Management guidelines for a loose housed soft bedding shelter for wintering dairy cows.

Minimising the moisture content of barn bedding is important both in terms of cost and animal welfare. Reducing the frequency and volumes of replacement bedding required reduces the overall cost to the farmer - not only is there the cost of replacement bedding but also the cost to remove it from the barn and spread it on paddocks. Increased moisture on the barn surface can reduce cow lying times; a negative effect on animal welfare. High moisture levels also increase the risk of mastitis and potentially lameness.

Key findings

- Longevity of bedding material is closely related to the moisture content. Management to reduce moisture in the bedding area will increase the longevity of the bedding material, reduce costs and labour requirements, and can improve animal welfare.
- The drier (lower the moisture %) the fresh barn bedding the better, as it lasts longer and needs replacing less often.
- The surface of the bedding is wetter than deeper layers, probably due to an accumulation of dung on the bedding surface. Daily scarifying or light cultivation of the bedding surface helps reduce the bedding moisture and dung accumulation, minimising the need for replacement.
- High traffic areas have higher moisture levels compared to other areas of the barn, especially when accessing outside areas or water troughs, and as a result will need more management.

Continued on Page 2.

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Key findings continued

- Topping up woodchips at intervals during the winter will help reduce moisture levels in the top layer. This does not have to be the whole area; replacement can target wetter areas such as entranceways. Visual assessment of the bedding surface is sufficient to determine when this is required.
- Other helpful measures include: minimising rain getting into the barn, maximising air flow to help dry bedding, and having feeding/water trough areas away from the bedded area but still under cover.
- Stocking density has a large impact on the longevity of the bedding material so ensure a minimum of 8 m2/cow is allowed.

Background

Loose-housed shelters with woodchip bedding are being used to winter dairy cows. There have been a number of questions raised regarding the management of these types of shelters. A monitoring trial of the woodchip bedding barn located at the Telford dairy farm in Balclutha, South Otago, has addressed some of these questions;

- what are the moisture levels in the barn and,
- does moisture vary over different areas of the barn.

Trials monitored the moisture of bedding material at different locations throughout the barn during winter. Bedding moisture was a key determinant of longevity of bedding. High traffic areas such as entranceways became wetter faster than low traffic areas. The moisture content of the fresh bedding going into the barn influenced the length of time the bedding lasted before requiring replacement. Regular ripping up or scarifying of the woodchip improved the surface condition, redistributing moisture and dung vertically through the bedding profile, and facilitated drainage of urine through the bedding material.

Management recommendations

Facility design and management: aim to reduce moisture in bedding materials.

- Correct stocking density for the size of the barn and frequency of use (allowing a minimum of 8 m2 cow if using 24/7 over winter).
- Design a barn that will minimise the amount of rain getting in while also maximising air flow.
- Site barn entrance towards prevailing weather
- Be prepared to put up shade cloth/gale breaker to reduce rain entering
- Design efficient drainage of liquid from barn bedding.
- Locate feeding and water trough areas away from the bedded area but preferably under cover.
- Use dry, more uniform woodchips and scarify or lightly cultivate bedding surface regularly (at least daily if being used 24/7 for wintering).

To work out the cost of bedding for a barn, use the cost check list in the Appendix 1.

Research results

A monitoring study was conducted on the Telford Farm in Balclutha measuring bedding moisture levels of their loose-housed barn with bark and sawdust bedding. It was used to house an average of 75 cows during winter, June to August. The basic barn structure was a roofed area over the bark bedding (10 m x 72 m) with an adjacent concrete feeding strip (5 m x 72 m) and feeding troughs (1 m x 72 m), both of which were uncovered.

The durability of the barn bedding was identified as an issue. Change in moisture content was used as an indicator of when to replace the bedding material. A monitoring trial measured the moisture content of the barn bedding material at three locations: barn entranceways (highly trafficked areas), middle of the barn (moderately trafficked) and along the wall at the opposite side of the feeding strip (low traffic area). Samples were also taken at two depths at each of these locations. Figure X shows the moisture levels of the three different trafficking areas over the winter period.

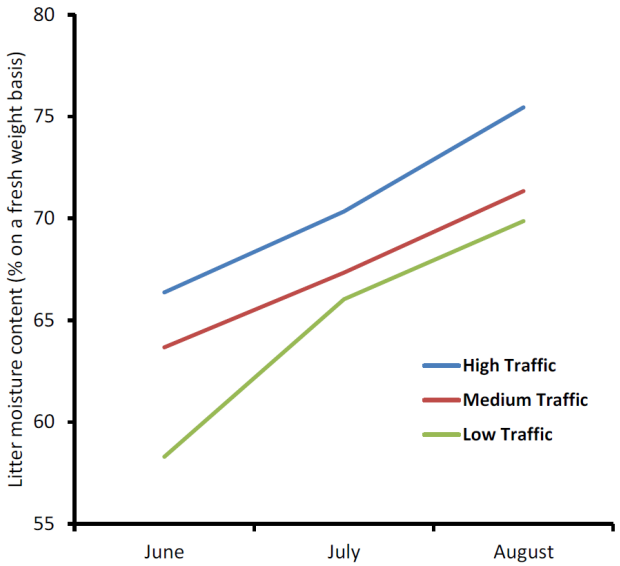

Figure 1: Barn bedding moisture contents at different locations throughout the barn.

Results showed:

- Highly trafficked areas had higher moisture levels than other areas of the shelter.
- Barn bedding moisture contents increased over time in all areas of the shelter.
- Detailed measurements of bedding moisture levels proved unnecessary - visual assessments of the bedding surface were sufficient to determine when this refreshing was required (see photos A and B below).

Barn surface condition at the end of winter (Aug) for low (A) and high (B) trafficked areas.

Volumes and nutrient concentrations of material generated by the Telford shelter in 2014

Basic information relating to the use of the barn in winter 2014 is outlined in Table 4 below. The shelter was emptied following autumn use and refreshed with fresh bedding ready for the winter period. Due to extreme wetness, a top layer was removed mid-winter (215 m3) and replaced with drier bedding. The shelter was then fully emptied at the end of the winter period. Ripping was practiced but discontinued due to difficulties associated with the machine being used and the large and non-uniform nature of the woodchip material used in 2014.

Table 1: Timeline of events for shelter use over autumn and winter 2014 (average of 75 cows/day).

Month	Event	Number of hours per day in barn
April		Milking cows spent 12 hours per day mid April until 11 May.
May	Emptied of bedding 11th May and refilled for winter use.	24 hr/day after cows were dried off at the end of May.
June		24 hr/day
July	15 July: 215 m3 of surface layer removed and stored on silage pad	24 hr/day
August		24 hr/day. Numbers reduced gradually with the last cows removed 31 Aug.
September	Bedding emptied 1st Sept and spread onto paddock.	

At the end of the 2014 winter, 550m3 of bedding was removed. It contained approximately 1,380kg N, 340kg P and 2,000kg K (Table 5).

Table 5: Total volume/nutrient content of bedding material generated by 75 cows over 89 winter days.

Parameter	Bedding material at the end of winter	Total per cow/ 89 day winter	Total per cow/day
Volume removed	550m^3	7.3m^3	0.08m^3
Wet weight removed	287,420kg	3,832kg	43kg
Nutrient removed			
Total Nitrogen	1,785kg	23.8kg	0.27kg
Phosphorus	435kg	5.8kg	0.07kg
Potassium	2,535kg	33.8kg	0.38kg
Carbon	44,625kg	595kg	6.7kg
Fertiliser value from N, P, K $ cow^{-1} year^{-1} (assuming $1.50kg^{-1} N, $4.50kg^{-1} P, $0.80kg^{-1} K)	**$6,663**	**$89**	

Experience at Telford managing the barn

Successful ripping of the barn made a huge difference to the state of the bedding material. There were three things that were deemed important for successful ripping:

- The type of bedding material (more uniform and smaller was better)
- The machine that was used – went to a rototiller rather than a ripper so it mixed the surface really well.
- The frequency of ripping.

Approach	Effectiveness in managing barn	Why?
Chipping the off cuts from own trees	Low	The chips were too large, non-uniform, stringy and wet (Photo C shows our material on left and purchased material on the right). The material used was the outside branches and slash material so it did not chip evenly.
Leaving the barn surface i.e. doing nothing to maintain it and only replacing when required.	Low	The dung remained on the surface of the bedding creating a wet, sloppy surface that quickly became mucky.
Daily ripping of bedding surface; with bedding comprised of large and unregular woodchip material.	Low	The ripper was not able to slice and turn the bedding due to the large chunks of wood material in the bedding and it pulled larger pieces to the surface making the lying conditions rough (Photo D).
Daily ripping of barn; with bedding comprised of small and uniform woodchips (purchased commercially).	High	Allowed incorporation of dung through the bedding thus redistributing the material with high moisture content throughout the bedding profile. Helped dry out the surface (Photo E).
Daily cultivation of barn; with a rototiller.	High	Mixed the surface material more efficiently than the ripper. Helped dry out the surface.

Photo C: Fresh barn bedding. Wetter and with larger woodchip pieces on left; drier with smaller, more uniform chips on right.

Photo D: Barn after ripping-uniform small bedding.

Photo E: Barn after ripping large non uniform bedding.

What management changes are made when using full time over winter rather than intermittently during wet periods for soil protection

- Get the stocking density right from the start (minimum of 8m2/cow when over wintering)
- Greater risk of mastitis when cows are lactating, therefore the barn bedding needs to be drier and be turned daily (ripped).
- The greater the time the cows are on the bedding the greater per cow area required for winter use, as this will extend the longevity of the bedding material.
- If milking from the barn the recommendation is to have 11m^2 to a minimum of 8m^2.

Loose-housed barn with bark and sawdust bedding on the first day of winter (mid-May).

Barn surface mid-July.

Appendix One

Check list

- Do you have a reliable source of bedding material?
- Are the water troughs located away from the bedding area?
- Is the bedding and new top-up bedding sheltered from rain?
- Do you have the equipment available to rip the bedding surface on a regular basis?
- Is the barn drained to minimise liquid accumulating in the bedding?
- Does your consent allow for disposal of the amount of effluent and bedding generated from the barn?
- Have you planned how old bedding will be stored and used?

*If considering composting the bedding material before spreading on to land then you may need to capture leachate in your effluent system during the composting process. For more information go to: http://www.dairynz.co.nz/media/1986505/effluent-pub_compliance_checklist_Southland.pdf

Annual Cost Checklist

		Calculations	Costs
Bedding costs during the year			
Set up cost - autumn The facility will need fresh bedding for the start of winter and start of spring (if milking from barn). This will depend on the size of the barn; the Telford barn was 10m wide and 72m long = 720m^2			
Length x width x depth = volume required Remembering a minimum of 8m^2 area per cow is required.	**A**	L_____x W_____x D_____ = A	_____m^3_____
Example Telford: 10m length x 72m width x 0.4m depth x 2 **= 288m3 (A)**			
Cost of bedding to fill barn - autumn	**B**	A x cost of bedding / m^3 x =	**B $**_____
Example Telford = cost of bedding $24.50 m^3 delivered*) *$21/m^3 + $3.50 (delivery)			A = 288 m3 x $24.50/m3 = $7,056 (B)
Cost of machinery of staff time replace bedding	**C**	hourly hire rate x # hrs = or hourly staff rate x # hrs =	**C $**_____
Telford example: it cost to hire a $130/hr digger and $160/hr muck spreader. ($130 x 6.2hrs) + ($160 x 6.2) = $1798 (C)			
Total set up cost - autumn (B+C) =		**D $**_____	
Maintenance cost:			
During the winter the facility will need to have the top 20cm of the bedding scrapped to remove damp bedding and dung. At Telford this was done once during late winter.			
Total volume of bedding removed autumn to spring	**E**	Depth x area c frequency =	E_____m^3
Example Volume of replacement material at Telford = 1 partial clean mid-winter taking top 20 to 30 cm. Depth 0.3 m x 720 = = 216 m3 (E)			
Cost of replacement bedding material	**F**	**E** x cost of bedding / m^3	**F $**_____

Cost of replacement bedding material - E = 216m^3 x \$24.50/m^3 = **\$5,292 (F)**			
Cost of removing top 20cm bedding removal during winter/spring Hire machinery or staff time	**G**	hourly hire rate x # hrs x = or hourly staff rate x # hrs =	**G \$**_____
No data on time taken to do this available - maybe could estimate as it's $^{3/4}$ of amount of material that was costed in step C above.			
Total maintenance cost (F+G) = H			
Additional costs if milking: If milking cows are in the barn, then the recommendation is that the barn is refilled.			
Cost of replacement bedding for spring use	**H**	= F + G	**H \$**_____
Total cost of bedding (-D+F+G+H) = I _____			
Time to manage barn system			
Labour			
Feeding	**J**		
Observing stock	**K**		
Bedding surface management	**L**		
Telford experience - cows spent 42 days in the barn at an average of 1 hour/day to feed, check, rip and manage cows. Assumed cost of \$20/hr.			
			42 days x \$20 - **\$840.00**
Total cost of management = **I+J+K+L+M = N** _____			

Ongoing Cost Checklist

Repair and maintenance associated with the barn
Tractor and silage wagon
Facility infrastructure
Effluent infrastructure

Additional research

Chrystal, J., Monaghan, R., Hedley, M., Horne D., 2016. Volumes and nutrient concentrations of effluent products generated from a loose-housed wintering barn with woodchip bedding. In: Integrated nutrient and water management for sustainable farming. (Eds L.D. Currie and R. Singh). http://flrc.massey.ac.nz/publications.html. Occasional Report No. 29. Fertilizer and Lime Research Centre, Massey University, Palmerston North, New Zealand. 12 pages.

Davison, L., Dalley, D.E., Chrystal, J., Monaghan, R., Laurenson, S., Stevens, D., Wall A., Pigou, J., Gorton, A. 2015. The lying behaviour of non-lactating, pregnant dairy cows wintered in a loose-housed barn on woodchip bedding material. Proceedings of the New Zealand Society of Animal Production 75: 24-28.

Resources

DairyNZ Booklets
dairynz.co.nz/publications/farm

- Dairy cow housing
- Investing in off paddocks facilities
- Stand-off pads: Your essential guide to planning, design and management.

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