End of Project Report-3981

Efficacy of Currently Recommended Control Measures for Lameness in Dairy Cows

Authors

Nola Leonard, MVB, Ph.D., MRCVS
Jim Crilly, MVB, DipAH, MPVM, MRCVS
Kevin O'Farrell, MVB, Ph.D., MRCVS

The authors are most grateful for the technical support provided by Michael Nolan and Jim Nash and for the cooperation of the Farm Relief Services, Mr. Denis Healy, MRCVS and all participating farmers. Many others provided invaluable assistance including N. Byrne, T. Condon, J. O'Connell, I. Stienezen and M. Walraven.

Teagasc acknowledges the support of Dairy Levy Farmer Funds and European Union Structural Funds (EAGGF) in the financing of this research project.

Teagasc,
Dairy Husbandry Department,
Moorepark Research Centre,
Fermoy, Co. Cork

December 1998

CONTENTS

SUMMARY

Lameness is a multifactorial condition, the principal factors influencing its development being genetics, nutrition, environment and management. The objectives of the studies reported here were:

(i) To determine the incidence of lameness on selected Irish commercial dairy farms,

ii) To identify and to quantify risk factors associated with lameness on Irish dairy farms and

(iii) To evaluate the efficacy of recommended control measures for lameness with the aid of information obtained through (i) and (ii).

- The average number of animals which became lame per six month period (Jan-Jun or July-December) on 14 commercial dairy farms was between 12 and 16 per 100 cows. On individual farms the figure could be as high as 31 per 100 during any six month period.

- White line disease was the most common cause of lameness with sole ulceration being the second most common.

- Poor maintenance of roads with little use of top dressing and the presence of concrete roadways on farms were both associated with a detrimental effect on lameness incidence. Thus, prevention of lameness at pasture entails maintaining roads in good condition and, if concrete roads are used for cows, care must be taken to ensure that the junction between the concrete and the dirt road is maintained in good condition and that the concrete is maintained free of grit.

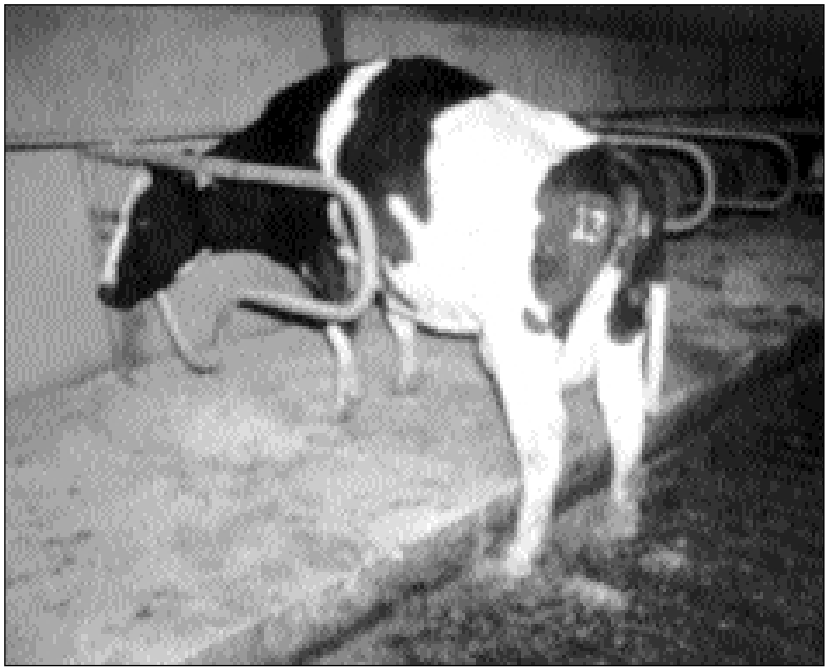
- Cubicles on most farms have not been upgraded sufficiently to provide adequate cow comfort. Many are too small for the size of cows housed and bedding is frequently insufficient. Uncomfortable housing conditions resulted in less lying behaviour and more standing half-in cubicles.

- Restricted feed space was associated with more lameness. Experimental studies suggested that this effect was likely to be mediated through increased aggression between animals.

- Higher levels of concentrate feeding correlated with more lameness. Increasing fibre in the diet in the form of sugar beet pulp appeared to protect against lameness. There was some evidence that feeding maize silage may increase lameness incidence but this effect requires further study.

• Cows housed in all space-sharing cubicle designs tested showed good lying times. The finding that cows will reduce use of cubicles in order to stand on a soft matted area suggests that even space-sharing cubicles may not always provide sufficiently comfortable conditions for cows. It also reinforces the findings of work at Moorepark and elsewhere that cows do not like standing on concrete in addition to the fact that it can be detrimental to claw health.

All of the above findings suggest that lameness incidence could be reduced by maintaining roads in good condition, avoiding the use of concrete if possible, providing comfortable housing conditions and avoiding all design features which reduce cubicle occupancy and which increase aggression between cows.



Incorrect cubicle dimensions can lead to cows spending long periods standing half in cubicles. This may be associated with lameness.

Introduction

During the three years from 1991 to 1994, a series of experiments were carried out at Moorepark Research Centre investigating the role of housing and behaviour in lameness development. These studies were undertaken because there was little information available on this aspect of lameness in comparison to the numerous studies on the influence of nutritional factors on foot health. Following these experimental studies, a detailed epidemiological study on commercial farms was begun at the end of 1994. The emphasis in this study was again on environmental rather than nutritional factors and some of the methodology used during the earlier experimental studies was applied to the on-farm investigations.

Epidemiological studies have been carried out in a number of countries but it was considered that the major differences that exist between Irish dairy production systems and those used elsewhere justified doing such a study in the Moorepark area. In addition, investigations into environmental factors affecting lameness development were more detailed and extensive than in previously reported observational studies. During the course of the on-farm study, questions arose which could not be adequately addressed through an epidemiological study alone. Therefore, some complimentary experimental studies were completed in Moorepark.

Lameness is a multifactorial condition, the principal factors influencing its development being genetics, nutrition, environment and management. It is difficult to determine the relative importance of these factors as each one can affect the expression of the other depending on the situation on a particular farm. Control of lameness is therefore considerably more difficult than control of other disease conditions caused by a single agent such as one bacterium or virus.

The objectives of the studies reported here were: (i) to determine the incidence of lameness on selected Irish commercial dairy farms, (ii) to identify and to quantify risk factors associated with lameness on Irish dairy farms, and (iii) to evaluate the efficacy of recommended control measures for lameness with the aid of information obtained through (i) and (ii). The report is divided into sections, each dealing with one aspect of the results of the study and one in which the conclusions are drawn.

LAMENESS INCIDENCE AND CONDITIONS CAUSING LAMENESS

Fourteen commercial farms in the north Cork area were chosen for this study with the aid of the Farm Relief Services and local veterinary surgeons. The principal criteria for inclusion were farmer willingness to cooperate and use of the Farm Relief Services for hoof care. It was not possible to conduct a random survey as farmer cooperation was essential in order to record lameness events and also to allow for the frequent visits and studies on the farms. The study was carried out over two years on 14 farms. Herd size ranged from 53 - 200 cows (average 92). Most herds were spring calving although three herds had a proportion of autumn calving animals (25%, 40% and 50% respectively).

Lameness was recorded at the time of herd foot trimming in December / January and the farmer recorded all cases of lameness which developed during the rest of the year. Lameness was recorded half-yearly because lameness in the first half of the year is influenced by factors relating to calving, housing and pasture conditions. Lameness in the second half of the year is influenced mainly by conditions at pasture. Insults sustained by the claw injure the quick immediately but effects may not be seen at the sole surface until 2-3 months later as it takes this length of time for horn to grow from the quick to the sole surface. Thus, effect of housing in November may not manifest as claw health problems until January or February.

Table 1 records the mean incidence and type of cases causing lameness during 1995 and 1996. Sole ulceration and white line disease were the conditions most frequently diagnosed as the cause of lameness. The category 'other' included conditions of the interdigital skin such as foul and digital dermatitis (Mortellaro). Conditions affecting the limb as distinct from the claw, were also included under 'other' but the number of cases was small. The final column in the table records the total 'animal incidence' which is the percentage of animals affected by lameness in the relevant 6-month period. This is lower than the case incidence as some animals could be affected by two different conditions in the same period or could be affected by the same condition more than once.

Table 1: The mean case and animal incidence of lameness on 14 commercial dairy farms for the first and second 6-month periods of 1995 and 1996.

	Case Incidence					Animal Incidence
	Sole Ulcer	White line disease	Laminitis	Other	Total (min-max)	Total (min-max)
Jan-Jun 1995	4.7	6.3	0.8	5.3	17.1 (3.5-23.5)	16.0 (3.5-22.0)
Jul-Dec 1995	4.0	8.6	0.6	3.5	16.7 (5.5-33.5)	15.0 (5.5-31.0)
Jan-Jun 1996	5.4	3.8	1.2	2.7	13.1 (3.5-33.5)	12.0 (3.5-28.5)
Jul-Dec 1996	3.4	6.5	0.7	2.4	13.0 (3.0-20.0)	12.0 (3.0-17.5)

As can be seen from Table 1, white line disease was the most significant cause of lameness in all half-yearly periods except the first half of 1996. This is different from other UK and European studies where sole ulceration is usually recorded as the top cause of lameness in dairy cows. The difference is probably due to the seasonal calving pattern in Irish herds.

Autumn and year-round calving is more common in other countries and sole ulceration is a particular problem when animals are housed, calve and receive a change in rations within a short space of time. Spring calving animals have time to adapt to changed housing and feeding conditions before they calve down. The grazing season in Munster is also considerably longer than in many European countries. White line disease is a common cause of lameness in animals at pasture as has been reported in countries such as New Zealand.

Foul-of-the-foot occurred in outbreaks on one or two farms each year and increased the numbers in the category 'other'. The outbreaks frequently occurred shortly after turnout to pasture and appeared to be associated with rough roadways or gateways. Although digital dermatitis was a problem on two of the farms, its occurrence in the other herds was sporadic.

ROAD SURFACES ON FARMS AND LAMENESS DEVELOPMENT

Road surface characteristics were assessed twice as part of this study, once during a period of dry weather and once during a period of wet weather. On each farm, a 100 mm by 100 mm metal square was thrown at random (over the shoulder) at intervals of 5 m along all farm roadways. Eight variables were recorded within the square, four of which reflected road composition [concrete, stones, fines, grass (as an indicator of upkeep of roads)] and four of which classified the roads according to character (depth of penetration of a probe, unevenness, drainage and sharpness). Assessments on all roads were carried out by the same person.

For each road, the variables were weighted for the length of the road and its estimated usage by the herd. The mean values for all the roads on each farm were taken to represent the road profile of that farm. Factor analysis is a data reduction technique which was used to condense the original 8 variables into three factors. The 14 study farms were then assigned scores, ranging from -2 to 2, for each of the three factors based on a linear weighted combination of the variables associated with that factor. Factor scores were used as determinants in a series of analysis of variance models with various measures of lameness as the dependent variables.

When the relationships between road surface materials were examined within farms, a negative association was detected between the use of concrete and the amount of fine material in roads ($P<0.05$). The prevalence of grass tended to be greater on farms with a high level of stones ($P=0.051$). When the four characteristics of roads were analyzed, there was a high degree of correlation between sharpness and the prevalence of stones ($P<0.001$). Drainage was related to sharpness ($P<0.01$), the prevalence of stones ($P<0.05$) and the amount of fines ($P=0.01$). There was also a significant relationship between depth and unevenness ($P<0.05$).

Factor analysis identified three factors which together accounted for 82% of the variance of the data. Factor 1 represented farms with roads containing a high level of stones and fine material and which tended to be sharp and well drained, farms represented by Factor 2 had the highest levels of concrete, the lowest of fines and significant levels of grass. The main attributes which loaded into Factor 3 were depth and unevenness and thus this factor represented farms with muddy tracks.

Factor 2 showed a significant correlation with a number of indices of lameness including overall animal incidence (P=0.037, r^2=0.26). The association was strongest for lameness incidence in the period January to June (P = 0.016, r^2=0.35), where it was present in both years of the study (Figure 1). Results from 10 herds which kept detailed lesion records indicated that white line disease was the main lesion affected by roadway conditions. There was a significant relationship between the incidence of white line disease and Factor 2 scores (P<0.05), particularly in the first half of the year (P=0.013, r^2=0.5) (Figure 2).

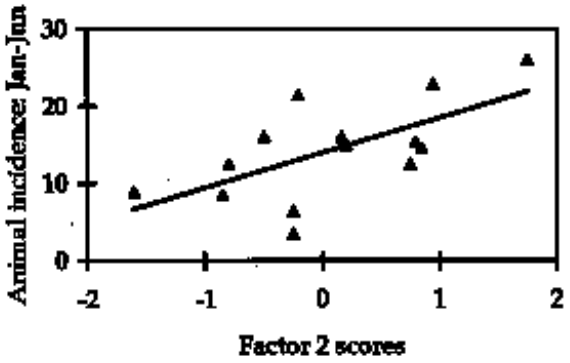


Figure 1: The relationship between Factor 2 road scores and the average incidence of lameness on 14 farms between January and June in 1995 and 1996.

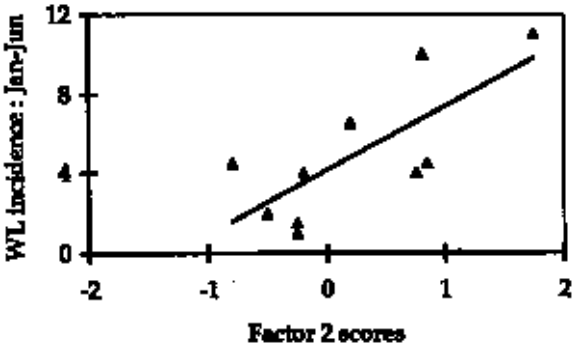


Figure 2: The relationship between Factor 2 road scores and the average incidence of white line disease on 10 farms between January and June in 1995 and 1996.

The method used for characterization of road surfaces principally reflected the materials of which the roads were made and the state of maintenance of the roadways. Other studies in New Zealand and Australia have used similar criteria for classification of roads. Although many of the variables were assessed in a subjective manner, statistical analysis revealed logical correlations between the variables, such as the significant correlation between sharpness and the prevalence of stones or the association between depth of penetration and unevenness. This suggests that the variables chosen were useful in the characterization of the roads and that they were consistently assessed.

The three factors identified by factor analysis represented farms with widely different roadways. Factor 1 roads had the highest level of fine material and of stones, had no grass, were even and well drained. Thus, although these roadways tended to be sharp, they were also well-maintained and thus there was no association between Factor 1 scores and lameness. In contrast, farms scoring highly for Factor 2 could be said to have poorly maintained roads and this was the only factor for which an association with lameness was detected.

State of track maintenance was found to be one of the most important variables in determining lameness level in a New Zealand study. The association detected between Factor 2 scores and lameness incidence was statistically strong and present in both years but the small size of the study population means that further studies are required to confirm the relationship observed. Both the absence of fines and the presence of concrete loaded highly into Factor 2, but regression analysis using the original variables indicated that the proportion of concrete roadways on the farm was the more significant determinant of lameness. However, as 9 herds had little or no concrete, the correlation between lameness incidence and concrete is biased by the results from those few herds using concrete. It is possible that farms making a high capital investment in concrete roadways tend to do less top dressing and therefore have a lower proportion of fines.

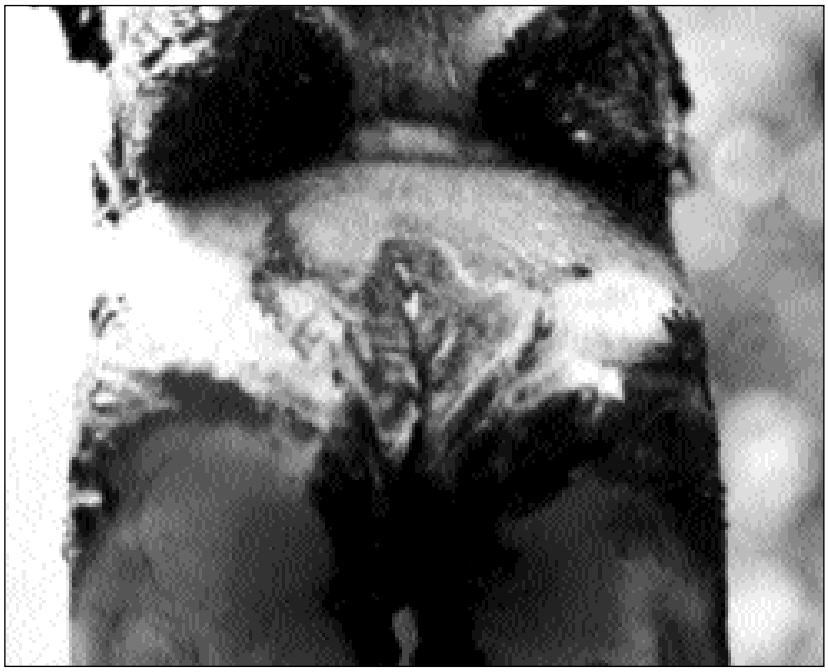
Factor 3 could also be said to represent farms with poorly maintained roads but, unlike Factor 2 farms, the roadways were soft (uneven and high depth of penetration) and contained no concrete.

The method described was useful in characterizing road surfaces in relation to lameness development. Results suggest that a larger study should be carried out to confirm the importance of top dressing with fine material. Clarification is also needed as to whether walking /

standing on concrete is detrimental to claw health. Concrete roadways, if present on farms, were always those roads nearest the milking parlour and cows therefore used these roads continuously during the grazing season.

On some farms cows were held on these roads for variable lengths of time before or after milking. It is possible that standing and walking on such hard surfaces adversely affected claw health as detrimental effects of standing on concrete have been shown for housed cows in previous Moorepark studies.

Another factor which may account in part for the increased lameness seen on farms using concrete roadways is that roadway conditions at the junction of the concrete and farm tracks were invariably extremely poor. It is likely that small pieces of grit were regularly carried onto the concrete on cows' hooves and these could then penetrate defects in the horn when trapped between the sole surface and unyielding concrete.



Martellaro is becoming increasingly common and may cause severe lameness.

ASSESSMENT OF HOUSING CONDITIONS ON FARMS

Data from large studies conducted in the UK and Europe indicated an association between different housing conditions and lameness incidence. Factors such as higher kerbs, poor bedding and slippery floors were associated with more lameness. However, there have been few studies in which cow behaviour has been recorded on a number of farms and related to housing conditions. The objectives of this part of the study were to record cow behaviour on farms over a number of hours and to correlate it with housing conditions and lameness measures.

Housing conditions such as cubicle design and dimensions were recorded by direct measurement and assessment. Behavioural data including lying, standing fully or half-in cubicles and rising and lying down behaviour was recorded for two three hour periods on two consecutive nights on each farm. The percentage of time spent performing each behaviour was calculated for the total number of cows, taking into account the cow to cubicle ratio.

Only one farm had all space-sharing cubicles, 8 of the 14 farms had combinations of cubicle types and 5 farms had all Newton-Rigg or crossrail cubicles. Cow diagonal body length was measured on all farms and compared with cubicle length. Cubicles were too short on all except one farm and indications were that cubicles fitted against a wall should have been 2.3 m long on most farms.

Adequate bedding (mats or generous amounts of sawdust) was provided on only half of the farms. Housing conditions were overcrowded on 4 farms (>1.2 cows for every one cubicle) and cows had inadequate feed space on 5 farms (< 0.4 m per head). Three farms provided 0.6 m of feed space per head which allows all animals to feed together and is considered optimal for cow welfare. Table 2 gives the median and minimum-maximum values for various behaviours recorded during the three hour observations on farms.

Table 2: The percentage of 3 hours (median and min-max values) spent performing various behaviours by cows on 14 commercial dairy farms

Behaviour in cubicles	Median	Minimum	Maximum
Lying	31	16	38
Standing	10	4	17
Half-in	13	7	26
Ruminating lying	16	9	21
All ruminating	30	22	42
No. cubicles visited	17	14	23

Because of the small number of farms in the study, the effect of cubicle comfort on cow behaviour was not as readily detectable as in experimental studies. However, when herds were classified according to good and poor cubicle comfort, a relationship with cow behaviour could be detected. Herds where cubicle comfort was good (at least two of the three parameters cubicle size, design and bedding satisfactory; only one farm was satisfactory on all three counts) tended to show longer lying times (P=0.1), less half-in behaviour (P=0.09) and more ruminating while lying down (P=0.09) than those with poor cubicle comfort. Standing half-in cubicles indicates that cubicles are too short or possibly too narrow. High levels of ruminating lying down are thought to indicate good cubicle comfort as cows at pasture exhibit similar behaviour.

When the relationship between lameness and behaviour was examined, an association was detected between better claw health and increased standing fully in cubicles ($P<0.05$). Both major causes of lameness, sole ulceration and white line disease had lower incidences on farms where cows stood more in cubicles. This association has also been observed in recent Scottish studies. The mechanism behind this finding is not fully understood but it is possible that where cubicles are of sufficient length to allow comfortable standing, cows stand less in the passages and thus exposure of the hooves to slurry is limited. Other Scottish studies have confirmed the detrimental effect of slurry on horn structure and hooves that are maintained in drier, cleaner environments are likely to be less susceptible to injury, bruising or development of cracks in the white line.

It was more difficult to detect relationships between cow behaviour, cubicle design and lameness in this study than in experimental studies in which uniform groups of first calving animals are used. However, some indices of lameness tended to decrease as cubicle length increased although the relationship did not reach significance at the 5% level. This finding is consistent with those of previous experiments in which there was more lameness in animals housed in short, narrow cubicles.

Increased levels of lameness were detected in herds where feeding space was restricted ($r_s = -0.53$, $P = 0.075$). This relationship was investigated further in an experimental study and results are presented in another section of this report.

Nutritional factors and lameness development

Information on feeding practices was collected by means of a questionnaire. As stated previously, assessment of nutritional effects on lameness was not one of the primary objectives of this study as many other workers have examined the effect of nutrition on lameness. In addition, detailed feeding records were not available on most farms. However, the results of the small amount of analysis that was possible tended to support the findings of other studies.

There was a positive relationship between the amount of concentrates fed and the number of animals that became lame on a farm ($P=0.05$). When the particular conditions which cause lameness were analysed in relation to nutrition, it appeared that white line disease was more strongly related to nutritional factors than other conditions ($P<0.09$) but this may simply reflect the fact that white line disease was the most frequent cause of lameness on most farms. Fewer cases of lameness were associated with the feeding of sugar beet pulp ($P<0.05$) whereas feeding of maize silage tended to be associated with increased levels of some lameness indices.

Experimental studies

1. Overcrowding at the feeding area and effects on behaviour and claw health in Friesian heifers

The objective of this experiment was to further investigate the association observed in the commercial farm study between increased lameness and farms with reduced feeding space per cow. It was hypothesized that reducing feed space per cow could affect claw health either through increasing aggression between animals or by increasing standing time as animals waited their turn to feed. Therefore, the experiment reported here was undertaken to determine the effect of restricting feeding space on aggression and queuing behaviour at the feed-face and any subsequent effects on claw health.

Forty spring-calving Friesian heifers were housed with one cubicle each from November to March and allocated to two groups according to body weight and expected calving date. One group of 20 animals was allocated 0.55 m of feed space per head (controls) while the treatment group was allowed 0.30 m of feed space per

head. Feeding and queuing behaviour at the feeding area as well as all aggressive encounters were recorded by continuous observation for 1 hour after feeding on at least one occasion per week, for each group throughout the housing season. Any feed remaining from the previous day was pushed up to the feeding barrier at 9 a.m. each morning. Behaviour in each group was recorded at this time on 5 occasions. Lying / standing behaviour was recorded every 15 minutes for one 24 hour period each month from December to March. Both hind feet and one front foot of each animal were examined for lesions at housing, 1 month after housing, at calving and monthly after calving for at least 2 months.

No differences between groups in lying/standing or feeding behaviour were detected during the day in any month of the housing season. At night, control animals tended to spend more time lying ($P=0.07$), less time feeding ($P<0.05$) and visited less cubicles per cow ($P<0.01$) than animals in the treatment group (Table 3).

More animals were observed at the feed-face in the control group ($P<0.01$) during the one hour observation after feeding because there was space for more animals to feed at the same time than in the treatment group. However, no differences were observed in the numbers of animals queuing for feed in the two groups.

Table 3: Behaviour at night [mean time in hours (standard error of the mean)] of animals housed with 0.55 m or 0.30 m of feed space per head

Behaviour	0.55 m per head	0.30 m per head	Significance (Mann-Whitney test)
Lying	6.68 (0.255)	6.07 (0.260)	P = 0.07
Feeding	1.88 (0.096)	2.25 (0.119)	P = 0.02
No. cubicles visited	6.89 (0.289)	8.60 (0.437)	P = 0.0025

Aggressive encounters were classified as either 'pushes', where the encounter did not result in an animal giving up its position to another, or 'displacements' in which one animal took the place of another. Significantly more pushes and displacements per hour were recorded in the treatment group at the 9 a.m. observation ($P<0.05$). More than 2,400 interactions were recorded throughout the study and the 5 cows at the top and bottom of the dominance hierarchies in each group were identified from this data and their claw health was compared.

No differences in claw health were detected between groups or between dominant and subordinate animals. It was observed during the course of the study that many individuals did not involve themselves in aggressive encounters except on a few occasions and this type of behaviour in groups of cattle has also been observed by other authors. Thus, irrespective of treatment group, claw health was compared for the animals involved in the most aggressive encounters (H) with the animals involved in the least aggressive encounters each month (L). There was a strong tendency for the median claw lesion score of H animals to be greater than the lesion score of L animals (Table 4). Differences in claw health were only observed three months after the behaviour was recorded because lesions appear at the sole surface 2-3 months after they are sustained at the quick.

Table 4 : A comparison of claw health in animals which showed many or few interactions at the feed-face three months previously (median and min-max. haemorrhage scores).

Behaviour	No. of animals	Haemorrhage score 3 months later		Significance* (Mann-Whitney test)
		Median	Min-Max	
Dec-high interactions	12	12.5	4 - 30	
-low interactions	9	7.0	4 - 37	P = 0.1
Jan-high interactions	9	16.0	7 - 46	
-low interactions	12	8.5	4 - 18	P = 0.02
Feb-high interactions	11	14	7 - 49	
-low interactions	11	9.0	4 - 16	P = 0.07

*Significance between 'high' and 'low' within months

In the present study, restriction of the feeding area to 0.30 m per head did not appear to cause sufficient behavioural changes to have detectable effects on claw health, although there was some reduction in lying time and aggression tended to be increased. Irrespective of treatment, animals involved in high numbers of interactions had poorer claw health. The effect of increased aggression was more marked when the interactions took place in January and February. It is likely that this is due to the fact that calving occurred in these months and damage to claw horn owing to calving effects was exacerbated by increased aggression. The association detected between increased interactions and poorer claw health implies that any management practice which results in more aggression within groups is likely to increase problems of claw health.

2. Provision of a soft surface at the feeding area on behaviour and claw health in Friesian heifers

During the two years of the on-farm epidemiological study, the provision of rubber matting on slats began to receive increasing attention in the farming press. Contacts with researchers on lameness in Sweden also revealed that some farmers there were installing matting in their feeding stalls to provide additional cow comfort and to prevent lameness. As studies at Moorepark and elsewhere had shown a relationship between prolonged standing on concrete and lameness development, it appeared logical that the provision of a soft 'relief' area for standing might help prevent lameness. However, there was no published work on the provision of rubber-matted standing areas and effects on behaviour and lameness.

The objectives of this study were to record the behaviour of first lactation animals which were provided with soft rubber matting at the feed-face and to assess effects on claw health.

Nine autumn-calving first lactation cows and nine spring-calving in-calf heifers were housed from December to March in 20 rubber-matted cubicles (7' x3'9") with a slatted passageway and feeding area. A similar group of 10 autumn- and 9 spring-calving animals were housed in an adjacent section of the same cubicle house. A 6-foot wide strip of soft rubber matting was provided at the feeding area for this group and some slightly harder matting was fitted to the slats immediately behind this strip. Only the hard matting was itself slatted. The soft matting was cleaned manually once daily. The slatted passage between the cubicles remained unmatted.

Claw health of all four feet was recorded monthly from the beginning of the study until two months after the animals were turned out to grass. Lying/ standing behaviour was recorded every 15 minutes for one 48-hour period for each of the four months of the study. The position of each animal within the shed was also recorded at each observation period. Differences in behaviour were observed between treatments and these are recorded in Table 5.

Table 5: Comparison of behaviour (median and min-max. hours per 24 hours) of two groups of first lactation animals, one group housed with mats at the feeding area and one without.

Behaviour	Matted feeding area		Unmatted feeding area		Sig.
	Median	Min-max	Median	Min-max	
Lying	9.4	3.8- 15.4	9.9	5.8-13.8	0.18
Standing fully in cubicle	0.4	0.0- 6.6	1.1	0.0-8.0	<0.01
Standing half-in cubicle	1.6	0.0- 8.0	1.1	0.0-4.5	<0.05
Total standing on matted /equivalent unmatted area	6.2	2.1- 10.6	5.4	2.4-7.5	<0.01
Cubicle utilisation	12.2	0.0*-16.9	13.0	0.4-16.1	0.11
Feeding	4.2	1.9- 6.5	4.1	1.9-6.5	0.87

* One animal never used the cubicles

The major finding of this experiment was that the animals with access to a matted standing area selected to stand on this area, partly in preference to using the cubicles. As can be seen from Table 5, cubicle utilisation was lower in the group with mats at the feed face and there was also a trend for lying times to be lower in this group. There were also significant differences between groups in time spent standing fully or half-in cubicles. The group with the matted feeding area spent less time standing fully in cubicles and more time standing half-in cubicles than the group with unmatted feed-face. This difference is probably mainly attributable to the fact that half of the cubicles in the group with matted feed-face were sited against a wall. The difference this would make to 'half-in' behaviour in particular was only realised after detailed analysis of other ongoing studies at Moorepark was completed. It is unfortunate that this confounding factor was allowed in the study design as it makes interpretation of results more difficult.

Differences in claw health were not detected in the autumn-calving animals, possibly because many of them were already calved 3-4 months when they entered the trial. Peak lesion scores were reached at or shortly after the beginning of the trial and thus detection of effect of treatment was more difficult. In contrast, the spring calving cows were allocated to treatment before calving and it was expected that effects of provision of matting at the feeding area would be more readily detectable in these animals. Numbers of animals per treatment were small but animals with matted feed

face showed worse haemorrhage scores at three (P=0.08) and four (P=0.01) months post calving. Effects were most significant in front feet, P=0.04 and P=0.02 at three and four months post calving respectively.

These results were disappointing but must be interpreted with caution due to the small numbers of animals involved. A possible explanation may be that substitution of lying by standing is detrimental to claw health, whether or not a soft surface is provided. The effect may have been more marked in front feet because these bear more weight than the hind legs.

It is not possible to draw definite conclusions from this trial but the results show that cattle will select to stand on a soft surface and will apparently select to stand in preference to using cubicles for at least part of the time. This raises doubts as to the comfort of the cubicles, as does the relatively high 'half-in' standing behaviour. Consideration may have to be given to providing far more spacious cubicles for cows, perhaps up to 7' 6" or even 8 feet long in some cases when housing large Holstein cows, as suggested by some UK workers. Results on claw health were unexpected and repetition of this trial with larger numbers of animals and with more comfortable cubicles is necessary before any conclusions can be drawn.

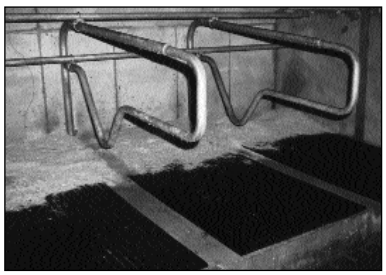
Haemorrhage of the sole and white line predisposes to sole ulcer and white line disease

3. Evaluation of cow behaviour in some recent cubicle designs

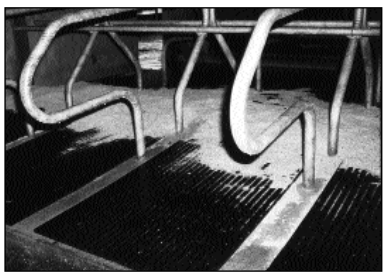
Previous work in Moorepark showed that cows did not exhibit preferences between different space-sharing cubicle types. As several new designs have come on the market since this work was conducted, evaluation of cow behaviour was carried out with three cubicle types which were installed at Curtins farm during renovations in 1995. Recent consumer concerns in relation to animal welfare and the relationship shown between increased standing behaviour and lameness development mean that cow preference studies on cubicle design are still necessary to provide farmers with useful practical guidelines on housing.

There are 120 cubicles in Curtins farm, 40 each of the Cantilever, Mushroom and Spinder designs (Figure 3). Cubicles are arranged to facilitate comparison of cow behaviour in the different designs and two groups of 20 cows were used to evaluate cow preferences during three 4-night observation periods. Cow behaviour was recorded every 15 minutes from 1700 h to 0700 h each night.

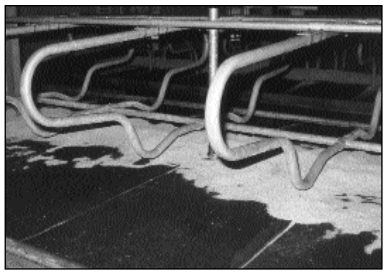
Figure 3 : Sharing cubicle designs a) Cantilever b) Mushroom and c) Spinder, evaluated on Curtins farm



a) Cantilever



b) Mushroom



c) Spinder

Pooled behaviour over the 12 observation periods for all cubicle types is presented in Table 6. Generally no major differences were detected between cubicle types over the 12 nights and good lying times of approximately 9 hours per 14 hours were achieved in all cubicle types. There was a higher incidence of standing fully in the cantilever cubicles and the mushroom cubicles appeared to have the lowest incidence of standing half-in cubicles.

Table 6 : Comparison of behaviour over 12 nights between Cantilever, Mushroom and Spinder cubicles (median lying times in hours).

Behaviour	Spinder	Mushroom	Cantilever
Lying	8.75	9.25	8.75
Standing fully in cubicle	0.5[a]	0.75[a]	1.00[b]
Standing half-in cubicle	1.25[a]	0.50[b]	1.00[a]

[a] Values within rows with different superscripts are significantly different.

The effect of the provision of mats versus no mats was evaluated during one 4-night observation period. Cows will always choose a bedded cubicle if choice is provided but in this case no choice was provided and no differences in lying time were detected between the two groups, matted and unmatted. Cows changed position more on the matted cubicles ($P<0.01$) as the cushioning effect of mats on the knees when getting up and lying down encourages rising/lying down behaviour.

The lack of effect of bedding on lying time must be interpreted with caution. Other studies at Moorepark showed increases in lying time from 7 to 9 hours per night when mats were provided in old-fashioned Newton Rigg cubicle types (no choice experiment). This suggests that it may be only in space-sharing cubicle types that lack of bedding has minimal effects on lying time.

The above results indicate that satisfactory lying times can probably be achieved with all space-sharing cubicle types. The provision of good bedding in the form of mats may not influence lying behaviour if cubicle design is good but mats influence other behaviours such as rising and lying down and thus always improve cow comfort and welfare.

CONCLUSIONS AND RECOMMENDATIONS

1 • The average number of animals which became lame in the first or second half of the year was between 12 and 16 per 100 cows but on individual farms the figure could be as high as 31 per 100.

2 • White line disease was the most common cause of lameness with sole ulceration being the second most common.

3 • Poor maintenance of roads with little use of top dressing and the presence of concrete roadways on farms were both associated with increased lameness incidence.

4 • Cubicles on most farms have not been upgraded sufficiently to provide adequate cow comfort. Many are too small for the size of cows housed and bedding is frequently insufficient.

5 • Uncomfortable housing conditions resulted in less lying behaviour and more standing half-in cubicles. Longer cubicles were associated with a decrease in some types of lameness. Results also suggested that cubicle dimensions which allow cows to stand fully in cubicles will help improve claw health.

6 • Restricted feed space was associated with more lameness. Experimental studies suggested that this effect was likely to be mediated through increased aggression between animals.

7 • Higher levels of concentrate feeding correlated with more lameness. Increasing fibre in the diet in the form of sugar beet pulp appeared to protect against lameness. There was some evidence that feeding maize silage may increase lameness incidence but this effect requires further study. It may be that farmers feeding increased concentrate levels also tended to feed maize silage.

8 • Cows housed in all space-sharing cubicle designs tested showed good lying times. The finding that cows will sacrifice lying time to stand on a soft matted area suggests that even space-sharing cubicles may not always provide adequately comfortable conditions for cows.

The findings of this study suggest that the following measures are useful in the control of lameness

1 • Road surfaces should be well maintained with adequate use of fine material for top dressing.

2 • If concrete roads are used for cows, care must be taken to ensure that the junction between the concrete and the dirt road is maintained in good condition: run-off from the concrete should be diverted away from the road, a lip at the end of the concrete section may be useful. Regular brushing / cleaning of the concrete may be required and holding cows for long periods on concrete before and after milking should be avoided.

3 • Good housing conditions with space - sharing cubicles of adequate size should be provided to ensure good lying times and ease of rising behaviour.

4 • Any conditions which increase aggression are likely to increase lameness. Thus, inadequate feed space, many blind alleys, excessively narrow passages and other features which lead to confrontation should be avoided.

5 • High levels of concentrate feeding with inadequate roughage should be avoided. Findings from studies in other countries suggest that concentrate to roughage ratio should not exceed 50:50 and that if cows are receiving high levels of concentrates, they should be divided between 4 feeds daily.

PUBLICATIONS

Leonard, F.C., O'Connell, J. and O'Farrell, K. J. (1994). Effect of different housing conditions on behaviour and foot lesions in Friesian heifers. Veterinary Record, 134, 490-494.

Leonard, F.C., O'Connell, J. and O'Farrell, K. J. (1996). Effect of overcrowding on claw health in first-calved Friesian heifers. British Veterinary Journal. 152, 459-472

Leonard, F.C., O'Connell, J. and O'Farrell K.J. (1996). Patterns of foot lesion development in replacement dairy heifers after housing and calving. In: Agricultural Research Forum, UCD, 28-Mar-1996, pp.185-186

O'Connell, J.M. and Leonard, F.C. (1997). Optimising winter housing systems for dairy cattle. In: Advances in Behaviour Analysis. Dillenburger, K., O'Reilly, M.F. and Keenan, M. (eds) . UCD press.

Leonard, F.C., Stienezen, I. and O'Farrell K.J. (1997). Overcrowding at the feeding area and effects on behaviour and claw health in Friesian heifers (Abstract). Irish Journal of Agricultural and Food Research 36, 112.

Leonard, F.C., O'Connell, J. and O'Farrell K.J. (1997). Housing conditions and foot lesions in Friesian heifers. In: 5th International Livestock Environment Symposium, Minneapolis, US, 01-May-1997, pp. 250-257.

Leonard, F.C, Crilly, J. and O'Farrell, K.J. (1997). Analysis of farm roadway surfaces on dairy farms and the relationship with lameness (Abstract). Irish Veterinary Journal, 51, 132.