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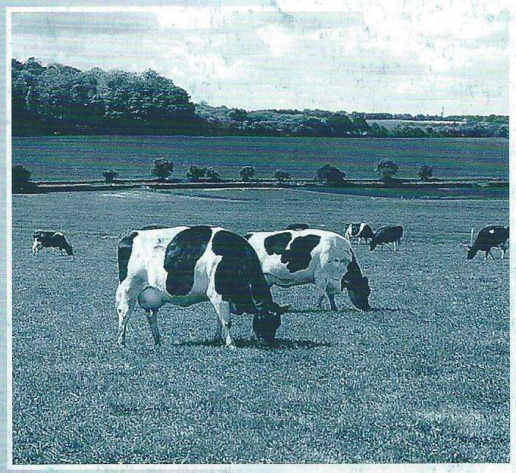

mdc
SERVING BRITAIN'S DAIRY INDUSTRY

RESEARCH INTO PRACTICE

The Milk Development Council

Project Title: Evaluating Cow Mattresses and Mats in Dairy Units

MDC Contract Number 96/R6/01

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List of Abbreviations

Clinical Lameness

N.LAME	the number of cows which went lame at least once.
WEEKS LAME	total number of weeks lame per cow.
N.EVENTS	the number of lameness events per cow.

Behaviour

L-scan	lying, recorded by scan sampling.
LR/L	proportion of lying time spent ruminating.
SO	idling (standing, doing nothing).
logSO	log transformed idling.
SO(C)/SO	proportion of idling time spent in cubicles.
S½	standing half-in cubicles with back feet in passageway.
logS½	log transformed S½.
L-TOTAL	total lying time, recorded by event sampling.
L-BOUTS	number of lying bouts over 24h.
L-MAX	maximum bout length.
L-MIN	minimum bout length.
L-AV	average bout length.

Auchincruive Metabolism Unit

S-TOTAL	total sleep time over 24h.
S-MAX	maximum bout length.
S-AV	average bout length.
S-BOUTS	number of sleeping bouts per 24h.

Summary

This trial took place between September 1997 and April 1998 at SAC Auchincruive and Myerscough College, Lancashire. At each site a total of 88 cows were placed in cubicle sections with either mattresses from Pasture Mat or mats from Cow Comfort UK Ltd. Once put in either a mattress or a mat group the cows were housed there for the trial period.

The cubicle houses at both sites were clear-span portal frame buildings with herringbone parlours. The cubicle divisions at Auchincruive were the Dutch Comfort type and the length and breadth of the cubicle beds were 2.2m and 1.15m respectively. The cubicle divisions at Myerscough were the Mushroom type with a bed length and breadth of 2.3m and 1.2m respectively.

The cows at both sites were milked twice daily and the milking period gave the farm staff the opportunity to refresh the sawdust bedding in the cubicles.

The objective of the trial was to determine if the more expensive mattress cubicle bed resulted in a better housing environment for the cows. That is, better in terms of greater lying time, fewer hock and knee injury incidences, better body and udder cleanliness, better feed intake and weight change results and more milk production.
Lying time observations were made throughout the trial period by a team of researchers at both sites. Individual cows were watched and their times for lying in cubicles, feeding and ruminating and standing doing nothing were recorded. The mattress cows did have longer lying times than the mat cows and spent less time standing doing nothing.

Hock and knee injury scores were recorded fortnightly on a scale of 0 - 5 where 0 was a superficial injury-free joint and 5 was a severe swelling. The mattress cows had fewer incidences of injuries overall but there was no difference between the groups in terms of the worst types of injury (scabbed and swollen joints).

Dirtiness scoring was also carried out on a fortnightly basis at both sites. Scoring was from 1 to 3 where 1 was 'perfectly clean' and 3 was ' very dirty'. The mat cows had cleaner udders than the mattress cows but there was no difference between the groups in terms of total body dirtiness results. Also, it should be noted that there was no difference between the mattresses and mats in terms of coliform counts in the sawdust bedding.

Body condition scores were assessed once per fortnight. Scoring was between 0 and 5 where 0 was 'very poor condition' and 5 was 'grossly fat'. There was no difference in these results despite the fact that the feed records revealed that the mattress cows ate more, on average, than the mat cows.

Finally, milk production records were kept and these showed that there was no significant difference between the groups in terms of milk yield or milk composition.

This trial showed that the cubicle housing environment offered to cows in winter can be enhanced by the addition of a mattress or a mat and that each of these two systems offers different advantages and disadvantages. The findings are summarised in Section 6.0 'Summary of Results'.

1.0 Introduction

1.1 The Importance of Cow Comfort

The comfort and health of the dairy cow is important to all sectors of the agricultural industry. The winter housing period represents the greatest challenge to cow welfare, and one important aspect in this respect is comfort when the cow is lying down. The cubicle is the dominant housing system throughout the UK and cows must be encouraged to use cubicles by making them as comfortable as possible. This requires good bed and division designs which allow for adequate lying and lunging space, together with a comfortable bed.

Mattresses and mats are one way to improve animal comfort, with the additional use of sawdust bedding to keep the beds clean. Many products are now on the market, with competing manufacturers making a variety of claims about their products. So which of these is a farmer best advised to choose? Is it wise to invest in a higher level of cow comfort in the belief that this will lead to more profit? This work assists farmers, and others, in making a choice between two products, representative of cow comfort mats and mattresses now widely available to the farming industry.

1.2 Cow Behaviour Indicators

The behaviours indicative of cow comfort can be divided into lying and standing behaviours. It has been widely stated that cows will lie down for longer at pasture and on softer bedding. Also lying times (L) are reduced at the changeover from pasture to winter housing (Singh et al, 1993). This reduction in total lying has often been associated with a concurrent reduction in the proportion of lying time spent ruminating (LR/L). These two behaviours (L and LR/L) should therefore be greater on the softer bedding.

Conversely, idling or standing doing nothing (SO), is rarely seen at pasture; when cows are standing they are usually either ruminating or investigating their surroundings. The idling seen in housed cattle represents a small, but significant proportion of their time.

Cows only engage in sleep for short periods and this sleep is characterised by the head/chin resting on the ground. The end of a period of sleep is marked by a sudden jerking of the head (Ruckebusch 1974). These periods of sleep are called sleeping bouts.

Singh et al (1993b) reported that, for both heifers and cows, maximum sleeping bout length was greater at pasture (4.1h and 4.8h respectively) than immediately post-housing (1.7h for both). Maximum sleeping bout lengths are associated with increased comfort (Singh et al, 1993b).

Lying time is also an indicator of comfort, and at pasture heifers and cows have similar lying times of 6.2h and 6.1h. After housing, the lying times increase to 8.9h and 9.9h respectively. As the housing period progresses, night lying, maximum lying time and rumination all increase (Singh *et al* 1993b). Hence, it is important to consider all these factors, in order to gain a broader understanding of cow comfort.

Uncomfortable lying areas are more likely to influence daytime lying periods rather than night-time periods (Dregus *et al* 1979). Inadequate cubicle comfort is also indicated by the cow standing half in a cubicle, indicating a fear to use the bed (Leonard et al, 1994, Colam-Ainsworth *et al* 1989, Faull *et al* 1996).

Soft bedding is preferred by cows instead of a hard concrete floor. This is not surprising considering how little the cows knees and hocks are protected by skin and tissue. Even when softer beds are further away from feed, cows will make the extra effort to walk and return to the softer bed (Irps 1983, Harper 1983). The question is how soft does a bed have to be, and at what cost, to give the cow an acceptable level of comfort?

Hygiene is also very important in practice. This is related to total body dirtiness as an indicator or the general environmental conditions being offered to the animal. Udder cleanliness is important in the control of mastitis. Assessment of hygiene in this

project was based on a specific methodology for measuring coliform counts in the sawdust used as outlined in Section 2.0 'Materials and Methods'.

1.3 The Scope of the Study

Farmers were questioned as part of this study to get their opinions on the mats or mattresses installed in their own dairy units. Cow performance was a major consideration for respondents coupled with a 'value for money' for the mat or mattress investment. Fifty-five dairy farmers in Britain and Ireland responded to the questionnaire, as summarised in Section 9.0 'Appendix'. This questionnaire underlines our commitment to produce a study giving results of direct relevance to dairy farmers making purchase decisions of mats or mattresses.

In this mat/mattress comparative test, records have been kept of milk yield, milk composition and somatic cell count. Also feed records have been made to determine if there is a connection between comfort factors and feed intake, weight changes and body condition. The reaction of the cow to one type of bed has been assessed in terms of injury levels, lameness and locomotion. The subjective scoring systems used for this work were standardised between the two sites. Rubber crumb mattresses and various types of mat have been reported in previous work to cause less harm to the hock joint than concrete and sawdust alone (Underwood *et al* 1995, House *et al* 1994).

Reports suggest that hock injuries should be monitored in the winter housing period in order to find out the optimum bed system for taking the high loads that leg joints must endure. In addition, damage to the soft tissues, the ligaments, cartilage, tendons and bursa, which support the hock and knee joint can be caused by direct impact onto any surface, but especially one which is harder. Significant impact pressure may be experienced from a load of 4kN (Dumelow, 1995) on such a small area as a knee or hock joint.

If cows lie down less their feet will spend more time in contact with concrete and slurry. The former can be abrasive and the latter is corrosive. Contact with concrete flooring and slurry are associated with severe claw horn disruption, a major precursor of lameness in dairy cattle.

A final part of the work done was a series of video recordings of lying and ruminating patterns of mattress and mat cows in the SAC Auchincruive Metabolism Unit. This allowed detailed scrutiny of the 24-hour behaviour of two adjacent cows on a mattress or a mat and added to the data on lying, feeding and ruminating periods.

The 'challenge' associated with winter housing is high. It is important to identify and relate all the factors which influence cow comfort over the housing period, especially those involved directly with improving the comfort of the cubicle bed.

2.0 Materials and Methods

2.1 Design of Experiment

The objective of this work was to determine if there were any differences in cow health, welfare and production levels given one of two different types of cubicle bed for the whole of the 1997-1998 winter period. The experiment was replicated at two sites: SAC Auchincruive, and Myerscough College, Lancashire, where the cubicle housing layout was very similar. Both dairy units were clear-span portal frame buildings with a three-section cow housing area and a herringbone parlour. The cubicle divisions at Auchincruive were the Dutch Comfort type and the length and breadth of the cubicle beds were 2.2m and 1.15m respectively. The cubicle divisions at Myerscough were the Mushroom type with a bed length and breadth of 2.3m and 1.2m respectively.

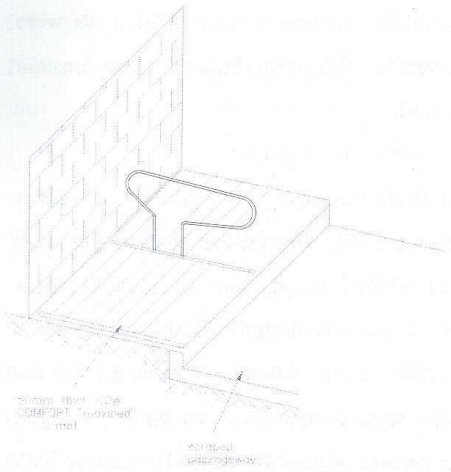
At each site 58 cows were divided into two groups and housed on either mattresses (Pasture B.V. "Pasture Mat"; Group 1) or mats (Cow Comfort "Maxi-bed"; Group 2). The suppliers for this project were:

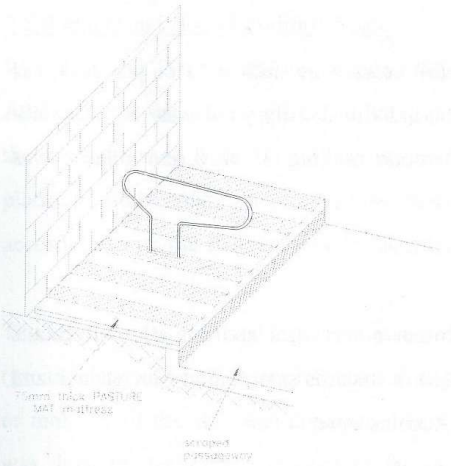
Pasture Mat	Maxibed
Fullwoodhead Dairy Supplies Ltd	Cow Comfort UK Ltd
River Place	Isle of Man Farm
Paddockholm Industrial Estate	Meadow Lane
Kilbirnie	Croston
Ayrshire	Lancashire
Scotland	England

The 75mm thick Pasture Mat (Mattress) is made up of a series of tubes of rubber crumbs sewn inside a polyester inner mattress which is covered by a heavier outer cover of non-woven polypropylene.

The 50mm thick Cow Comfort Maxibed (Mat) is made from ethylene vinyl acetate (EVA).

Figure 1 **Cow Comfort Maxibed 'Mat' and Pasture Mat 'Mattress'**





These cubicle beds are representative of products on the market with the mat being around 30% cheaper than the mattress at the time of purchase for the trial.

Each group of 29 cows comprised 15 autumn-calved "core" cows and 14 summer-calved "fillers". After week 6, at both sites, the summer-calving filler cows were replaced by early lactation, late-autumn-calvers and the groups then remained constant throughout the remainder of the housing period.

At Auchincruive the herd included both Holstein-Friesians and Ayrshires, whereas at Myerscough there were only Holstein-Friesians. The two groups at each site were matched for lactation number, days post-calving, breed, and previous lameness history. At Auchincruive all cows were housed abruptly from grass but at Myerscough the cows were allowed a transition period of about one week prior to the trial starting. During the transition period the Myerscough cows were housed at night, grouped randomly and allowed access to pasture during the day. Hence, for both groups, the beginning of the trial marked the onset of winter housing period.

2.2 Milk Yield

The milk yield of each cow in the trial (all cows were milked twice per day) was recorded on a daily basis at each site. The individual daily yield was the total milk from two milkings starting with the afternoon milking. If only one milking was recorded for any reason it was discarded.

2.3 Milk Composition

Individual cow butterfat percentages, protein percentages and somatic cell counts were obtained from the monthly National Milk Records sampling at Myerscough and the Scottish Milk Records Association at Auchincruive.

2.4 Feed

The weight of feed offered to the cow groups once or twice daily *ad libitum* was recorded, the refusals were weighed weekly and a mean weekly feed intake was determined for the mattress and mat groups.

The detail of the feed offered at Auchincruive was as follows:

40 kg per head of first cut silage (DM ~ 22%)
plus 6 kg per head of supergrains (DM ~ 22%)
plus 3 kg per head of barley (DM ~ 85%)
plus for the first 100 days of the trial 3 kg per head of concentrates
for the remainder of the trial $^1/_2$ kg per head of concentrates

The detail of the feed offered at Myerscough was as follows:

40 kg per head of first cut silage (DM ~ 21.5%)
plus 8 kg per head of maize silage (DM ~ 29%)
plus 3.5 kg per head of caustic treated wheat
plus 2 kg per head of 40% protein meal
plus 0.12 kg per head of minerals

2.5 Weights and Body Condition Score

Weighing and Body Condition Scoring was always done after evening milking at Auchincruive and after morning milking at Myerscough. Weights were recorded as the cows returned from the parlour into the handling area via a crush with a weigh platform. Body condition scoring was carried out on a score range of '0' to '5' in accordance with the standard practice established by Mulvaney (1977).

The fat at the tailhead and loin were assessed using the scale from 0 (very poor) to 5 (grossly fat) with half scores in between to give an eleven point scale. Any tightness or mobility of the skin was determined at these two main areas and the assessment was done by feeling the amount of fat since a visual assessment is not accurate enough.

2.6 Subjective Scoring for Hock/Knee Injury, Dirtiness and Locomotion

Cows were weighed and scored just before the trial and fortnightly thereafter, from the beginning of October 1997 until April 1998. This gave sixteen scores for each core cow in the study.

2.6.1 Hock and Knee Injury Score

The knees and hocks of each cow were scored in order to establish a pattern for the conditions of these joints in the housing time spent going onto and getting up from the cubicle beds. The scoring system for knee and hock injury was specifically developed for use in this study but closely based on the method 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 = adventitious bursae ('big', or swollen, knee/hock).

2.6.2 Dirtiness Score

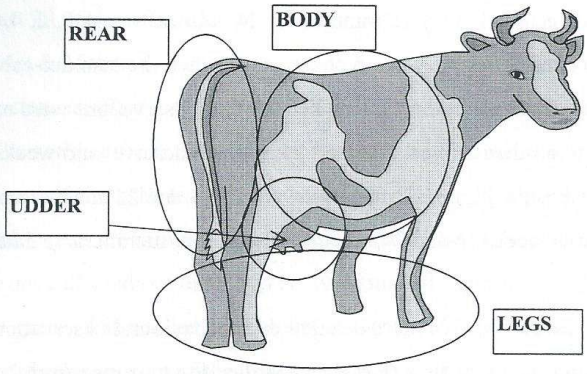
Four areas of the cow, body, rear, udder, legs (Figure 2) were scored for dirtiness on a scale of 1 to 3, with half points, based on work done by Bergsten and Pettersson (1992):

1 = perfectly clean;

2 = quite dirty;

3 = very dirty.

Figure 2 **Areas of the cow for dirtiness scoring**



2.6.3 Locomotion Score

Cows were scored on a scale of 1 to 5, with half-points, as described by Manson and Leaver (1988):

1 = walking freely and soundly, no unevenness or tenderness;

2 = walking 'short' (<75% tracking up). May have uneven gait and appear tender, possibly with downward extension of the head;

3 = slight lameness, not affecting normal behaviour;

4 = obvious lameness, affecting normal behaviour;

5 = severe lameness, difficulty rising.

2.7 Clinical Lameness

Cows with a locomotion score of 3 or greater were considered to be clinically lame and the incidence and prevalence were defined by several parameters. These were; the number of cows which went lame at least once during the trial (N.LAME); total number of weeks lame per cow (WEEKS LAME); and the number of lameness events per cow during the trial (N.EVENTS). A locomotion score 3 or greater was defined as a new lameness event if it was preceded by two scores of less than 3 (i.e. 4 lameness-free weeks). No distinction was made regarding the site or cause of lameness.

2.8 Behaviour

The lying, standing, feeding, drinking and ruminating behavioural pattern of 15 core cows in each group was recorded every 15 minutes for 24 hours at weeks 0, 2, 4, and 6 post-housing on both sites. After the week 6 observation, when the summer-calving filler cows were replaced by late-autumn-calvers, behavioural observations were made at week 8 on both sites and then at weeks 16 and 24 at Auchincruive, and weeks 14 and 22 at Myerscough. For the purposes of analysis, weeks 14 and 22 at Myerscough were then corresponded to weeks 16 and 24, respectively, of the Auchincruive data.

In addition, lying time was recorded in more detail at each behavioural observation by event sampling, recording the exact time that each cow lay down or rose from lying, and the cubicle that she used.

2.9 Coliform Counts for Cubicle Bed Sawdust Samples at Auchincruive

Sawdust sampling was performed each Monday for five weeks from January 19th to 16th of February 1998 before the beds were "remade" (9.00 am for the Auchincruive dairy farm).

Six cubicles were selected from each group and from each side of the cubicle house (facing wall & facing feed face) top, end and middle. The selected cubicles were marked with baler twine.

Temperature & humidity in the house were also recorded at the time of sampling. These readings were taken at the parlour end of the shed and then again at the experimental site or "bed" site.

2.9.1 Sawdust Samples

Sawdust samples were taken from:

i) the sawdust wagon -Control

ii) the mats & mattresses (as detailed above) -Mat (1-6) & Mattress (1-6)

They were labelled as above.

2.9.2 Obtaining the sample

A) Control

A layer of sawdust fresh was scrapped off with a gloved hand to fill a plastic bag with at least 20 grams of sawdust.

B) Mat & Mattress

1. A clean sheet of A4 paper was taken and folded into four quarters;
2. The sawdust from both sides of the bed was scraped in a line 10cm parallel to the back end of the cubicle (with the short end of the folded paper). This left a small pile of bedding in the middle of the scraped area to be put into the sample bag. Cowpats were not collected but there was no avoidance of "splashes" of faeces;
3. 20 grams was needed so if the pile did not look sufficient the above process was repeated from in front of the original scraped area;

2.9.3 Bacteriology

The methodology of establishing coliform counts (*Escherichia coli*) for sawdust bedding was as follows:

1. A 10 gram aliquot, taken randomly from the sample, was weighed and transferred to a stomacher bag. 50 ml of sterile peptone water was added;
2. This was homogenised in the stomacher for 3 minutes. The resulting fluid was decanted into 50 ml of sterile peptone water to give a 10^{-1} dilution;
3. Serial 10 fold dilutions were made by taking 1 ml of fluid and 9 ml of fresh sterile peptone water. Under SAC Auchincruive conditions a pilot study has shown that the best dilution rates were as follows:

Dilutions for control	$10^{-1}, 10^{-2}, 10^{-3}$
Dilutions for sawdust from Mats and Mattresses	$10^{-3}, 10^{-4}, 10^{-5}$

4. Duplicates of 0.1 ml from each dilution were plated onto MacConkey agar using sterile glass or metal spreaders and incubated at 37°C for 18-24 hours;
5. The appropriate plates were subjected to a colony count making sure that the duplicates were comparable and in agreement with the dilution above and below.

The coliform count (CC) was calculated as the mean of the two results and expressed as cfu/gram.

2.10 Behavioural Observation at Auchincruive Metabolism Unit

At Auchincruive, after the end of the housing period, six core cows from each group were restrained by yokes in the Metabolism Unit. The cows were brought inside from pasture and given one week in the main dairy unit cubicles, then one week of adjustment in the Metabolism Unit. Video recordings were started in the third week, after which the cows were put out to pasture again.

Cows selected for the Metabolism Unit video study were those which had shown average lying times over the course of the main trial. The cubicles were fitted alternately with mattresses and mats and the cows were allocated a mattress or mat in matched pairs, as in the main trial. Cows which had been housed on mattresses in cubicles during the main experiment were again bedded on mattresses in the Metabolism Unit and, likewise, cows which had been on mats in the main experiment were given mats in the Metabolism Unit. The yokes prevented the cows from exercising free choice in terms of cubicle selection but this meant that video recordings could be made of each cow's behaviour over 24 hours, apart from when they were taken out for milking.

Paradoxical sleep, as described by Ruckebusch and Bell (1970), was easily seen in the video recordings (Table 1). With very few exceptions, the cows only rested their heads in the fashion described for short periods corresponding to the duration of paradoxical sleep described by Ruckebusch (1974). This characteristic posture was therefore referred to as "sleep" and was event sampled from the videos.

It was also obvious from the video recordings that cows make intentions to lie down without actually lying (bending one knee and then standing upright again, or sniffing the ground with a side-to-side swinging of the head) and they also make intentions to sleep (defined as turning and resting the head for less than 1.5 minutes). The number of intentions to lie and to sleep were recorded for each cow.

Table 1 **Stages of sleep in dairy cows**

Stage	EEG waves	Behaviour
I – awake	rapid, low amplitude	awake and attentive with phases of psycho-sensorial rest
II – somnolence	fuseaux and slow waves	standing or lying, usually progresses from a phase of psycho-sensorial rest
III – sleep	slow waves only	total detachment from surroundings, unresponsive to loud noises, usually (but not always) lying, drooping ears and a resting head are, in 20% of cases associated with this stage
IV - paradoxical sleep	rapid waves	always lying, closed eyelids, resting head, lying on side with at least one hind limb extended

As described by Ruckebusch and Bell (1970).

3.0 Analysis

Statistical tests were performed using Genstat for Windows Version 5.3.3.2., unless otherwise stated, and the effects investigated throughout were; herd (Auchincruive or Myerscough), group (mattress or mat) and herd*group interaction. The level of significance used in the analysis was 5%.

3.1 Milk Yield

The daily milk yield results were tabulated for each cow and an average milk yield per cow was worked out for each group.

Although individual results for each cow were obtained the study was undertaken to observe the two groups as a whole and so the statistical analysis was carried out on the average milk yield figures per cow/ week for each group.

The statistical tests were performed using the Unistat Statistical Package version 4.007. To do the appropriate tests it was necessary for the results to be normally

distributed. To test for normal distribution, a one sample Kolmogorov-Smirnov Test: Normal was carried out.

All the data that showed a normal distribution was analysed through a test for ANOVA (analysis of variance).

3.2 Milk Composition

The monthly milk composition results were tabulated for each cow and an average butterfat and protein percentage for each group at each site was determined.

As with the milk yield results the statistical analysis was conducted on the average butterfat and protein content per cow per month for each group.

3.3 Feed

The feed amount offered to the mattress and mat cow groups at each site was recorded and the amount eaten by each group was determined from what remained at the end of each week. The changes in intake over the trial period has been determined for each group on this basis and has been illustrated in Figures 6a and 6b in the results section.

3.4 Weights and Body Condition Score

The average, maximum and minimum weights were calculated for each cow in the trial. ANOVA was then carried out for the Auchincruive and Myerscough herds and the mattress and mat groups for both herds. Also, any herd/group interaction was established. Weight change was calculated by taking the minimum weight from the maximum weight for each cow and this parameter was also analysed by ANOVA to determine if there were differences between the herds and groups.

ANOVA was used to determine any differences in the average, maximum and minimum body condition scores of the cows in the trial.

3.5 Subjective Scoring for Hock/Knee Injury, Dirtiness and Locomotion

All subjective scores were transformed logarithmically to give a normal distribution (log SCORE = $\log_{10}$ (SCORE+1)). The average, maximum and minimum scores recorded for each cow during the trial were analysed by ANOVA (General Linear Model).

3.5.1 Hock and knee injury score

The fortnightly scoring was split into categories of injury from 0, injury-free joints, to 10, adventitious bursae on both knees (i.e. two scores of 5). The total number of injury observations was isolated for each cow and the mattress and mat groups were compared on this basis using ANOVA in regression.

3.5.2 Dirtiness Score

The scores were analysed using ANOVA for the average and maximum total body dirtiness and udder dirtiness scores. Each cow in the trial was scored fortnightly and the mattress and mat cow grouped average and maximum scores were then compared for a significance of difference.

3.5.3 Locomotion Score

In addition to analysis of average and maximum scores during the trial, pre-trial locomotion scores were also compared to check for pre-existing differences.

3.6 Clinical Lameness

N.LAME was binomially distributed (cows had either been lame or not lame during the period of the trial) and therefore was analysed by logistic regression.

The data for N.EVENTS and WEEKS LAME both followed a Poisson distribution (count data with discrete intervals and no upper limit) and so were analysed using Generalised Linear Regression, specifying a Poisson distribution and a canonical link function.

3.7 Behaviour

The behaviours analysed were: lying (L-scan), proportion of lying time spent ruminating (LR/L), idling (SO; standing, doing nothing), proportion of idling time spent in cubicles (SO(C)/SO), and standing half-in cubicles with back feet in the passageway (S½). Each behaviour was expressed as a proportion of the time observed in cubicles as during milking time they were not free to engage in lying, standing half-in cubicles, or idling in cubicles.

SO and S½ data were skewed and so were transformed logarithmically before analysis. The remaining behavioural data was normally distributed and did not require transformation.

Event sampled lying behaviour was characterised by: total lying time over 24h (L-TOTAL); number of lying bouts over 24h (L-BOUTS); maximum bout length (L-MAX); minimum bout length (L-MIN); and average bout length (L-AV).

All behavioural data was analysed by slit-plot ANOVA (repeated measures ANOVA) with group and week of scoring as treatment effects, herd as whole plots, group as sub-plots and individual cows as blocks.

3.8 Coliform Counts for Cubicle Bed Sawdust Samples at Auchincruive

The coliform counts were log transformed and the data analysed. Descriptive Statistics were preferred for each individual week between mats and mattresses and then for the full five weeks for both mats and mattresses again, to obtain mean and standard error values.

Preliminary graphs were made up to display the figures in a more comprehensible way so the next stage of the analysis could be determined. Graphs were also drawn to show the possible relationship between coliform counts temperature and humidity.

An ANOVA (two factor without replication) was used to compare mat and mattress sawdust as well as differences within the individual weeks.

3.9 Behavioural Observation at Auchincruive Metabolism Unit

Sleep was described by the parameters: total sleep time over 24 hours (S-TOTAL), maximum bout length (S-MAX); average bout length (S-AV); and, number of sleeping bouts per 24 hours (S-BOUTS). Lying behaviour was also recorded, using the same parameters as in the main trial:

L-TOTAL total lying time, recorded by event sampling;

L-BOUTS number of lying bouts over 24h;

L-MAX maximum bout length;

L-MIN minimum bout length;

L-AV average bout length.

All data, except that for number of bouts, was analysed by ANOVA looking for differences between the groups (mattress or mat). S-BOUTS and L-BOUTS were Poisson distributed and so were analysed by Generalised Linear Regression, specifying a Poisson distribution, again looking for differences between the mattress and mat groups. Results for S-BOUTS and L-BOUTS were presented as medians.

4.0 Results

4.1 Milk Yield

The average milk yield at Myerscough was marginally, but not significantly, higher on the mats than the mattresses (Table 2). The reverse was the case at Auchincruive with mattress cows giving a slightly higher average yield. Statistically the milk yield results showed that there was no significant difference between the groups (mattresses and mats), P = 0.5699 at Myerscough and P = 0.9206 at Auchincruive. The average milk yield for the herd at Myerscough was higher than that at Auchincruive.

Table 2 **Daily average and maximum milk yields per cow in each group**

	Auchincruive		Myerscough	
	Mattress	Mat	Mattress	Mat
Average Milk Yield (litres)	24.7	24.4	29.2	30.3
Maximum Yield (litres)	30.0	29.9	33.3	33.9

4.2 Milk Composition

At both sites the butterfat percentage was higher on the Mattresses than on the mats (Table 3), although, again, this was not a significant difference. Myerscough, P = 0.1779 and Auchincruive, P = 0.4152.

Table 3 **Average and maximum butterfat content for milk yield in each group**

	Auchincruive		Myerscough	
	Mattress	Mat	Mattress	Mat
Average Butterfat %	4.03	3.89	4.18	4.06
Maximum %	4.51	4.23	4.37	4.30

As with the butterfat results the protein averages were again higher at both sites on the mattresses (Table 4) although the maximum percentage at Auchincruive was higher on the mats. This again did not prove to be a significant difference when analysed.

Table 4 **Average and maximum protein content for milk yield in each group**

	Auchincruive		Myerscough	
	Mattress	Mat	Mattress	Mat
Average Protein %	3.06	2.99	3.29	3.22
Maximum %	2.95	3.29	3.42	3.27

Using the NMR and SMRA data individual somatic cell count records were analysed and there were no significant differences between the mattress and mat cows in terms of average, maximum and minimum somatic cell count levels. All somatic cell count levels were at a satisfactory level (Figures 3, 4 and 5).

Figure 3 **Mean monthly somatic cell counts (± SE) for the two groups (Auchincruive and Myerscough data pooled), October 1997 to April 1998**

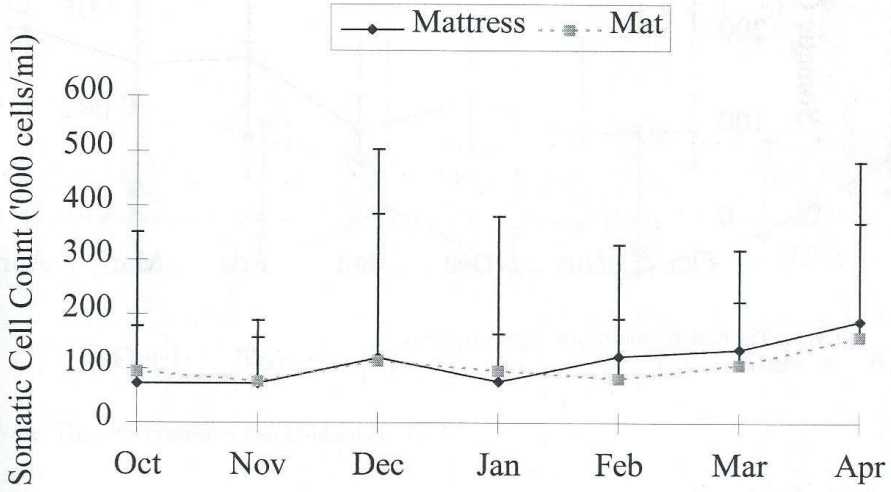
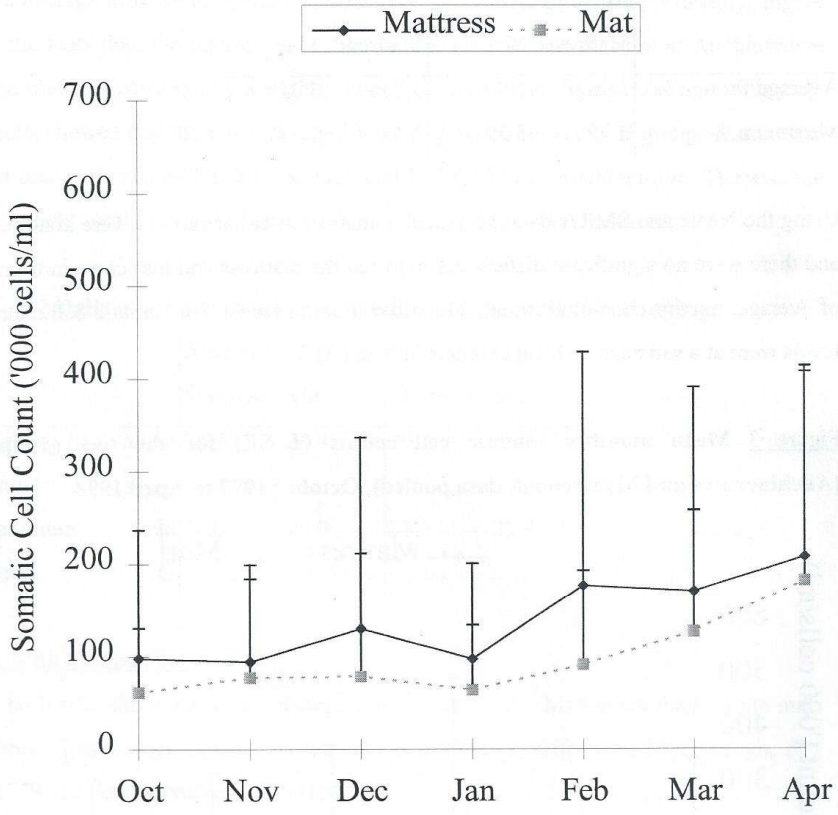
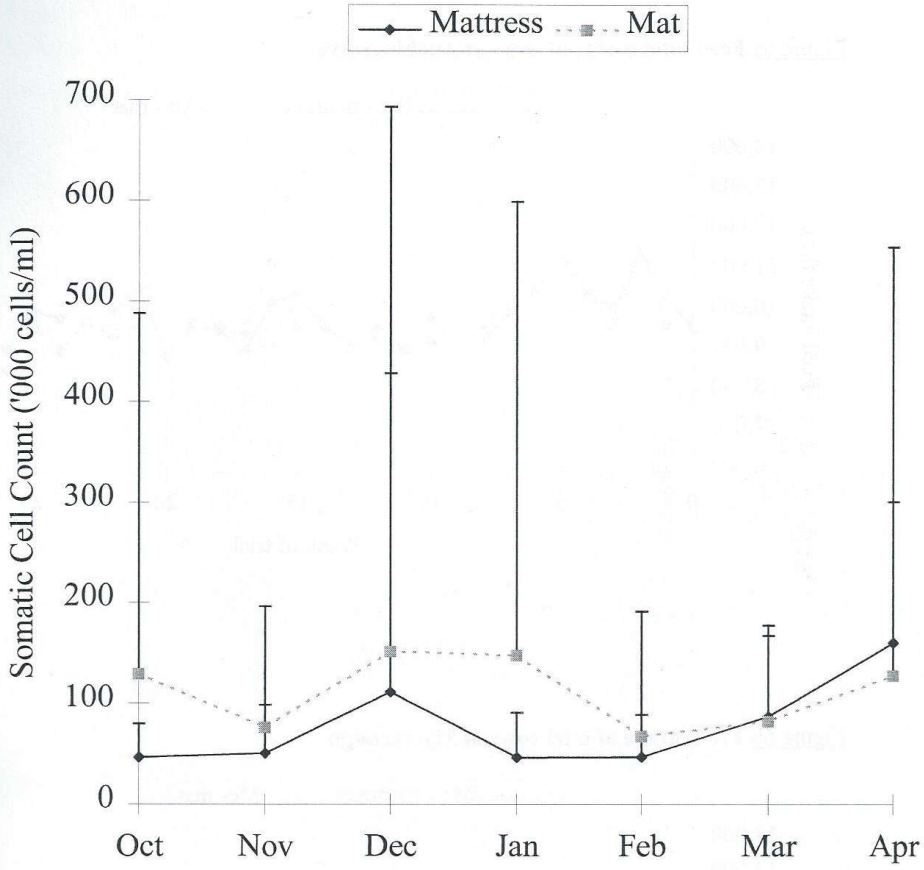


Figure 4 **Comparison of somatic cell counts from October '97 to April '98 for groups at Auchincruive**



(Note: The bars represent the standard error)

Figure 5 **Comparison of somatic cell counts from October '97 to April '98 for groups at Myerscough**



(Note: The bars represent the standard error)

4.3 Feed

Figures 6a and 6b show the weekly intake of feed for the mattress and mat groups at each site. The average weekly intake of the mattress and mat groups was 10,619 kg and 10,367 kg freshweight, respectively, taking the Auchincruive and Myerscough herds together. As there were a total of 58 cows in each group, this difference equates to approximately 4.3 kg/cow per week. The feed at Auchincruive consisted of 15 kg

DM/cow/day for the first 100 days of the trial and 12 kg DM/cow/day for the remaining time. The complete diet feed at Myerscough consisted of 13 kg DM/cow/day for the trial period.

Figure 6a **Feed intake of trial cows at Auchincruive**

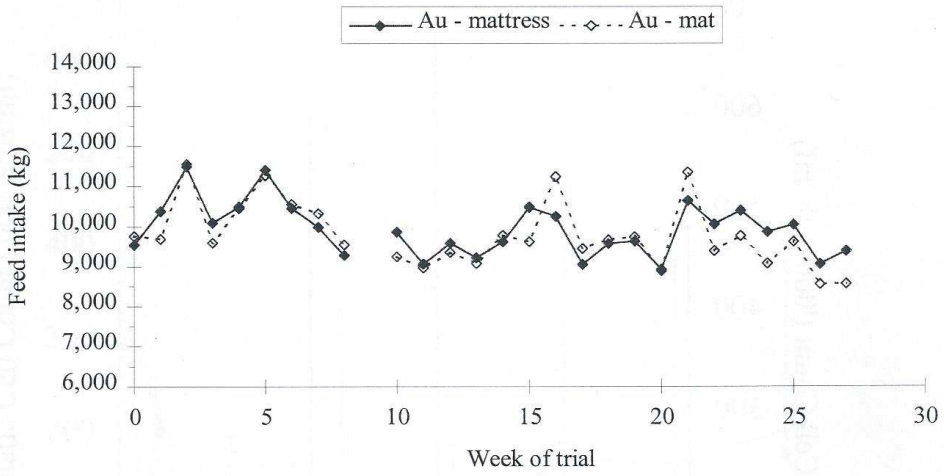
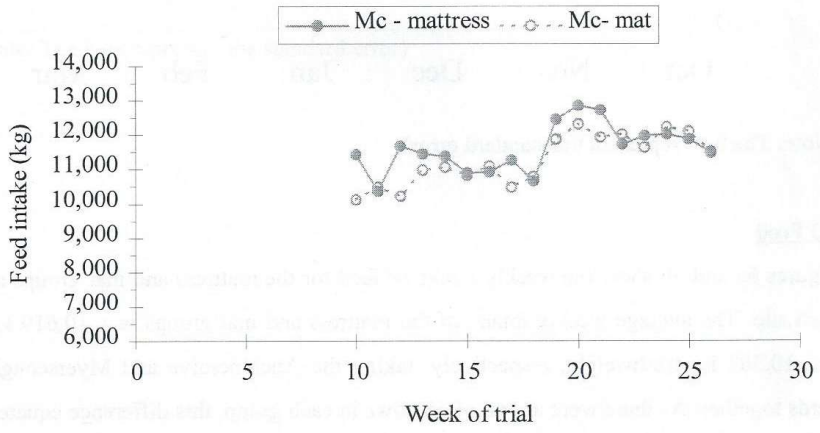


Figure 6b **Feed intake of trial cows at Myerscough**



4.4 Weights

Weight loss (the difference between maximum and minimum weight) in the cows during the trial period was measured (Table 5). There were no significant differences between the mattress and mat cows in terms of weight change (P = 0.436).

Table 5 **Weight change in the trial cows**

	Auchincruive		Myerscough	
	Mattress	Mat	Mattress	Mat
Weight change (kg) in trial period	49.9	47.8	39.5	48.5

4.5 Body Condition Score

Body condition average, minimum and maximum scores are given in the table below in terms of herd and group mean. There were no significant differences between the body condition scores of the mattress and mat cows. (P = 0.827 for the mean average score; P = 0.422 for the mean minimum score; and, P = 0.254 for the mean maximum score). The Myerscough herd had higher average (P < 0.001) and minimum scores (P < 0.001) but there was no difference (P = 0.762) in the mean maximum score.

Table 6 **Body condition scores results**

	Auchincruive		Myerscough	
	Mattress	Mat	Mattress	Mat
Average Score	2.4	2.4	2.5	2.5
Minimum Score	2.0	1.9	2.2	2.3
Maximum Score	2.9	2.8	2.9	2.8

4.6 Hock and Knee Injury Score

The incidence of hock injuries in all cows in the trial showed that there was a significant difference between the mattress and mat groups, (P=0.009), in terms of the number of injury-free cows (cows which scored '0') with the mattress cows faring better (Table 7). However, when comparing mattresses and mats in terms of specific injury levels there were no significant differences found.

For scores of greater than 1 (>1): no significant difference, for scores of 5 (either hock swollen): no significant difference, (P=0.054-left hock) / (P=0.465-right hock) and for scores of 10 (both hocks swollen): no significant difference, (P=0.185).

The knee injury results were similar to the hock results. There was a significant difference between the mattress and mat groups in terms of the incidences of cows uninjured (0 scores), with the mattress cows doing better, ($P < 0.001$). The results for scores of >1 also showed that there was a significant difference between the mattress and mat cows, again with the mattress cows faring better, ($P < 0.001$). For scores of 5 (either knee swollen) there was no significant difference, ($P = 0.128$-left knee) / ($P = 0.964$-right knee) and for scores of 10 (both knees swollen) there was no significant difference, ($P = 0.236$).

Table 7 **Mattress/Mat comparison for hock and knee injury scores**

	All cows in trial			
Score	0	>1	5	10
Hocks	Mattresses better (P=0.009)	No Difference	No Difference (P=0.054)LH[1] (P=0.465)RH[2]	No Difference (P=0.185)
Knees	Mattresses better (P=0.001)	Mattresses better (P=0.001)	No Difference (P=0.128)LK[3] (P=0.964)RK[4]	No Difference (P=0.236)

1=Left Hock; 2=Right Hock; 3=Left Knee; 4=Right Knee

Further analysis was done for the hock and knee injury scores in order to confirm the pattern of injury for all cows in the trial. Considering the incidences of 0 or 1 scores as a measure of a positive cow reaction to a mattress or mat, the following results were found and show, again, that a higher proportion of mattress cows had the 0 or 1 rating for both knee and hock injury. However looking at the knee scores at Myerscough, there was no significant difference between mattress and mat cows.

Table 8 **Mattress/Mat proportions of hock and knee injury scores of 0 or 1 in all cows in the trial**

All Cows	Mattress		Mat	
	Possible	Actual	Possible	Actual
Hock Scores of 0/1	929	542 (58%)	928	473 (51%)
Knee Scores of 0/1	934	814 (87%)	930	720 (77%)

Incidences of 0 or 1 scores at Auchincruive and Myerscough separately is shown in Table 9.

Table 9 **Mattress/Mat proportions of hock and knee injury scores of 0 or 1 in Auchincruive and Myerscough cows**

	Mattress		Mat	
	Possible	Actual	Possible	Actual
Auchincruive Cows				
Hock Scores of 0/1	471	163 (35%)	469	114 (24%)
Knee Scores of 0/1	476	378 (79%)	471	292 (62%)
Myerscough Cows				
Hock Scores of 0/1	458	379 (83%)	459	359 (78%)
Knee Scores of 0/1	458	436 (95%)	459	428 (93%)

4.7 Dirtiness Score

The average total dirtiness scores showed that there was no significant difference between the scores of mattress and mat cows (P=0.074). Also, taking all cows on mattresses and comparing them to those on mats there was no significant difference (P=0.463) between the maximum total dirtiness scores (Table 10).

Table 10 **Total body dirtiness scores**

	Auchincruive		Myerscough	
	Mattress	Mat	Mattress	Mat
Average Score	6.2	6.0	5.7	5.6
Maximum Score	7.5	7.5	6.6	6.4

However, examination of specific areas showed that there was a significant difference in average udder dirtiness scores between the mattress and mat cows when those at both Auchincruive and Myerscough are considered (P=0.042) with the udders of the cows on mats being cleaner (Table 11). The maximum udder dirtiness scores showed that there was no significant difference between the mattress and mat cows (P=0.147).

Table 11 **Udder dirtiness scores**

	Auchincruive		Myerscough	
	Mattress	Mat	Mattress	Mat
Average Score	1.5	1.4	1.3	1.2
Maximum Score	2.0	1.9	1.6	1.6

4.8 Locomotion Score

There was no difference between the mattress and mat groups at both sites before the trial commenced, P = 0.062, although there was a difference between the Auchincruive and Myerscough herds. Pre-trial scores for the new fillers at Week 8 were significantly different between herds, P < 0.001.

Table 12 **Mean pre-trial locomotion scores.**

	Auchincruive	Myerscough
Pre-housing	1.61	1.71
Week 8 (new fillers)	1.58	1.91

Average scores for the trial were consistently higher at Myerscough than at Auchincruive but there was no difference in the maximum scores. There were no significant differences between the mattress and mat cows in terms of locomotion

scores. Average score, P = 0.403; maximum score, P = 0.345; minimum score, P = 0.793. (Table 1).

Table 13 **Locomotion scores of groups in the trial period**

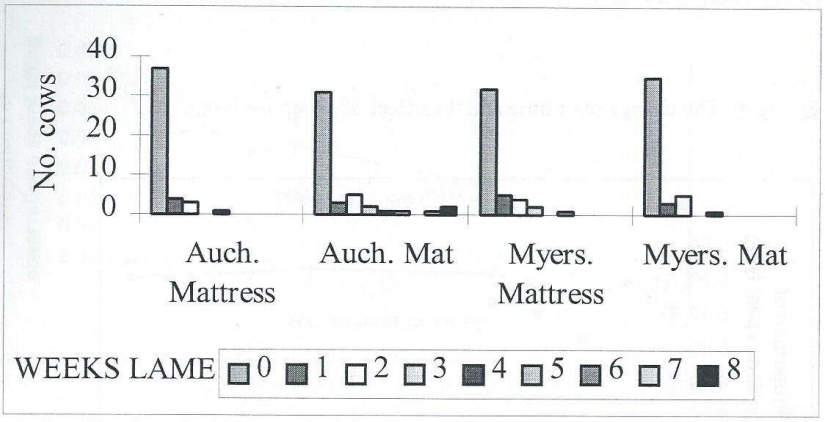
	Auchincruive		Myerscough	
	Mattress	Mat	Mattress	Mat
Average	0.66	0.70	0.77	0.81
Maximum	1.21	1.36	1.23	1.25
Minimum	0.32	0.28	0.53	0.55

4.9 Clinical Lameness

There was no difference in the number of cows which went lame at least once, (N.LAME), either between the groups or between the herds and no difference in the number of lameness events per cow, (N.EVENTS), between herds (P=0.128). Mattress cows appeared to have more lameness events than those on mats (P=0.063), although the interaction between group and herd was more significant (P=0.019). The total number of weeks lame per cow, (WEEKS LAME), did not differ either between herds (P=0.101) or between groups (P=0.266) but, again, the interaction was significant (P=0.013, Figure 7).

Figure 7 shows the number of cows which had a given number of weeks lame. The lowest number of weeks lame for all four groups in the trial was 0 and the highest number of weeks lame was 8 (found in the Auchincruive Mat group).

Figure 7 **Effect of interaction between group and herd on WEEKS LAME.**



4.10 Behaviour

Mattress cows had longer lying times and longer periods of ruminating while lying which indicates greater comfort levels. Also, the mattress cows spent less of their time standing doing nothing.

Figure 8 (a) - (e) illustrates the change in each of the behaviours investigated, for the core cows of the two groups. The two herds (Auchincruive and Myerscough) differed only in lying time scanned (L-scan), lying and ruminating as a proportion of total lying time (LR/L) and standing half-in a cubicle (logS½).

The variation over time was highly significant ($P \leq 0.001$) for all behaviours and in each behaviour, with the exception of standing half-in a cubicle, the variation was different in the two groups ($P < 0.05$).

Overall, Mattress cows had a greater proportion of lying time scanned (L-scan) (0.50 vs. 0.44, $P=0.004$) and lying and ruminating as a proportion of total lying time (LR/L) (0.58 vs. 0.50, $P<0.001$). Also, mattress cows had less time idling (SO) (0.10 vs. 0.13,

P<0.001) and less time idling in a cubicle as a proportion of total idling time (SO(C)/SO) (0.05 vs. 0.07, P=0.004).

Figure 8a The change over time and the effect of group for lying.

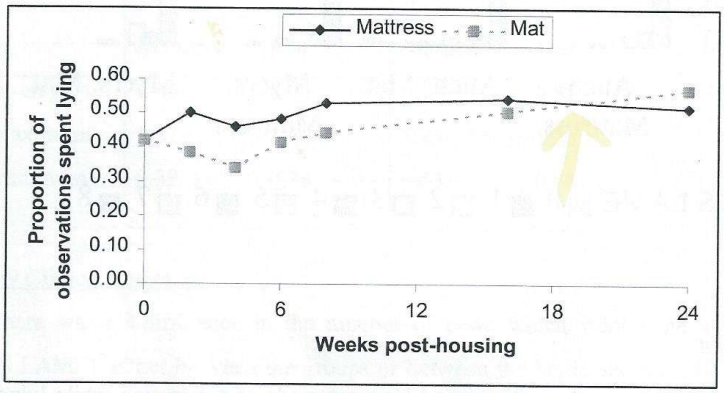


Figure 8b The change over time and the effect of group for lying-ruminating as a proportion of total lying.

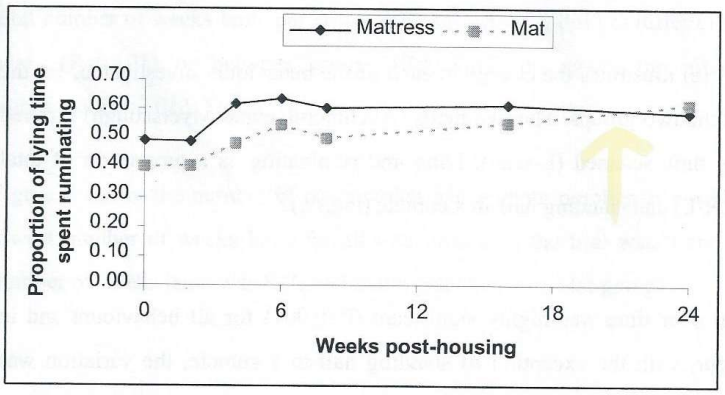


Figure 8c The change over time and the effect of group for idling.

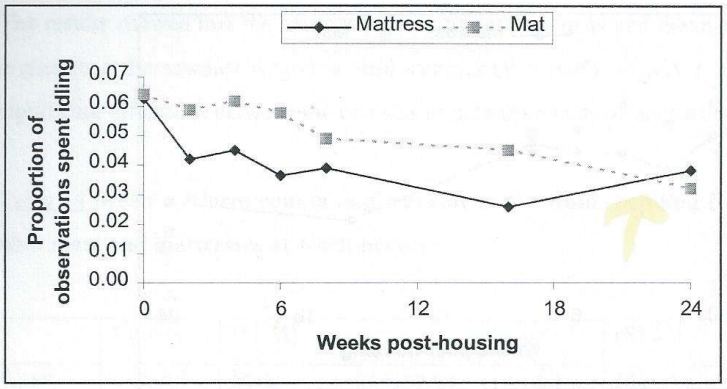


Figure 8d The change over time and the effect of group for idling in cubicles as a proportion of total idling.

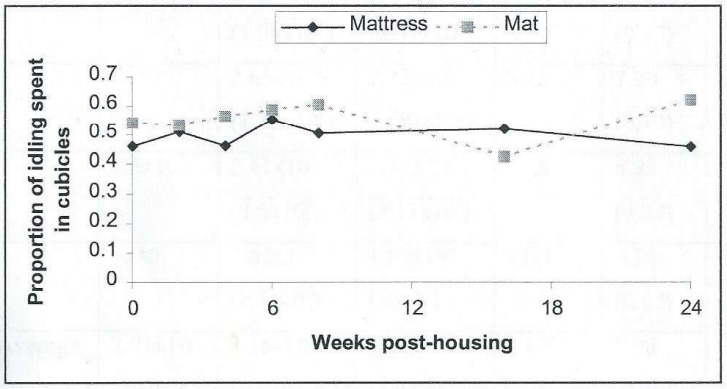
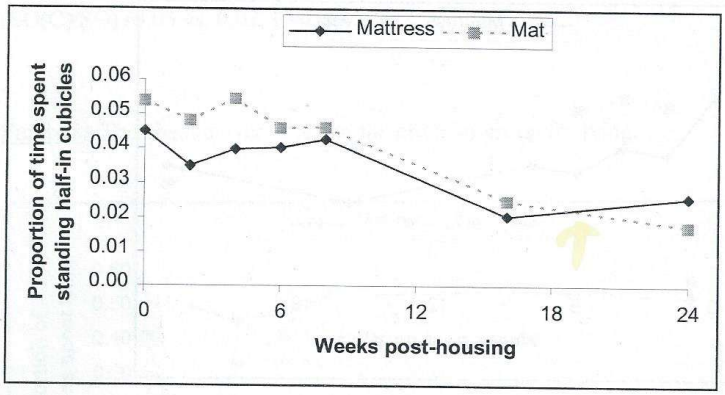


Figure 8e The change over time and the effect of group for standing half-in cubicles.



4.11 Coliform Counts for Cubicle Bed Sawdust Samples at Auchincruive

The results showed that the coliform counts of both the mats and the mattresses were higher than the sawdust wagon control samples ($P < 0.05$). However, there was no significant difference between the two sets of data from mats or mattresses (Table 14).

Table 14 **Mean coliform counts (log transformed) within bedding from cubicles with mats and mattresses at Auchincruive**

	Counts	(SEM)		Logs	(SEM)	
Week	Control	Mats	Mattress	Control	Mats	Mattress
1	$3.5x10^4$	$6.90x10^6$ ($1.23x10^7$)	$1.80x10^7$ ($2.57x10^6$)	4.54	6.18 (0.23)	6.82 (0.25)
2	$8x10^3$	$5.57x10^6$ ($1.06x10^6$)	$2.23x10^6$ ($2.57x10^6$)	3.90	6.88 (0.25)	6.30 (0.21)
3	$3x10^3$	$2.65x10^6$ ($1.23x10^6$)	$2.23x10^6$ ($6.50x10^5$)	3.48	7.90 (0.13)	6.20 (0.19)
4	$1.5x10^4$	$2.41x10^7$ ($8.6x10^6$)	$3.38x10^7$ ($2.17x10^7$)	4.18	6.32 (0.23)	7.20 (0.27)
5	$1x10^7$	$7.63x10^6$ ($1.7x10^6$)	$1.89x10^7$ ($1x10^7$)	7.00	6.75 (0.12)	6.83 (0.29)
Average	$2.01x10^6$ ($2x10^6$)	$9.36x10^6$ ($4.87x10^6$)	$1.50x10^7$ ($1.93x10^6$)	4.62 (0.51)	7.08 (0.20)	6.67 (0.24)

(Standard errors are displayed in brackets)

The temperature and humidity readings are shown on the next page (Table 15).

There is no significant relationship between either temperature or humidity and the coliform counts.($P > 0.05$)

Table 15 **Temperature and humidity during coliform count testing**

Week	Humidity (Parlour)%	Humidity (Bed area) %	Temperature °C
1	92.5	75	6
2	75	72.5	6.25
3	75	75	7.75
4	85	87.5	12
5	80	80	10.5

4.12 Behavioural Observation at Auchincruive Metabolism Unit

There were no differences between groups in any of the sleep or lying parameters except the number of sleeping bouts. Cows on mattresses had more sleeping bouts than cows on mats (group medians; 11 vs. 5, P=0.009).

Table 16 **Auchincruive metabolism unit sleep/lying results**

Parameter	Mattress	Mat	P-value
Sleep: Total (hrs)	1.240	0.930	NS
Max bout length (hrs)	0.239	0.247	NS
Average bout length (hrs)	0.114	0.111	NS
No. of bouts per 24h	11.0	5.0	S (0.009)
Lying: Total (hrs)	11.370	10.340	NS
Max. bout length (hrs)	2.070	2.090	NS
Min. bout length (hrs)	0.342	0.460	NS
Average bout length (hrs)	1.056	1.140	NS
No. of bouts per 24h	10.5	10.0	NS

Group means (and medians for number of bouts) for various sleep and lying parameters for 5 pairs of cows, recorded over 24 hours)

NS - P≥0.05

5.0 Discussion

5.1 Lying and Idling Time

Lying time and the proportion of lying time spent ruminating were greater in the mattress group suggesting that this bedding was more comfortable for cows, although reduced lying times associated with the onset of housing were seen in both groups. Likewise, idling was greater in the mat group and greatest in the initial week of housing for both groups, suggesting that it is indicative of unsettled behaviour. However, this apparent higher level of comfort did not have any impact, favourable or unfavourable, on milk production levels, butterfat percentages or protein percentages.

The proportion of idling time spent in cubicles might suggest that cows are motivated to lie down but unwilling to do so because of discomfort and this may be a possible explanation for the reduction in total lying. However, there was no difference between the groups in this parameter and neither did standing half-in cubicles vary between the groups. It may be that these two behaviours were more closely related to cubicle design than to the softness of the bedding.

The Group*Week interaction effect, which was seen for all the behaviours except standing half in a cubicle (logS½), was largely due to the observations made in week 24, when the differences between the groups were reversed. This week 24 reversal (Figure 8a) may have been due to the mat cows becoming increasingly happy with their cubicle bed option while the mattress cows stayed at a consistent level of comfort.

5.2 Injury to Hocks and Knees

The analysis of injuries showed that there was a significant difference between the mattress and mat cows, in favour of the mattresses, when considering the incidence of minor hock and knee problems. However, analysis of the worst hock and knee injuries, 5 - 10, showed that there was no difference between the mattress and mat groups. Taking the Myerscough results only, there was no significant difference between the mattress and mat groups in terms of '0' scores for knee injury but there

were for hock injury with mattress cows doing better. There were more hock and knee injury-free cows at Auchincruive.

Injury to the dairy cow hocks and knees are common in the winter housing period. In this experiment there have been cases on both the mattresses and mats which range from the minor "bare, pale area" to the severe "adventitious bursae". These injuries may have come from the physical surroundings or from an infection but typical building-related causes are banging against the cubicle division or the handling gates, from the cubicle beds via abrasive rubbing or from pressing the joint onto the surface without there being enough absorption of this load by the bed.

Hock injury research suggests that concrete cubicle beds are harmful to cows and that mattresses and mats improve things. For example, Underwood *et al* (1995) tested recycled rubber tyre mattresses in a dairy unit for 84 cows in tie-stalls and states that "mattresses greatly reduced the incidence of leg and udder injuries"; McFarland and Gamroth (1994) state that the main purpose of the cubicle bed is to provide a cushion layer; Rodenburg *et al* (1994) report on a test of mattresses and mats for hock injury scores where 0 is the best condition (no swelling, no hair off) and 3 is the worst (swelling, hair off) and conclude that swelling incidences are less for mattresses but that hair loss is similar for both mattresses and mats; House *et al* (1994) report on the use of rubber-filled mattresses in Canada and give results for hock injuries that suggest a reduction in injury levels in a 130 cow herd after the installation of mattresses.

Differences between the hock and knee injury scores in the Auchincruive and Myerscough herds are likely to have been due to the subjective nature of the scoring system. The cubicle divisions at Auchincruive are the Dutch Supercomfort type and have a back leg at the passageway edge of the cubicle and those at Myerscough are the Mushroom type which has two legs near the middle of the cubicle length. This may also have been a contributing factor in the difference between scores at the two sites. However, neither of these points affect the mattress versus mat analysis within one site since the mattress and mat cows were housed in the same type of cubicle.

5.3 Feed Intake

It was not possible to analyse the feed intake records on a statistical basis but the feed intake was higher in the Myerscough herd than in that of Auchincruive and mattress cows at both sites had higher intake levels than mat cows. The cows at Myerscough were heavier overall than those at Auchincruive since there is a mix of Ayrshires and Holstein-Friesians in the latter herd and only Holstein-Friesians in the former. However, the key consideration is any variation between the mattress and mat groups at each site so the difference in cow type and size between sites is not a factor.

Weight change in cows is important because it reflects their performance over the lactation period and also important is the fact that cows tend to lose weight at the beginning of lactation since their feed intake cannot make up for the demands of milk production. Cows that are not 'doing well' may be expected to lose more weight (Livesey *et al*, 1997) and this may be a good indicator of what type of cubicle bed is suited to cows in early lactation.

5.4 Locomotion

Locomotion scores were lower at the beginning of the trial as cows were only recently calved and had not been housed. The transition period at Myerscough could be responsible for the pre-trial herd difference. Also, there was a large number of heifers in the Auchincruive herd and as heifers do not usually have a history of lameness, their mobility is often better than that of older cows.

Overall, mattress cows had a lower average locomotion score and this was mediated by a lower minimum score. This was not accompanied by a difference in maximum score which suggests that the same number of cows went lame in each group. There were more cows with uneven gait in the mat group. This slight unsoundness could be due to the greater standing time of the mat cows.

The interaction between group and herd seen for N.EVENTS and WEEKS LAME was due to a few, persistently lame cows in the Auchincruive Mat group which had repeated incidents of lameness. These were not all older cows with a history of

lameness and there were equal numbers of old cows on the trial which did not become lame. As this effect was not mirrored in the Myerscough Mat group, it is questionable whether it can be entirely attributed to the bedding type since there are many factors which cause lameness. It was not possible to undertake a full series of hoof examinations for all cows on the trial so we cannot speculate as to its cause. Hence no differences were found in clinical lameness between the mattress and mat groups.

5.5 Cow dirtiness

In this experiment the herd management at the two sites was very similar and statistical analysis has been applied. The results show that the average udder cleanliness was better for the mat cows. The scoring was carried out by the same person at all times, the sawdust bedding was applied in the same quantities and cubicles were cleaned in the same way for both mattress and mat cows at each site.

Total dirtiness, whole body dirtiness, may be affected by diet. That is, perhaps a low D.M. diet leads to dirtier cows. Other possible factors of influence are the efficiency of the automatic scrapers, the weather if the animals have to wait outside, and the provision of brushes and mutual grooming.

Environmental mastitis is recognised as being a key concern to farmers and milk buyers and research indicates that udder health is threatened by the teat orifice remaining open for many hours after milking (Schultze *et al* 1983). Hence udder cleanliness is a major area of concern for the dairy industry. Rodenburg *et al* (1994) compared cleanliness scores in 6 herds on mattresses and 12 herds on mats and generally found that mattress cows are cleaner than mat cows although they did not analyse their data statistically and it was recognised by the authors that there were different management practices such as stall cleaning and bedding-up frequency.

5.6 Hygiene

Coliforms were able to multiply in the sawdust as it became soiled. During the trial there were days when the sawdust was wet and days when it was comparatively dry. This had no effect on the coliform count as the counts did not vary sufficiently over the study period.

Temperature and humidity did not seem to have an effect on bacterial numbers in the bedding. Thus the climate made no difference in the conditions studied.

Coliforms have an optimal temperature for growth, around 37°C (Singleton, 1997). The temperatures in the cubicle house were therefore sub-optimal for coliforms and perhaps severely inhibited the growth to a baseline level.

There was no significant difference between the coliform counts in sawdust from the mats and mattresses.

The level of coliforms was identical in sawdust bedding from each cubicle type. The level of challenge to the teats by these environmental organisms and the likely prevalence of environmental mastitis was the same in both groups.

5.7 Milk Records

The milk records showed that there was no difference between the yields of the cows on mattresses and mats at either site. Taking this result on its own would favour mats because they cost less than mattresses but it could be argued that, in the long term, an increase in total milk production could arise as a consequence of longer life due to better comfort levels that have been shown in the mattress cows in this one-winter study. Further work in this area of concern is essential if a reliable conclusion is to be made regarding comfort levels and milk production.

6.0 Summary of Results

This trial set out to identify any differences in the physical reaction of dairy cows when housed on mattresses or mats. The following conclusions have been made:

* mattress cows spent more time lying down and less time standing doing nothing;
* mattress cows generally had fewer hock and knee injuries at both Auchincruive and Myerscough. However, at Myerscough the mat cows had equally healthy looking knees, and in terms of the worst type of hock and knee injury there were no differences between the groups;
* examination of total body dirtiness results showed no significant difference between mattress and mat cows but mat cows had cleaner udders;
* mattress cows ate more than mat cows at both sites in the trial but weight changes and body condition scores were not significantly different between mattress and mat groups;
* milk yield and milk composition results (butterfat and protein percentage levels and somatic cell count) showed that there was no difference in cow performance whether on mattresses or mats;
* there were no differences in cow locomotion or clinical lameness results;
* coliform levels in the sawdust bedding were not significantly different for either mattresses or mats.

7.0 Practical Recommendations

Research has shown that the cubicle housing environment offered to dairy cows in winter can be enhanced by the addition of a synthetic bed. This trial found that there was a good response from the cows involved to both of the products evaluated.

The researchers set out to establish, in a one-winter trial period, if the rubber-crumb mattress cubicle bed was worth the extra cost to a farmer in terms of better health and welfare for a dairy herd and higher production levels. In terms of a direct comparison of the mattress and the mat in the areas of lying behaviour, hock and knee injuries the mattress was the better product. In the matter of cow cleanliness the mat was better for the udder. There was no clear difference in terms of feed eaten, milk production, locomotion, clinical lameness or sawdust bedding bacteria levels.

Therefore, if the purchasing decision was based on health and welfare the results of this trial point to a Pasture Mat (Mattress) purchase. If, however, the decision to buy was based on milk yield and composition then the Maxibed (Mat) would be chosen because of its lower cost.

Simplifying the purchasing decision to a matter of price paid per bed, the higher the price differential between mattresses and mats, the less attractive the mattress purchase becomes. Conversely, the lower the price differential, the more attractive the mattress becomes.

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10.0 Appendix

Questionnaire response from Dairy Farmers in Britain and Ireland

In 1997 and 1998 eighty dairy farmers in Britain and Ireland were asked, via a written questionnaire, for their opinions on the mat or mattress cubicle bed they had installed in their cow housing area. They were asked about management matters and perceived bed and cow performance. Fifty-five responded and their thoughts are summarised below.

The most common reason given for the purchase of cubicle beds was to improve cow comfort and welfare and farmers clearly recognise that their animals can be harmed by a poor built environment. The farmers were mainly looking for cleaner cows, longer lying bouts and better leg joint conditions but some also expressed a desire to have lower somatic cell counts and to have lower sawdust bedding costs. The cubicle bed performance was generally reported to be very good for both mats and mattresses in terms of the durability of the surface material. Only two farmers with mats commented that their fixings were a concern to them and two farmers with mattresses stated that there was some discoloration of the topcover, all others surveyed were happy with the physical condition of their beds. Cow performance was the major consideration for respondents and they were asked to give an impression of cow cleanliness, lying behaviour and hock joint condition after being housed on mats or mattresses. Again, a high proportion of farmers were happy with the reaction of their cows with improvements being perceived in all three of these key welfare areas. The cows were cleaner, thought to be lying longer and had less swollen hocks after the installation of the beds.

Many of the farmers had only recently installed the cubicle beds and so it was not possible to get long-term feedback on performance.

Finally, the farmers were asked if they thought that the cubicle beds were "value for money". Again the responses were very positive with 69% of farmers with mats and 68% of farmers with mattresses saying 'yes'. .

A summary of questionnaire results is given below:

	Mats	Mattresses
Are cows cleaner after installing the cubicle beds?	Yes 54%	Yes 64%
Are cows lying longer after installing the cubicle beds?	Yes 85%	Yes 86%
Are hock joints improved after installing the cubicle beds?	Yes 46%	Yes 77%
Are beds value for money after installing the cubicle beds?	Yes 69% No 8% Don't Know Yet 23%	Yes 68% No 5% Don't Know Yet 27%