

Extreme Makeover: Freestall Edition

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Introduction

Despite a general appreciation that a clean dry comfortable place to lie down for dairy cows is associated with improved milk production and health, there is reluctance by farmers to remodel existing facilities to achieve this goal. It is very easy to understand why. Industry recommendations for stall design have not been consistent with much debate among consultants over appropriate dimensions and size over the last few years. Also, the construction of partial budgets has been hampered by a lack of knowledge of the potential financial benefits that might accrue from stall improvements, when compared with quite substantial costs that have been relatively easy to measure.

During a period of favorable milk prices and armed with an improved knowledge over what cows' need from the environments that we place them in, we have been directly involved in several cow comfort improvements. This article tracks four herds over a minimum period of two years, charting improvements in milk production and health. Two barns were remodeled from mattresses to sand bedding, and two barns were remodeled to improve existing mattress stalls.

While each individual herd taken in isolation is merely an interesting story, the group of herds taken together give us insight into the actual rewards that may be realized and assist in the justification for improving stall comfort in existing facilities.

Mattress to Sand Conversions

We have shown that sand bedded freestalls allow lame cows to maintain normal patterns of stall use behavior, while mattress freestalls fail to provide a surface that lame cows can rise and lie down easily upon, resulting in increased time spent standing and lower lying times. This work has stimulated several farms to remodel their mattress freestalls to sand. The decision to move to sand carries with it associated costs in converting the manure handling system. Two herds in Wisconsin achieved this goal by converting to a flush flume system of manure handling.

In flush flume systems, manure is scraped into an 18 inch diameter pipe while a pump pushes the liquid component from a 2 or 3 stage settling manure pit into the top end of the line at 5 to 8 feet per second. The liquid carries the sand laden manure to a settling lane, where the flow decelerates to around 1-2 feet per second along a 2-300 foot long concrete settling lane. The majority of the sand is left in the lane to be recycled back into the stalls and the liquid component goes through a 2 or 3 stage settling process before the liquid component is used to pump back into the system.

In the Fall of 2004 two herds went through these mattress to sand conversions.

Example Herd A

Herd A was expanding from 600 to 800 cows in November 2004. Existing housing consisted of a 6 year old 2-row tail to tail rubber crumb filled mattress barn for lactating cows and a 3-row special needs barn. BST use in the herd was label for mature cows throughout the follow-up period. BST was used on approximately one third of the first lactation heifers up to March 2005, and then it was used on all heifers.

Table 1. Original stall dimensions for herd A

Dimension	Inches
Length	91
Width	44
Curb to brisket locator	70
Curb to neck rail	63
Height of lower divider rail	10
Height of neck rail	46
Loop diameter	35
Curb height	10
Surface	Mattress



The special needs barn was extended to increase capacity for dry cows and post-fresh cows. Stalls in this barn were 10 feet long against the side wall, 50 inches wide, with a PVC pipe brisket locator 70 inches from the rear curb, built to accommodate 1700lb special needs cows. The old barn was converted by removing the mattresses and adding a 4 inch o.d. fiber glass retaining pipe bolted to the rear edge of the stall. Approximately 4-5 inches of sand were maintained on the platform and no other changes were made to the stall design.

Figure 1. A remodeled stall (left) with sand on a concrete platform and a fiber glass bedding retainer, and new stalls (right) which are 10 feet long against the side wall to accommodate front lunge.



Herd performance data up to November 2006 is shown in Table 2. Rolling herd average milk production has increased by 2,590lbs per cow, while turnover rate has been held at 18-19% to facilitate expansion up to 834 cows.

Table 2. Herd performance statistics for 2 years following the change from mattresses to sand for herd A.

Parameter	Year			Difference Year 1 to Year 3
	11/1/04	11/1/05	11/24/06	
Herd Size	650	769	834	223
Turnover rate (%)	30	19	18	12
Rolling Herd Average Milk (lbs)	26,524	28,066	29,114	2,590
1 st Lactation ME305 (lbs)	28,597	31,509	31,342	2,745
Mature cow ME305 (lbs)	27,571	30,260	30,881	3,310
Weighted Annual Mean SCC ('000/ml)	220	160	162	58
Milk per cow (lbs)	85	90	91	6
Rolling Average DIM	176	183	188	-12

Mean annual average SCC has fallen from 220,000/ml with organic bedding to 162,000/ml with sand (Figure 2) and milk per cow per day average for the year has increased by 6lbs per cow. With the increased production, herd rolling average DIM has increased slightly.

Figure 2. Mean weighted monthly somatic cell count before and after the switch from organic bedding to sand in herd A.

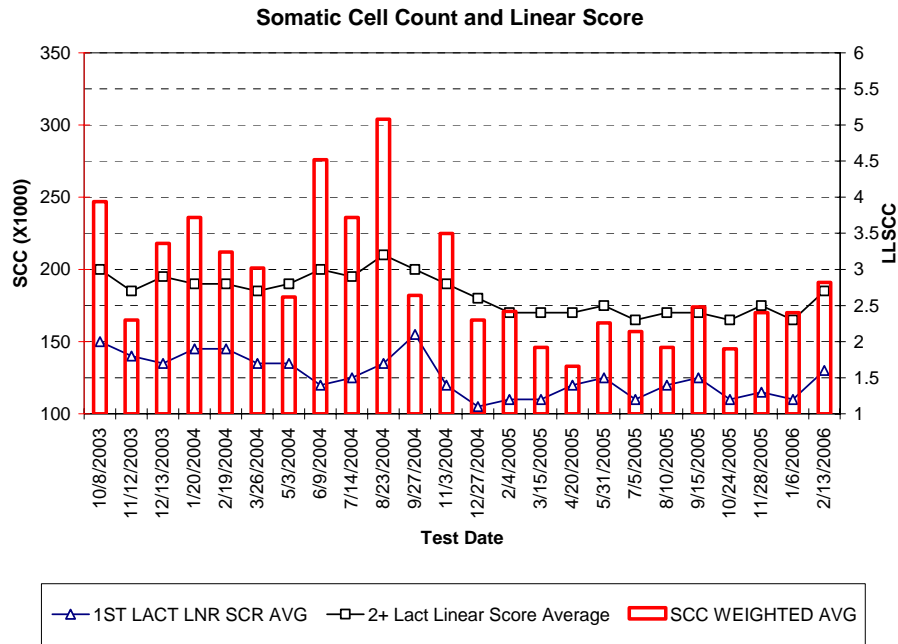


Table 3 is a completed one year partial budget for the stall changes, which cost the herd \$310,000 (\$403 per cow). The positive impacts assume a \$13.00 milk price (actual price achieved for the farm was \$16.10), 3lbs of milk per cow per day attributed to the stalls and some improvements in SCC premium, and mastitis and lameness treatments.

Table 3. Partial budget for the stall changes in herd A.

POSITIVE IMPACTS		COMPETING IMPACTS	
Increased Incomes		Increased Costs	
1. Improved SCC Premium from 220 to 160 Higher premiums	33,206	1. Increased feed costs at \$0.03 per lb milk,	25,262
2. Improved turnover rate from 30 to 19% 42 more dairy sales	84,000	2. Cost of installation of flush flume sand separation system	309,560
3. Increase in milk production by 3lbs milk per cow per day 769 cows x 3 lbs x 365 days x \$13.00	109,467		
Total Increased Incomes	226,673	Total Increased Costs	334,822
Reduced Costs		Reduced Incomes	
1. Reduced number clinical mastitis cases 108 fewer cases @ \$90 per case	9,720	1. Improved turnover rate from 30 to 19% 42 fewer cull sales @ \$600	25,200
2. Fewer lame cows treated 90 fewer cows treated @ \$100 per case	9,000		
Total Reduced Costs	18,720	Total Reduced Incomes	25,200
Increased Incomes + Reduced Costs = Total Positive Impacts	245,393	Increased Costs + Reduced Incomes = Total Competing Impacts	360,022
Positive Impacts minus Competing Impacts of this Project - \$ 114,629			
Time for Payback on Investment = 1.5 years			


The financial investment was paid back within 1.5 years with an increased income of \$286 per cow after feed costs. This allowed a further expansion of the herd in 2006 and the addition of a new sand stall barn. The flush flume now reclaims sufficient sand to recycle back into the stalls. The financial aspect of this barn remodel is only part of the story. At a time when concerns over dairy cow welfare are mounting, this herd proves that we can manage high producing dairy cows to maximize health and longevity in a large dairy.

Example Herd B

Herd B was also a mattress facility milking 700 cows, with plans to expand to 1000 cows. In September 2004 they built new sand stalls for first lactation heifers and by March 2005, they had removed the existing mattresses in the old barns. Herd B went one step further than Herd A and removed the concrete platform, re-pouring the rear curb to provide a deep sand bed. All other stall dimensions remained the same. Up to September 2005, cows and heifers were started on BST at 110 DIM, after which the herd reverted to label use.

Table 4. Stall dimensions in the old barn at herd B – before and after conversion to sand

Dimension	Inches
Length	96
Width	47
Curb to brisket locator	66
Curb to neck rail	65
Height of lower divider rail	12
Height of neck rail	47
Loop diameter	32
Curb height	11
Surface	Mattress to Sand



Herd performance data are given in Table 4 for the 2 years after the change over to sand. In the last year, the herd has added a new section to the barn and now houses over 1200 cows. Rolling herd average milk production has increased by 1869lbs per cow, with a 6lb per cow per day increase. Somatic cell count has fallen slightly and rolling average DIM has increased by 21 days.

Table 4. Herd performance statistics for 2 years following the change from mattresses to sand for herd B.

Parameter	Year			Difference Year 1 to Year 3
	09/01/04	09/01/05	09/01/06	
Herd Size	794	1009	1220	426
Turnover rate (%)	38	31	24	14
Rolling Herd Average Milk (lbs)	28,532	30,103	30,401	1869
1 st Lactation ME305 (lbs)	30,232	31,701	32,662	2430
Mature cow ME305 (lbs)	29,484	31,615	31,781	2297
Weighted Annual Mean SCC ('000/ml)	222	229	206	16
Milk per cow (lbs)	87	93	93	6
Rolling Average DIM	170	177	191	-21

The changes in herd B are remarkably similar to those seen in herd A. Both were very well managed herds before the change and the improvement in cow comfort has allowed both herds to achieve their potential. Assuming an investment of \$40 per cow for 794 cows for the stall changes and around \$350,000 for the sand lanes, total expenditure was \$382,000. An increase in milk production of 3lbs per cow per day attributable to sand at \$13.00 per cwt less \$0.03 per lb increased feed costs yields $(794 \times 3 \times 365) \times (0.13 - .03) = \$86,943$ extra revenue. The reduced turnover rate yielded approximately 56 more potential dairy sales at \$1800-\$300 = \$1500 per transaction, for a total of \$84,000. Increase in income per cow was therefore $\$86,943 + 84,000 = \$170,943$ or \$215 per cow. The investment will be paid back in 2.3 years.

Improving Existing Mattress Barns

While converting to sand bedding appears to carry with it some substantial benefits, it is also clear that for those herds with mattress stalls, that are unwilling to go to the expense of converting manure handling system, there are benefits to be accrued from improving the design of existing mattress stalls.


Example Herd C

Herd C is a 163 cow registered Holstein dairy herd. Mature cows average around 1800lbs and lactating dairy cows are housed in a three year old 6-row rubber crumb filled mattress freestall barn. Stalls were sized for first lactation heifers and were hopelessly inadequate for larger mature cows, proving that the concept of one size of stall fitting all cows is a fallacy (Table 5). BST was

used on an individual cow basis. Continual problems with poor stall use and lameness prompted the herd owners to consider a radical barn overhaul.

Table 5. Stall dimensions before changes were implemented in Herd C.

Dimension	Inches
Length	102
Width	47
Curb to brisket locator	67
Curb to neck rail	75
Height of lower divider rail	12.5
Height of neck rail	45
Loop diameter	29
Curb height	11.5
Surface	Mattress



In November 2003, the owners of the herd remodeled the mature cow pen to remove the existing loops and the concrete fill between the brisket locators, and remount new Y2K loops (Artex Fabricators Ltd) 54 inches on-center, add extra foam over the rubber crumb cells, install new mattress covers and Poly-Pillow brisket locators 71 inches from the rear curb. The new stalls are shown in Figure 3. They then remodeled the pre-fresh and post-fresh pens and finished remodeling the first lactation heifer pen in November 2004, one year later.

Figure 3. Improved stalls in herd C. 54 inches wide to accommodate 1800 lb mature cows, 71 inches from curb to brisket locator, with added foam padding and new mattress covers and Poly-Pillow brisket locators.



Herd performance data over the last three years are given in Table 6. Herd size and turnover rate has remained relatively stable with a small increase in cow numbers. Rolling herd average milk production has increased by 1992 lbs per cow while the increase in milk per cow per day peaked in Year 3 at 5 lbs and has fallen off a little in the last year to 3lbs overall. Most of the improvement in milk production has been seen in the mature cows. Stalls were not changed for first lactation heifers until 2004, and since then ME305 has risen 506lbs. Mature cow MEs peaked in 2005 and have fallen back a little since then.

Despite concerns by some consultants that wider stalls lead to dirtier beds and increased udder health problems, this has certainly not been the case in this herd where mean annual weighted SCC has fallen by 110,000/ml.

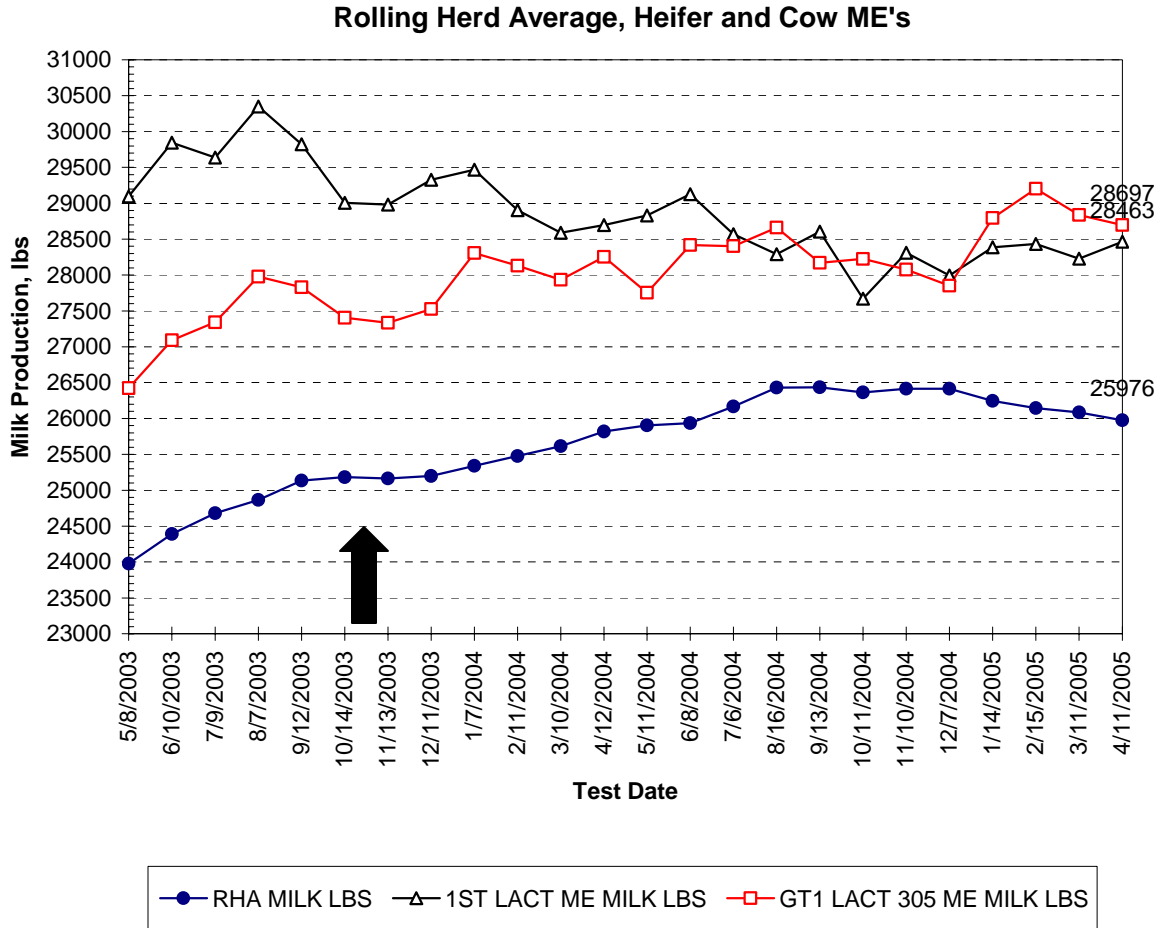
Table 6. Herd performance statistics for 3 years following the stall modification in herd C.

Parameter	Year				Difference Year 1 to Year 4
	11/01/03	11/01/04	11/01/05	10/10/06	
Herd Size	163	189	180	193	30
Turnover rate (%)	32	24	33	33	-1
Rolling Herd Average Milk (lbs)	25,161	26,417	26,929	27,153	1992
1 st Lactation ME305 (lbs)	28,982	28,312	28,332	28,818	-164
Mature cow ME305 (lbs)	27,333	28,075	29,521	28,632	1299
Weighted Annual Mean SCC ('000/ml)	339	220	218	229	110
Milk per cow (lbs)	84	86	89	87	3
Rolling Average DIM	182	179	176	180	2

It is interesting to compare ME305 of mature cows with first lactation heifers during the period when the mature cow stalls had been changed, while the first lactation heifer pens had stayed the same (Figure 4). Note that the mature cow ME305 climbs from 1600lbs below that of the first lactation heifers, to a point where it is comparable. Performance of the first lactation heifers declined through this period and only started to improve once their stalls were remodeled in November 2004.

The cost of stall modifications was approximately \$100,000, with all the labor being done by the owners. With an increase of 3lbs of milk per cow per day, revenue after feed costs increased by $(163 \times 3 \times 365) \times (0.13 - 0.03) = \$17,849$. SCC premium improved by an estimated \$0.25 per cwt. The herd shipped $163 \times 87 \times 365 = 5176065$ lbs per year at \$0.0025 extra per lb = \$12,940 extra revenue per year. Total revenue increased by \$30,789. Thus, the investment will be paid off in 3.2 years.

Figure 4. Change in rolling herd average milk production, mature cow ME305 and first lactation heifer ME305 during the period immediately following changes to stalls in the mature cow pen in November 2003.




Example Herd D

This 310 cow Holstein dairy was remodeled in February 2003. Cows were housed in a 6-row mattress freestall barn with 4 pens. BST was used per label directions for all mature cows and heifers. The first lactation heifer pen was left unchanged, while each of the three mature cow pens were altered at low cost by increasing width from 44 inches to 48 inches on center and moving neck rails from 63 inches from the rear curb to 70 inches. All the work was done by the owners.

Table 7. Stall dimensions before changes were implemented in Herd D.

Dimension	Inches
Length	98
Width	44
Curb to brisket locator	66
Curb to neck rail	63
Height of lower divider rail	10
Height of neck rail	43
Loop diameter	32
Curb height	12
Surface	Mattress

A photograph showing a cow in a stall. The cow is black and white, lying down. The stall is constructed with metal railings and a concrete floor. The cow's head is visible, and it appears to be resting. The background shows other stalls and the interior of a barn.

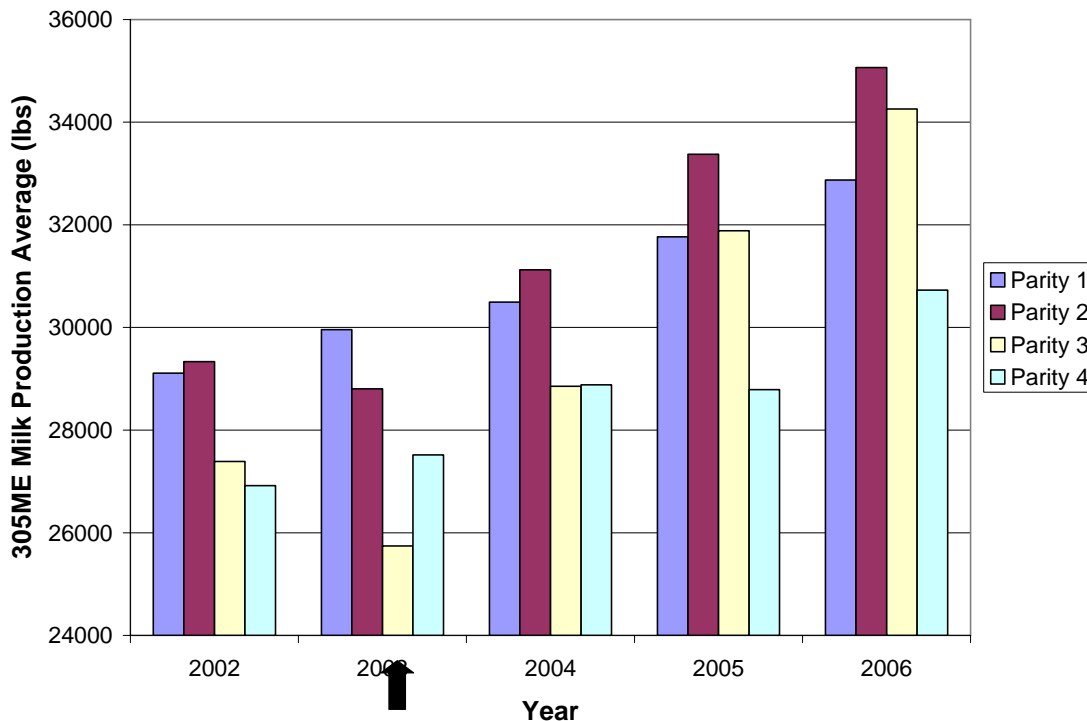
Each of the three mature cow pens went from 74 stalls to 68 stalls (total loss of 18 stalls) and herd size was reduced to 298 cows. 11 cows were sold as dairy sales.

Table 8. Herd performance statistics for 3 years following the stall modification in herd D.

Parameter	Year				Difference Year 1 to Year 4
	02/01/03	02/01/04	02/01/05	02/01/06	
Herd Size	310	298	297	299	-11
Turnover rate (%)	48	49	43	38	10
Rolling Herd Average Milk (lbs)	25,999	26,864	28,649	30,904	4905
1 st Lactation ME305 (lbs)	29,042	29,701	31,858	34,482	5440
Mature cow ME305 (lbs)	26,645	28,230	30,741	32,318	5673
Weighted Annual Mean SCC ('000/ml)	285	211	160	191	94
Milk per cow (lbs)	84	87	90	98	14
Rolling Average DIM	185	173	183	169	16

Herd size has remained lower than previous as stocking density has been held at around 115% in most pens. Turnover rate has been reduced while rolling herd average has increased by an astonishing 4,905lbs over the last 3 years, and milk per cow per day has increased by 14lbs.

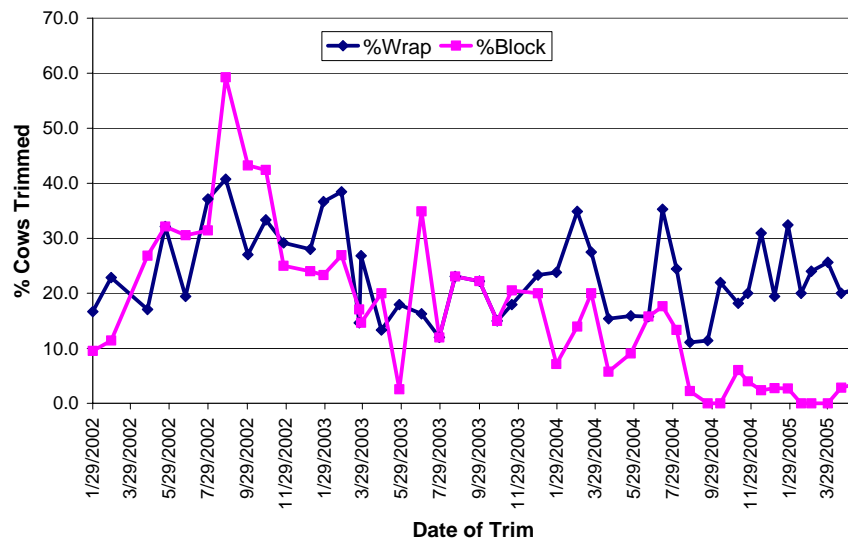
Figure 5. Change in ME305 by parity before and after the stall remodel in 2003. Note the change in ME in 2nd lactation and older cows by year compared to first lactation heifers.



Changes in ME305 by parity have been tracked in DC305 and are shown in Figure 5. Note the rate of change in ME in older parity groups compared to first lactation heifers. Once again, concerns over increased stall width have not been realized, with a reduction of 94,000/ml in weighted mean annual SCC.

Herd improvements in cow comfort reduced the new lameness case rate in herd D and allowed the hoof-trimmer to move to trimming cows twice a year. These improvements did not change the rate of infectious lameness, but dramatically reduced the proportion of cows receiving hoof blocks for claw horn lesions to less than 5% of cows trimmed (Figure 6).

Figure 6. Rate of infectious lesions and block treatments for claw horn lesions from hoof trimming records before and after the change in stalls and increase in preventive trimming.



Conclusions

All four herds show that improvements in cow comfort pay. Provided the alternations are done correctly, at reasonable cost, investments have been covered within the period 6 months to 3.5 years by improved milk production, lower turnover rates, higher milk quality, less lameness and an increase in the proportion of older healthier cows in the herd. For any given herd it is impossible to predict the actual outcome of improvements in cow comfort. However, a good starting point is to compare mature cow ME305 and first lactation heifer ME305 milk production. If there is a large gap between the heifers and the cows, model the potential benefits to the herd if mature cows achieve the same ME305 as the heifers over a three year period.

Improvements in milk production are obviously influenced by nutrition and other management factors over time, and none of these case studies were controlled. However, it is clear that milk also comes from older cows that remain in the herd longer and stay healthy and free of hoof problems as a result of improved cow comfort. Although, the improvement in dairy cow welfare has not been given a dollar value in these assessments, the owners of these dairy farms and the author believe that it is priceless.