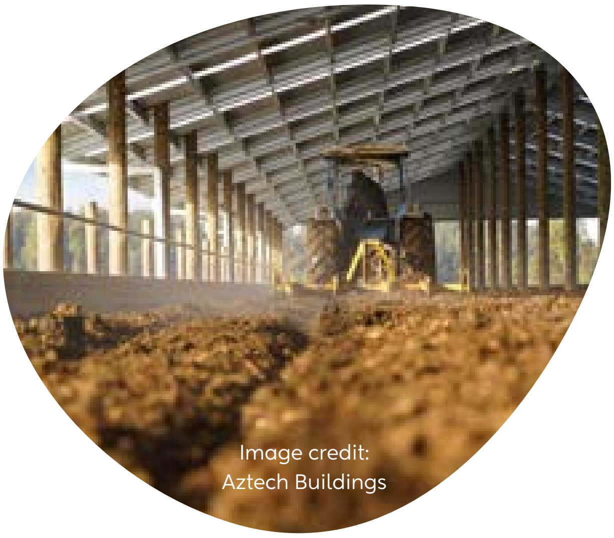


Image credit:
Aztech Buildings

Before spreading compost

Check the C:N ratio before spreading compost onto pasture:

- Above 20:1: microbes will immobilise nitrogen from the soil to keep breaking down the carbon – less available for pasture.
- Below 20:1 – better nitrogen availability

As a guide, aim to remove and apply compost when C:N is approximately 15:1. If compost needs to come out early and C:N is still high, store it on a sealed pad or in a stack to allow further composting before spreading. This allows the carbon to decompose further, helping stabilise the compost and reducing the risk of nitrogen being immobilised in the soil when it is applied to land. This helps stabilise the compost and improves nitrogen availability to give you the most value.

Example nutrient analysis (wet weight)

	% wet weight
Moisture %	63
C:N Ratio	19:1
Nitrogen	0.68
Carbon	13.1
Phosphorus	0.22
Potassium	1.19
Sulphur	0.13
Calcium	0.53
Magnesium	0.21
Sodium	0.08

⑦ Feed management

Crude protein (CP)

You don't need to target a minimum crude protein level for composting.

If cows are meeting their standard nutritional requirements, there will already be enough nitrogen in the manure to support composting.

The bigger risk is feeding too much protein. Spring pasture can sit at 20%- 30% crude protein, often higher than what cows can use. Excess protein is converted to urea and excreted through their urine.

In a composting barn, this creates practical challenges:

- **Strong ammonia odour:** Excess nitrogen quickly converts to ammonia gas, reducing air quality for cows and people.
- **Wet bedding packs:** High protein diets increase the cow's water intake and urine volume. This makes it harder to maintain the target bedding moisture of 50-60%.

For crude protein content of feeds visit: **dairynz.co.nz/feed-values**

Dry matter content

Keep a close eye on bedding moisture when cows are transitioning to the barn or if pasture or crop is a significant percentage of their diet.

- Diets high in pasture or crops = wetter manure = higher moisture load on the pack
- Diets high in dry supplement (e.g. dry silage, balage, PKE) = risk of the bedding becoming too dry

Both situations can reduce composting performance, so aim for balance.

Meeting cow demand

Meet cow requirements for energy and protein first. A well-balanced diet supports production and helps manage nitrogen losses and system performance.

Use the Feed Checker tool to check your feed is meeting cow demand for energy and protein: **dairynz.co.nz/feed-checker**

Image credit: Aztech Buildings

> *A dry summer or wet winter/ spring doesn't determine the outcome of our season anymore. We're far more consistent."*

Mike and Becky Sargent

⑧ Animal health

Heat stress

Composting barns can help reduce heat stress by providing shade to the whole herd. Design choice will influence how effective this is.

Hoop-design barns can increase the risk of heat stress if the design for ventilation and air flow is poor. If using a hooped design with clear plastic, speak to your design company for advice on managing heat stress.

Gable-roof barns with proper venting are often better at maintaining airflow and providing shade.

Mastitis – how to mitigate the risk

Some New Zealand farms, particularly in the North Island, have reported mastitis cases caused by E. coli and other gram-negative bacteria when barns are used during lactation. The risk can build up over several years. Some farms that have ongoing issues have opted to implement a strict vaccination programme for *E.coli* mastitis to mitigate the risk.

Key points to manage risk:

- Keep compost temperatures above 50°C to suppress bacteria
- Fully clean out bedding when it is time to replace
- Work with your vet before the season to set a mastitis management plan
- Consider whether vaccination is appropriate for your herd

Gram-negative mastitis behaves differently to gram-positive mastitis, which is more common in pasture-based systems, so it may need a different approach.

Body condition

Cows wintered in a composting barn require less feed (up to 30-40% less has been reported by NZ farmers, depending on the pre-barn system) than those wintered outside, particularly for herds in the South Island or in cool areas of the North Island. This generally results from both a higher utilisation of feed and reduced cow energy requirements for maintenance.

Many farmers report cows gain condition more easily in barns, sometimes up to half a condition score higher.

Image credit: Numat Agri

What this means for you: plan feed quality and allocation carefully, especially before calving, to avoid cows gaining too much condition.

Calving and transition

If you're calving in a composting barn, plan how you'll manage mobs. Some farmers use temporary fencing or gates to create separate areas. Allow enough space for cows to separate themselves to calve.

Transition feeding can be easier in barns, with cows in better condition at and after calving. Minerals can be supplied in the feed making it easier to ensure cows are getting the correct allocation during transition periods.

Image credit: Numat Agri

Moving cows back to pasture

After winter housing, cows need time to adjust to outdoor conditions and prevent metabolic issues. Key steps:

- Transition feed gradually over 7-10 days
- Introduce pasture slowly to reduce metabolic risk
- Provide access to dry lying areas and shelter belts
- Build up time outside as cows adapt

⑨ Environmental and effluent considerations

Whole-farm environmental impact

Composting barns can reduce environmental risk, but the benefits depend on your farm system.

Housing cows during wetter periods reduces the time they spend grazing, which can:

- Lower nitrogen loss risk (from urine patches)
- Reduce soil damage and pugging during wet conditions
- Help protect pasture and maintain production

Reductions in nitrogen leaching of 10-50% have been modelled using Overseer for New Zealand farms. The 50% reduction farms were modelled using the shelter year-round with high usage through autumn and winter and removing winter cropping from the system.

A composting barn may directly or indirectly result in changes to the farm's greenhouse gas emissions, seek advice from your farm advisor.

A full assessment of whole-farm environmental benefit, including emissions to air e.g. methane needs to be done at an individual farm level. Consider the farm system, soils, and regional context as it may be required for the consenting process.

Effluent management

The goal of a well-managed composting system is for all liquid effluent to evaporate. This is achievable, but environmental safeguards will still be required. Local authority requirements for effluent capture and management may vary depending on your location and system design.

When planning your barn, talk with your local authorities early to understand what may be required on your farm. Adding in new infrastructure may require upgrades to manage the additional solids being collected (woodchip, maize, hay etc).

> *"When evaluating housing options, farmers should consider whether they want their effluent stream managed as liquid slurry or converted into solid compost through the bedding system."*

Mike Phillips,
Waka Dairies

Consent requirements

Whatever your effluent system design, some local authorities may require consent. Check requirements early, before construction. Designing to best practice gives you more flexibility if rules change.

Designing for effluent risk

A good management practice is to regularly check how your barn is performing, including watching for any liquid draining below the bedding. When designing or building the barn, it's worth thinking ahead about how you would collect and manage any liquid if it becomes an issue in the future.

If the barn is close to the milking shed, consider how effluent management from the barn could be integrated with the existing system. If cows are standing on concrete during feeding, that area will need daily cleaning and a more formal effluent setup.

Similarly, if you plan to have concrete aprons at the ends of the barn for entry and exit, consider how that area will be cleaned.

Storage and system capacity

If you're adding barn effluent (e.g. from concrete areas) into your system, check that your storage is still adequate.

You should consider:

- A modest lengthways slope on the barn floor
- A piped collection system
- Humping and hollowing with drainage

The Dairy Effluent Storage Calculator (DESC) can help estimate storage requirements based on your farm system: **dairynz.co.nz/desc**

Regional considerations

Regional conditions can have a big impact on how well a composting barn performs. Temperature, humidity, rainfall, wind exposure, and drying conditions all influence how easily the pack can stay active, manage moisture, and maintain cow comfort.

For example:
Wet or humid regions may need more roof cover, stronger drainage, more area per cow or more ventilation.
Cooler regions may need to retain heat in the pack by reducing cold air exposure.

Taking local conditions into account during the design stage can help improve pack performance, reduce management challenges, and support long-term barn success.


Image credit: Numat Agri

Upper North Island

The upper North Island's warm, humid climate and high rainfall can influence composting barn design, bedding management, and ventilation requirements. Infrastructure planning should consider managing moisture levels, providing shelter from heat stress, maintaining bedding quality, good drainage and integrating the barn with existing farm systems to support cow comfort, environmental performance, and efficient use of nutrients and effluent.

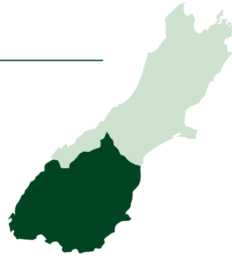
Lower North Island

The lower North Island's variable climate, strong winds, heavy soils and periods of summer drought can make infrastructure that improves feed and grazing flexibility attractive. When considering a composting barn, farmers should assess how the barn is positioned for wind exposure, how it will fit within their feed system, support pasture management during dry periods, and integrate with nutrient, effluent, and water management across the farm.

Upper South Island

The upper South Island's cold winter temperatures may provide challenges for barns to achieve optimal composting temperatures. Intensive farming systems and increasing heat stress risk require careful planning when introducing a composting barn. Considerations include how shed design and management will assist achieving effective composting, integration with existing infrastructure, bedding and feed availability, nutrient management requirements, and how the facility can support cow comfort while meeting environmental expectations.

Lower South Island



The lower South Island's colder winters, winter grazing systems, and environmentally sensitive catchments require a whole-farm approach when evaluating infrastructure investments such as composting barns. Cold, wet winters may provide challenges for barns to achieve optimal composting temperatures. Both shed design and management will assist effective composting. Key considerations include identifying opportunities to reduce wintering impacts, managing nutrients and bedding materials, protecting soil and water quality, and ensuring the infrastructure complements existing farm management practices.

See more about Reducing your environmental footprint here: **dairynz.co.nz/resources?spotlight=11605**

⑩ Assessing costs and returns

Whether a composting barn makes financial sense will depend on your farm system, land, climate, herd, and what you're aiming to achieve. Running your own numbers using realistic assumptions is essential.

Costs to consider

Capital costs

A complete composting barn system – including site preparation, consenting, concrete, effluent systems, yarding, laneways, barn materials and construction – typically ranges from ~$1,500 to $3,000+ per cow.

The range is wide as costs will vary depending on design, site conditions, scale and how the barn fits within your farm system.

You may also need to budget for:

- equipment for bedding maintenance, cleaning and feeding.
- storage for fresh bedding and compost.

Storage of fresh bedding and composted bedding might be the same place or in two different locations, however it should be planned to avoid issues if you are unable to synchronise the spreading of compost and the addition of new bedding.

Consider other infrastructure changes e.g. silage bunkers, stormwater and drainage, tanks, railing/bars for feed bins, water systems, troughs and manure and effluent management if applicable.

Be cautious when comparing costs on a per cow basis. Designs vary in space allowances per cow, and stocking density plays a big role in barn performance. Assessing cost on a $/m^2/cow comparison may give you a clearer picture.

Ongoing costs

Building the barn is just the starting point. Ongoing costs will influence how the system performs financially over time.

Consider how the following apply to your farm:

- Bedding (ongoing operational cost)
- Tilling equipment maintenance and replacement
- Tractors and fuel costs
- Effluent system upgrades (if necessary)

Also factor in the time required to manage the system, particularly in the first few years.

Bedding costs

Bedding costs can vary by region and availability.

Managing bedding well has a big impact on cost. Replacing bedding only once the carbon-to-nitrogen (C:N) ratio reaches the lower limit can help minimise costs.

For example:

- 8 m^2/cow at 700 mm depth = 5.6 m^3/cow at $30/m^3 = $168/cow
- If bedding can be managed well so that only the half the bedding ($84/cow) or less has to be replaced each year, it will make a big difference to ongoing operational costs and overall profitability of the system.

Many farmers tend to only replace the top half and/or get more than one season from the bedding. However, some farmers prefer to have fresh bedding stored on farm for regular top-ups when needed.

The significant cost of the bedding highlights the importance of managing the composting process well and making the most of available carbon.

⑪ Assumptions

Dairy cow weight assumptions

Dimensions for space requirements and building design in dairy cow composting barns are closely related to the weight and size 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, composting barns can be designed to cater to the needs of all cows in the herd, enhancing their comfort and welfare and the best chance for optimal composting.

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. 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.

DairyNZ's Facts and Figures for standard assumptions on weights of cows based on breed at **dairynz.co.nz/resources/resource-list/facts-and-figures**

Image credit: Aztech Buildings

Image credit: Smartshelters

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