An evaluation of mattresses and mats in two dairy units

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Abstract

In order to investigate the relative merits of mats and mattresses in terms of cow comfort, production and performance, 29 cows were housed on ethylethene vinyl acetate (EVA) mats and 29 on mattresses of loose rubber crumb with a polypropylene cover, at each of two similar dairy units (SAC Auchincruive and Myerscough). Both mats and mattresses were newly installed at the start of the trial. The cows were housed in the autumn after calving. Milk yield was recorded daily. Cows were weighed and scored for body condition, locomotion, dirtiness and hock and knee injury at fortnightly intervals. Feed offered was recorded daily and refusals were weighed weekly. Monthly milk records of milk yield, milk composition and somatic cell count data were available for both herds. In addition, 24 h behavioural observations of 15 core cows in each group were made at weeks 0, 2, 4, 6, 8, 16, and 32 post-housing. There was no difference between cows on mats and mattresses in milk yield, composition or quality; in feed intake; in weight loss or body condition score; in severe hock or knee injury, or in the incidence of lameness. Cows on mattresses tended to have slightly higher total dirtiness scores than those on mats (7.06 vs. 6.95, \( P = 0.074 \)) and had dirtier udders (mattress, 7.50 vs. mat, 6.52, \( P = 0.05 \)). However, over the whole housing period, cows on mattresses spent longer feeding, ruminating and lying and a greater proportion of their lying time was spent ruminating. They spent less time standing doing nothing (idling) than cows on mats and less time idling in cubicles. Cows on mattresses appeared to adapt to housing more quickly than those on mats. Overall, neither mat nor mattress gave...
advantages in terms of production or performance, cows were slightly cleaner on mats but
behavioural indices suggest that cow comfort was greater on mattresses. © 2000 Elsevier Science
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Keywords: Cattle-welfare; Mattress; Lying behaviour

1. Introduction

Lying surfaces for dairy cows must provide thermal comfort and softness, yet be
durable and have sufficient friction to allow rising and lying down without slipping. Finally, they should help in keeping cows clean and healthy whilst minimising daily
labour requirements (Natzke et al., 1982; Nilsson, 1992; Rodenburg et al., 1994). Cermák (1990) and Bölling (1994) both found that as the softness of bedding in cubicles increased from bare concrete, to concrete with rubber mats, to straw bedding, lying
times increased. Bölling (1994) also showed that lying times on mattresses are equiva-|lent to those on straw bedding. The results suggested that cow comfort can be assessed
by lying behaviour.

Where straw is not an economic option for cow bedding, mats and mattresses are
often used to cushion a concrete cubicle base. There are many products available to
dairy farmers, all claiming such advantages as: improved cow comfort, longer lying
times, reduced stress, increased milk yield, better cow cleanliness and cubicle hygiene and less cow injury. Previous studies comparing mats and mattresses have either focused
on cow cleanliness (Rodenburg et al., 1994; Visser, 1994) or short-term cow preferences
(Natzke et al., 1982). None have evaluated the longer-term performance of these
products. This is particularly important for mattresses that flatten with time. Rubber
mats offer little cushion and require additional bedding for cow comfort (Britten, 1994). If
mattresses flatten with time and are allowed to become too hard they offer little
benefit over mats and hock lesions may result (Britten, 1994).

This study was designed to compare and contrast the relative merits of mats and
mattresses in terms of cow comfort, production and performance over a whole housing
period.

2. Materials and methods

At each of two similar dairy units (SAC Auchincruive and Myerscough), 29 cows
were housed on either mats (Cow Comfort ‘‘Maxi-bed’’) or mattresses (Pasture B.V.
‘‘Pasture Mat’’). The mats were made of ethylene vinyl acetate (EVA) whereas the
mattresses were made of small rubber crumb enclosed in a bag with 12 cells to prevent
movement and compaction, and covered with polypropylene. Both products were market
leaders of their type and all mats and mattresses were newly installed at the start of the
trial. All cows calving in the 30 days prior to housing at the end of September were
selected as ‘‘core’’ cows (15 in each group) and 14 summer-calved ‘‘fillers’’ were
added to each group to maintain the stocking density until a further 28 cows had calved at each site. At eight weeks post-housing, the summer-calved “fillers” were replaced by these early lactation, autumn calving “fillers”. The groups then remained constant for the remainder of the housing period, which was approximately 28 weeks in total. At both sites, the groups were matched for lactation number, days post calving, previous lameness history and previous milk yield. The groups were also balanced for breed at Auchincruive, where a mixture of Holstein–Friesians and Ayrshires were milked.

At Auchincruive all cows were housed abruptly from grass but at Myerscough the cows were allowed a transition period of about one week before housing. Cubicles at Auchincruive were all of the Dutch Comfort design (length, 2.10–2.20 m × width, 1.15–1.18 m). At Myerscough, Mushroom cubicles were installed (length, 2.30 m × width, 1.20–1.21 m). Both of these cubicle types are designed to allow space-sharing and provide forward lunging space for rising. Floors were solid concrete at both sites and automatic scrapers were used.

Cows at both sites were fed 40 kg/cow of first cut silage in total mixed ration (TMR) either once or twice daily ad libitum. The dry matter intake (DMI) of the TMR at Auchincruive was approximately 271 g/kg with a 16.8% crude protein (CP) and at Myerscough, DMI was 298 g/kg DMI and CP was 16.7%. Concentrates were fed in parlour according to a stepped flat rate at Auchincruive (3 kg/cow up to 100 days post-calving and 0.5 kg/cow thereafter) and according to yield at Myerscough (0.1–0.3 kg/l).

Milk yield was recorded daily and each herd was milk recorded so monthly milk composition and somatic cell count data was also available for analysis. Weekly feed intake per group was determined from daily records of feed offered and weekly weighing of feed refusals. Every two weeks all cows were weighed and scored for body condition, locomotion, dirtiness and hock and knee injury. Scoring was always carried out by the same person at each site (SC at Auchincruive and CS at Myerscough). Locomotion was scored on a five-point scale with half points, as described by Manson and Leaver (1988). For dirtiness, four areas of the cow (body, legs, rear and udder) were scored: (1) perfectly clean, (2) quite dirty, or (3) very dirty, with half points, based on the scoring system described by Bergsten and Pettersson (1992). The sum of the four scores given was the total dirtiness score. Each hock and knee was scored for lesions, based on the scores described by Gustafson (1993): (0) no lesions observed, (1) bare, pale areas, (2) bare, red areas, (3) occurrence of serum and/or sore scabs, (4) open, infected wounds, (5) swelling and/or adventitious bursae (fluid filled sac on knee or hock).

The behaviour of the core cows was observed by scan sampling every 15 min for 24 h at weeks 0, 2, 4, 6, 8, 16 and 24, with the first observation being made on the day of housing. A record was made of each cow’s posture (standing or lying), location (feed-face, passageway or cubicle) and activity (feeding, drinking, ruminating, doing nothing or other). Lying behaviour was recorded continuously by noting the exact times of lying down and rising to give true frequencies and durations of lying bouts. The behaviours of interest taken from these records were: feeding (F), lying (L), ruminating (R), lying–ruminating (LR), proportion of lying time spent ruminating (LR/L), idling (standing, doing nothing — SO), idling in cubicles (SO(C)), proportion of idling time
spent in cubicles (SO(C)/SO), maximum lying bout length (MaxL), number of lying bouts in 24 h (N bouts).

3. Statistical analysis

Behavioural data was expressed as proportion of observations made, to allow for any differences in the time that cows were away from the cubicles being milked. SO, SO(C) and SO(C)/SO were not normally distributed and so were logarithmically transformed before analysis. The data was then analysed by split-plot ANOVA, with herd as blocks, cow as the whole plot and time as the sub-plot using the treatment model: Group + Time + Group × Time. Group was therefore the main plot treatment, and week the sub-plot.

The number of cows having adventitious bursae on the hock or knee (the occurrence at least once of an adventitious bursa or swelling); having serious lesions on the hock or knee (score 3 or 4 at least once); and, having no severe recorded lesions (no hock or knee injury score of greater than 2) were analysed by chi-square. Lameness prevalence was calculated as the number of lame cow weeks divided by the number of cow weeks observed, where lameness was defined as a locomotion score of ≥ 3, and chi-square was used to determine significance.

Weight loss was calculated as initial weight (the first weight recorded after housing) minus minimum weight. Weight loss data was heavily skewed, even after log transformation, so a Mann–Whitney test was used on the original data for comparison of the two groups.

All other data was summarised by taking a mean for each cow over the housing period and then analysing the means using a general linear model ANOVA and the model: Herd + Group + Herd × Group.

As the total dirtiness score was a composite score of four areas, the lowest possible total dirtiness score for a perfectly clean cow was 4 and the highest possible score was 

Table 1
Milk yield, composition and quality for cows on mats or mattresses at Auchincruive and Myerscough

<table>
<thead>
<tr>
<th></th>
<th>Mattress</th>
<th>Mat</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Au</td>
<td>Mc</td>
</tr>
<tr>
<td>Average daily milk yield (l/cow)</td>
<td>25.3</td>
<td>28.7</td>
</tr>
<tr>
<td>Protein %</td>
<td>3.19</td>
<td>3.33</td>
</tr>
<tr>
<td>Butterfat %</td>
<td>4.13</td>
<td>4.22</td>
</tr>
<tr>
<td>SCC (×10⁶ cells/ml)</td>
<td>0.095</td>
<td>0.052</td>
</tr>
<tr>
<td>Average daily milk yield (l/cow)</td>
<td>27.0</td>
<td></td>
</tr>
<tr>
<td>Protein %</td>
<td>3.26</td>
<td></td>
</tr>
<tr>
<td>Butterfat %</td>
<td>4.17</td>
<td></td>
</tr>
<tr>
<td>Weight of fat and protein (g/cow)</td>
<td>200.1</td>
<td></td>
</tr>
<tr>
<td>SCC (×10⁶ cells/ml)</td>
<td>0.071</td>
<td></td>
</tr>
</tbody>
</table>
Table 2
Lameness and hock and knee injury scores for cows on mats and mattresses\(^a\), both herds pooled

<table>
<thead>
<tr>
<th>Behaviour</th>
<th>Mattress n = 89</th>
<th>Mat n = 89</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hocks</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum score of 5 (no. cows)</td>
<td>12</td>
<td>14</td>
<td>0.671</td>
</tr>
<tr>
<td>Maximum score of 3 or 4 (no. cows)</td>
<td>29</td>
<td>34</td>
<td>0.433</td>
</tr>
<tr>
<td>Maximum score of 2 (no. cows)</td>
<td>48</td>
<td>41</td>
<td>0.294</td>
</tr>
<tr>
<td><strong>Knees</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum score of 5 (no. cows)</td>
<td>25</td>
<td>19</td>
<td>0.297</td>
</tr>
<tr>
<td>Maximum score of 3 or 4 (no. cows)</td>
<td>7</td>
<td>5</td>
<td>0.550</td>
</tr>
<tr>
<td>Maximum score of 2 (no. cows)</td>
<td>57</td>
<td>65</td>
<td>0.197</td>
</tr>
<tr>
<td>Prevalence of lameness(^b)</td>
<td>0.060</td>
<td>0.082</td>
<td>0.069</td>
</tr>
</tbody>
</table>

\(^a\)All cows in each group, including summer-calved “fillers”.  
\(^b\)No. of lame cow weeks divided by the no. of cow weeks observed.

12. Average total dirtiness and average udder dirtiness scores were log transformed by the formula: \(\log_{10}(\text{score} + 1)\), before analysis.  
All statistical tests were carried out using Genstat Version 5, Release 4.1 (© Lawes Agricultural Trust, IACR, Rothamsted).

4. Results

There was no difference in milk yield, composition or quality between the groups \((P > 0.05, \text{Table 1})\) but Myerscough cows had a higher mean daily yield than Auchincruive cows (29.5 vs. 25.1 l/cow/day, \(P < 0.001\)), a higher mean protein % (3.27 vs. 3.19, \(P = 0.02\) and a lower somatic cell count (0.059 vs. \(0.083 \times 10^6\) cells/ml, \(P = 0.01\)). There was no difference in milk fat % between the two herds \((P = 0.883)\).

Table 3
Differences in behaviour, expressed as proportion of observations unless otherwise stated, between cows on mattresses and cows on mats

<table>
<thead>
<tr>
<th>Behaviour</th>
<th>Abbreviation</th>
<th>Mattress</th>
<th>Mat</th>
<th>SED</th>
<th>(P)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feeding</td>
<td>F</td>
<td>0.25</td>
<td>0.23</td>
<td>0.011</td>
<td>0.057</td>
</tr>
<tr>
<td>Ruminating</td>
<td>R</td>
<td>0.43</td>
<td>0.39</td>
<td>0.011</td>
<td>0.002</td>
</tr>
<tr>
<td>Lying</td>
<td>L</td>
<td>0.50</td>
<td>0.44</td>
<td>0.018</td>
<td>0.004</td>
</tr>
<tr>
<td>Lying–ruminating</td>
<td>LR</td>
<td>0.29</td>
<td>0.23</td>
<td>0.014</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Lying–ruminating</td>
<td>LR/L</td>
<td>0.58</td>
<td>0.50</td>
<td>0.016</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>(proportion of total lying)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum bout length (h)</td>
<td>MaxL</td>
<td>2.18</td>
<td>1.89</td>
<td>0.101</td>
<td>0.005</td>
</tr>
<tr>
<td>Number of lying bouts (bouts/24 h)</td>
<td>Nbout</td>
<td>11</td>
<td>13</td>
<td>0.805</td>
<td>0.017</td>
</tr>
<tr>
<td>Idling</td>
<td>SO</td>
<td>0.10*</td>
<td>0.13*</td>
<td>0.007*</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Idling in cubicles</td>
<td>SO(C)</td>
<td>0.05*</td>
<td>0.07*</td>
<td>0.007*</td>
<td>0.004</td>
</tr>
<tr>
<td>Idling in cubicles</td>
<td>SO(C)/SO</td>
<td>2.13*</td>
<td>2.58*</td>
<td>0.102*</td>
<td>0.166</td>
</tr>
</tbody>
</table>

\(^a\)Back transformed values.
Cows on mattresses had the higher feed intake in both herds. At Auchincruive the daily DMI of TMR of the mattress group was 12.95 kg/cow compared with 12.70 kg/cow for the mat group, a difference of 0.25 kg DMI/cow/day. At Myerscough, the daily DMI was 17.01 kg/cow for the mattress group and 16.55 kg/cow for the mat group, a difference of 0.47 kg/cow. Average feed intake was higher at Myerscough than Auchincruive (28.15 vs. 23.67 kg freshweight/cow/day). It was impossible to do statistical analysis on these figures as only group averages were available.

There was no difference in weight, body condition score or weight loss between cows on mattresses and cows on mats ($P > 0.05$). Myerscough cows were heavier than those at Auchincruive (mean weight: 581 vs. 521 kg, $P < 0.001$) and had slightly better body condition scores (2.6 vs. 2.3, $P < 0.001$).

There was a tendency for cows on mattresses to be slightly dirtier than those on mats although this was not statistically significant (total dirtiness: 7.06 vs. 6.95, $P = 0.074$). However, when udder dirtiness alone was considered, the difference between the groups was significant (mattress: 1.38 vs. mat: 1.32, $P < 0.05$). Dirtiness scores were higher at Auchincruive than at Myerscough (total dirtiness: 7.50 vs. 6.52, $P < 0.001$).

![Fig. 1. Changes in lying behaviour over the course of the housing period for cows on mattresses and on mats.](image)
There was no difference between the groups in the number of cows which only ever showed hair loss or reddened skin on their hocks and knees (score ≤ 2 for hock and knee injury), in the incidence of swellings and/or adventitious bursae on hocks or knees (score 5 for hock or knee injury), or in the number of cows showing evidence of lesions (sore scabs, score 3, or open lesions, score 4). However, a high proportion of cows in both groups (mattress: 46%, mat: 49%) had a maximum hock lesion score of greater than 3 (Table 2).

The incidence of lameness (a locomotion score of ≥ 3 at least once during the housing period) was the same for both groups (Table 2).

All of the behaviours investigated varied significantly with time (P < 0.001). Total lying times increased after housing for the cows on mats in the later part of the housing period whereas cows on mattresses reached a plateau and this group*time interaction was significant (P < 0.001). MaxL was greater for cows on mattresses by about 15–20 min and these cows also had more lying bouts per 24 h (Table 3). Fig. 1 shows how lying behaviour changed over the course of the housing period.

There was a tendency for cows on mattresses to spend longer feeding. They also spent more time ruminating and lying and a greater proportion of the lying time was
spent ruminating. Cows in the mat area idled for longer and spent longer idling in cubicles, although when idling in cubicles was expressed as a proportion of total idling, there was no difference between the groups. Differences between the groups are shown in Table 3. The group × time interaction was significant for all of these behaviours ($P < 0.05$).

5. Discussion

The provision of mattresses did not give any advantages in terms of production or performance: there were no differences between the groups in milk yield, weight, body condition score or weight loss in early lactation. The differences in milk yield between the herds show that Myerscough was a higher producing herd and so the herd differences in milk quality and composition and in feed intake are not surprising. The average liveweight was lower at Auchincruive, probably due to the smaller Ayrshire cows which make up a proportion of that herd.

Udder cleanliness is important in reducing the risk of mastitis and lessening the need to wash cows’ udders in the parlour. Indeed cow cleanliness is required by law: the Dairy Products (Hygiene) (Scotland) Regulations 1995 state that before milking, the teats, udders, flanks, hindquarters and adjacent parts of the abdomen should be clean. In a survey of 18 herds, Rodenburg et al. (1994) found that cows on mattresses were cleaner than cows on mats although their results were confounded by differences in stall management practices.

The difference in price between the two products makes mattresses a considerable investment and it is possible that many of the improvements that farmers report after fitting mattresses may be due to concurrent improvements in management. In this study, cows on mats were slightly cleaner than those on mattresses, and the farm staff believed that this was because mats held the bedding better and were drier. However, although the difference in udder dirtiness was significant, it was not large. A small study on faecal contamination run in conjunction with the main trial showed that there was no difference in the coliform count of sawdust collected from mats and mattresses (Kelly et al., 1999).

Despite reports that mattresses reduce the extent of hock injury in cubicle-housed dairy cows (Rodenburg et al., 1994), there were no differences in hock and knee injury found in this trial although the proportion of cows with hock lesions scoring 3 or greater was very high in both groups.

Due to the distance between the two sites, it was impossible for one observer to score the cows in both herds and so, whilst real differences in dirtiness, locomotion and body condition may well exist between the herds no comparisons can be made on the strength of this data. However, within each herd, cows were consistently scored by the same observer (SC at Auchincruive and CS at Myerscough) so comparisons between the groups are valid.

The behavioural variation over time is worth noting: the continued improvement in resting behaviour shown by cows on mats when the cows on mattresses had settled into a plateau suggests that although the early housing period is a time of adjustment which
is eased by the provision of mattresses, by the end of the housing period the cows on mats had managed to adapt too. The early housing period coincided with early lactation for the cows in this trial. Cows in early lactation are known to have more unsettled lying behaviour compared with cows in later lactation, that is they have a shorter total lying time, higher frequency of lying and lower maximum bout length (Chaplin and Munksgaard, 1999). Whether the effect is due to housing or calving, or a combination of the two, the results reported here still reflect the consequences of management for a considerable proportion of cows in the UK which are winter-housed autumn-calvers.

A greater proportion of the time cows spend lying occurs at night (Singh et al., 1993, 1994). At night, lying is usually divided into two bouts (Ruckebusch and Bell, 1970). Bout lengths are longer than during the day (Hedlund and Rolls, 1977) and the time between the first intention movement and lying down is shorter (Müller et al., 1989). At Auchincruive, where cows were fed morning and evening, it seemed that after the evening feeding, cows on mattresses would enter cubicles and quickly lie down whereas cows on mats would stand in the cubicles for some time before lying down. The difference in idling times between the groups was largely due to increased idling in cubicles, supporting this observation.

6. Conclusion

Installing mattresses offered no advantage in terms of production, performance or health to offset the higher cost. However, although cows on mattresses were slightly dirtier than those on mat, they had more restful behaviour, suggesting that mattresses do improve cow comfort.

Acknowledgements

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References

Bergsten, C., Pettersson, B., 1992. The cleanliness of cows tied in stalls and the health of their hooves as influenced by the use of electric trainers. Preventative Veterinary Medicine 13, 229–238.
Chaplin, S.J., Munksgaard, L., 1999. Effects of stage of lactation and parity on the lying behaviour of dairy...


