Preference of lactating dairy cows for strawyard or cubicle housing systems at two space allowances

Preferência de vacas leiteiras em lactação por sistemas de confinamentos com ou sem baias em duas disponibilidades de espaço

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Abstract

Two preference tests were conducted with 16 lactating dairy cows in which they were allowed to choose between strawyard and cubicle housing systems. The two tests each of 14 days duration examined preferences at high and low space allowances. All cows had previous experience of both systems, but in the week prior to the preference tests, half the animals were housed in a strawyard and half in a cubicle system. This prior treatment was found to have no significant influence on subsequent choice of housing system. Continuous video recordings showed that the mean proportion of time over 14 days spent in the strawyard and cubicle areas was 66:34 at high space allowance and 68:32 at low space allowance respectively. In the second week of test at both space allowances, the total lying time proportion in the strawyard and cubicles was 91:09 indicating a strong preference to lie in the strawyard area, even when the area was restricted at the low space allowance. Social rank and dominance values were determined prior to the tests, and were found to correlate more strongly with age than with liveweight. They did not significantly influence the choice of housing system at either space allowance. The occurrence of minority preferences for the cubicle system suggests that using preference as an indicator of welfare, may lead to the development of systems which will not provide the best welfare for all animals.
Key words: Dairy cows; Preference test; Housing systems; Social Rank; Resting Behaviour.

Resumo

Dois testes de preferência foram conduzidos em 16 vacas leiteiras em lactação as quais tiveram que escolher entre confinamento com baias (com divisórias na área de repouso) ou sem baias (sem divisórias na área de repouso). Os dois testes, cada um com 14 dias de duração examinaram preferência dos animais em diferentes disponibilidades de espaço. Todas as vacas tinham experiência prévia nos dois tipos de confinamentos, mas, na semana anterior aos testes de preferência, metade dos animais foram mantidos no confinamento sem baias e a outra metade no confinamento com baias. Não foi observada influência desse tratamento prévio na escolha do tipo de confinamento pelos animais. O registro continuo, através de vídeo mostrou que, depois de 14 dias, a proporção mêdia de tempo despendido nas áreas dos confinamento sem e com baias foi respectivamente de 66:34 quando havia maior disponibilidade de espaço e de 68:32 quando havia menor disponibilidade de espaço. Na segunda semana dos dois testes verificou-se que, em ambas disponibilidade de espaço a proporção total de tempo em repou-

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so no confinamento sem e com baias foi de 91:09, indicando uma forte preferência dos animais para se deitarem na área do confinamento sem baias, mesmo quando o espaço disponível para os mesmos foi restringido. Ordem social e valor de dominância foram determinados antes dos testes e verificou-se que correlacionavam mais fortemente com idade do que com peso vivo. Eles não tiveram influência significativa na escolha do sistema de confinamento pelos animais em ambas disponibilidades de espaço. A escolha do sistema de confinamento com baias pela minoria dos animais sugere que o fato de se usar testes de preferência como indicador de bem-estar pode levar ao desenvolvimento de sistemas que não fornecem o melhor bem-estar para todos os animais.
Palavras Chave: Vacas leiteiras; Teste de preferência; Sistema de Confinamento; Ordem Social; Comportamento de Repouso.

Introduction

Animal-centred definitions of welfare are concerned with what animals feel in response to their environment (DAWKINS, 1983; DUNCAN, 1993). One method of assessing how animals perceive their environment is by a preference test (FRASER; PHILLIPS; THOMPSON, 1993). Animals are able to express their feelings in choosing the environment which is in their best welfare interests.

The environment of housing systems appears to be an important factor influencing the behaviour of dairy cows. Observations during the early development phase of loose housing systems, suggested that dairy cows prefer strawyards to cubicle (free stall) housing (SCHMISSEUR et al., 1966). Such a preference may be due to both physical and social factors relating to the two housing systems (WIERENGA, 1983; PHILLIPS; SCHOFIELD, 1994). Choice in preference tests may also be influenced by other factors such as the animals' previous experience (DAWKINS, 1983; PHILLIPS, 1993), the amount of space allowance on offer and social rank of the animal. In lower ranking animals, decreased space allowance has been found to result in a reduction in the time spent lying in the bedded area, and these cows may try to compensate by lying down elsewhere (WIERENGA, 1983; POTTER; BROOM, 1987).

A preference test experiment was conducted with the objective of quantifying the preference of lactating dairy cows for strawyards or cubicles, at low and high space allowance following immediate past experience of strawyard or cubicle systems. The role of social rank in these preferences was also investigated.

Material and methods

1. Experimental animals and feeding

Sixteen lactating Holstein Friesian cows from the Wye College Dairy Research Unit herd were paired on the basis of liveweight, milk yield and parity. They had a mean initial liveweight of 601 kg (range 498-722), milk yield 26.9kg (20.5-34.0), parity of 2.6 lactations (1-7) and included 4 first parity animals, 6 second and 6 of three or more parities. The animals had been reared as calves in straw pens and they had been housed as lactating dairy cows in a cubicle system. Therefore they had experience of both systems to be used in the preference test.

The cows were fed *ad libitum* with a total mixed ration (TMR) using a Keenan mixer wagon. The amount of TMR offered each morning on a group basis averaged 60 kg of fresh grass silage, 3 kg of maize gluten and 0.15 kg of mineral/vitamin supplement per cow. Also, 2 kg/cow/day of a compound concentrate was offered individually in the milking parlour.

2. Experimental design

The preference test was carried out over six weeks from July to September 1997. It consisted of a pre-experimental period of two weeks and two experimental periods each of two weeks (Table 1). The aims of the pre-experimental period were to deter-

mine the social hierarchy of animals (week 1), and to control prior experience effects (week 2) before starting the preference tests. The experimental period consisted of two preference tests, firstly at a high space allowance and secondly at a low space allowance. The objective was to study dairy cow preference for strawyards or cubicles and to see whether the preference changed due to different space allowances and to social rank.

Table 1 – Experimental design; S = strawyard, C = cubicles, High = high space allowance, and Low = low space allowance.

	Housing Treatments	Allocation
Week 1	High S	all 16 animals
Week 2	High S and High C	8 in S, 8 in C
Weeks 3 - 4	High S or High C	all 16 with choice
Weeks 5 – 6	Low S or Low C	all 16 with choice

The strawyard and cubicle systems were located in the same building and had approximately 110 m² of concrete area each as shown in Figure 1. All 16 cows were housed together in a separate strawyard system for one week (week 1) at a high space allowance of 10m² /cow in total and 6.8m² /cow bedded area. This allowed the social hierarchy of the cows to be determined. In week 2 the cows were separated into two groups (8 cows in the cubicle area and 8 cows in the strawyard) and housed separately for one week in the experimental areas. Cows were allocated at random within matched pairs to the two systems. During this period the gate between the two systems was closed and the animals were milked as two separate groups.

The gate (Figure 1) linking the two housing systems was opened on the first day of week 3, allowing the animals free access to both strawyard and cubicle systems. During weeks 3 and 4 the animals had a high space allowance in both housing areas. The two systems were reversed after seven days of data collection (on day 7 of week 3), and data were collected for seven more days (week 4). This reversal was achieved by removing the cubicle divisions from the cubicle system and reconstructing them where the strawyard system had been, and vice versa. This protocol was followed to ensure that preference was associated with system, not with geographical position of the strawyard and cubicles.

The animals had the same management and procedures during weeks 5 and 6, as for weeks 3 and 4, but lying space allowances of both cubicle and strawyard systems were reduced. The two housing systems were reversed again after seven days of data recording (on day 7 of week 5) to remove the possibility of side preferences and data were collected for seven more days (week 6).

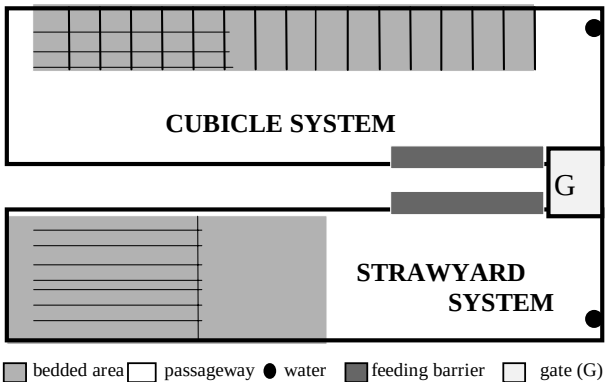

Figure 1 – Schematic drawing of the strawyard and cubicle areas at high and low space (hatched area removed) allowances.

3. Housing areas and management

In weeks 1 to 4 the strawyard had a 65 m² bedding area to which long wheat straw was added daily to keep the bed clean. The standing/walking area measured 45 m² and had one plastic water bowl for all animals. This floor was scraped twice daily using a scraper mounted on the back of a tractor. The feeding barrier was a tombstone type (vertical height 0.7m) giving individual access to a choice of feed bins and allowing 8 cows to eat at the same time in the strawyard area. For 8 animals in week 2, the strawyard provided a space allowance of 13.8 m²/ cow in total, a bedded area of 8.2 m²/cow and feeding barrier with 1.0 space/cow.

In the cubicle area there were 16 raised (150mm) cubicle beds each measuring 1.25 m wide and 2.10 m long, forming a single row with the cows facing a wall when lying. Chopped wheat straw was added daily to the beds to keep them clean. The cubicle divisions consisted of two horizontal metal pipes at 1.15 m and 1.70 m from the ground. The standing/walking area was 68 m². The feed fence, water bowl and floor scraping method were the same as the strawyard system. For the 8 animals in week 2, the cubicle area provided space allowances of 13.8 m²/cow in total, a bedded area of 2.0 cubicles/cow and a feeding barrier with 1.0 space/cow.

There was a feeding passage 1.40 m wide between the two housing systems across which animals had free movement from one system to the other when the gate between the two areas was opened at the start of week 3 (G on Figure 1).

In weeks 5 and 6 the bedded area of the strawyard was reduced to 42.5m², and in the cubicle system, the lying area was reduced to 10 cubicles. All other areas and facilities including concrete passage area, feeding spaces and water bowls were as for weeks 3 and 4. If all 16 animals had chosen to move into one of the two yards, the lying area space allowances would have been as follows; strawyard total area 5.5 m²/cow, bedded area 2.65 m²/cow, feeding barrier 0.5 spaces/cow; and cubicle yard total area 5.8 m²/cow, bed 0.625 cubicles/cow with feeding barrier 0.5 spaces/cow.

The cows were milked twice daily in a herringbone milking parlour. They were milked as two separate groups (strawyard and cubicle groups) during week 2 of the pre-experimental period. In the experimental period they were milked as one group. After each milking the 16 animals were brought from the milking parlour, divided into two groups at random and then one group was put into the strawyard system and one put into the cubicle system. The order was alternated daily with the first group being put in the strawyard one day and into the cubicle area the next day. This procedure was to avoid any influence of housing area entered after milking on choice. Morning milking was at approximately 06:30h and the afternoon milking at 16:30h.

4. Measurements

Maintenance behaviour (lying down, ruminating, standing and feeding) was recorded for 24h (5 minute intervals) by direct observation once weekly. In addition a continuous video recording was made throughout weeks 3 to 6, to record occupation and usage of the two housing systems. Agonistic behaviour (threats, bunts, pushes and fights) was recorded using a sociometric matrix (JENSEN; ALGERS; EKESBO, 1986). This was carried out after initial grouping of the cows in the strawyard in week 1, and by continuous direct observation twice weekly for 30 minutes at random times of the day in both strawyard and cubicle housing systems. A dominance matrix chart was calculated from the recorded interactions between pairs of animals (SCHEIN; FOHRMAN, 1955). These measurements were used to determine the social rank and dominance values of the cows.

Animal performance was recorded to characterise the group of cows in the preference tests. Milk yield was recorded automatically at each milking for individual cows by a computer-linked flow meter. Morning and afternoon samples of milk were taken once weekly from individual cows for analysis of milk constituents (fat, protein and lactose). The food intake was estimated by recording the amount of TMR offered to each side (strawyards and cubicles) daily and the refusals were recorded three times each week. The milk cell count was recorded for each cow at week 6, the data being obtained from the monthly National Milk Recording (NMR) report. Body condition scores (MULVANY, 1977) were recorded at the start and end of the experiment, and liveweight was recorded weekly. Dry bulb thermometer environmental temperature was recorded daily in the building.

Heart rate was recorded with a portable heart-rate monitor, Polar® Sport Tester (PST), on two cows for two hours every day of each experimental period. The objective was to use heart rate as an indicator of stress, and determine whether space allowance was influential.

5. Statistical analysis

The dominance value for individual cows was calculated using the following equation:

$$d.v. = X/Y \quad (1)$$

where d.v. is the dominance value of the cow, X is the number of cows subordinate to that cow, and Y is the number of known dominance relationships of the cow within the group (WIERENGA, 1990).

The behavioural activity results including time and percentage time spent in each housing system, maintenance behaviour and social behaviour were analysed by a range of tests including Chi-square, t-test, Spearman's rank correlation using Minitab (1995) software.

Results

1. Preference for strawyard or cubicle areas

The mean results from video recording at high and low space allowances showed that cows significantly (P<0.001) preferred the strawyard to the cubicle area (Table 2). At the high allowance the mean occupancy over 24h was 66:34, and at the low space allowance 68:32 for strawyard and cubicle areas respectively. On the first day of choice (day 1 in week 3) there was a 50:50 occupancy of the two areas, but this increased to 77:23 on day 2. Similarly on day 8 after the straw and cubicle areas had been reversed, the cows did not show any significant preference (46:54), but the preference became clear on the following day (68:32).

On day 1 at the low allowance the preference for the strawyard remained. This followed no change in the geographical positioning of the two areas following the final week of the high space allowance. However, when the areas were reversed at the end of day 7, the cows took one day to re-establish their preference. On day 8 the occupancy averaged 54:46 and on day 9, 71:29 for strawyard and cubicle areas respectively.

Table 2 – Mean percentage of cows observed (from video recording) in strawyard and cubicle housing systems over 24h, at high space allowance, and low space allowance.

High space allowance								
Days	1	2	3	4	5	6	7	mean
S	50	77	74	68	67	64	60	66
C	50	23	26	32	33	36	40	34
sem	4.1ns	3.1***	3.1***	3.6***	4.1***	5.7**	5.7ns	2.7***
Day	8	9	10	11	12	13	14	mean
S	46	68	68	68	69	67	69	65
C	54	32	32	32	31	33	31	35
sem	2.4ns	3.7***	3.4***	5.2**	2.8***	4.0***	4.3***	2.4***
Low space allowance								
Days	1	2	3	4	5	6	7	mean
S	69	62	62	64	68	66	70	66
C	31	38	38	36	32	34	30	34
sem	5.7**	6.9ns	6.8ns	7.4ns	6.3*	7.2*	6.0**	5.7***
Days	8	9	10	11	12	13	14	mean
S	54	71	71	68	72	75	81	70
C	46	29	29	32	28	25	19	30
sem	5.9ns	4.0***	4.6***	3.6***	5.4***	2.5***	6.4***	3.4***

One sample t-test (two tailed = significantly different from 50%)

There was no significant effect of prior experience in the week before the commencement of the preference test, on choice of strawyard or cubicle areas during days 1 and 2 (Table 3), or subsequently. The cows with prior experience in the strawyard increased from 46 to 79% occupancy of the strawyard from day 1 to day 2. Those with prior experience in the cubicles increased from 54 to 74% occupancy of the strawyard.

Table 3 – Percentage of time observed (from video recording) in strawyard (S) and cubicle (C) housing systems during days 1 and 2 of week 3, according to prior experience in week 2.

Period	Prior experience in week 2	Percentage of time spent in each area S	C	sem
Day 1	S	46	54	5.1ns
Day 1	C	54	46	6.3ns
Day 2	S	79	21	3.7***
Day 2	C	74	26	4.6**

One sample t-test (two tailed = significantly different from 50%)

2. Maintenance behaviour

In the preference tests at both space allowances, the percentage of time the cows were observed lying in the strawyard area compared with the cubicle area, increased from the first to the second week (Table 4). At the high allowance the increase was from 65 to 91% and at the low allowance from 81 to 91%. The preference for lying in the strawyard was significant for the second week at the high allowance, and for both weeks at the low allowance. There was no indication therefore that the reduced area of straw bedding at the low allowance induced cows to move to the cubicle area to lie.

Table 4 – Maintenance behaviour (percentage of time) spent in the strawyard (S) or cubicle (C) housing systems during 24h of behaviour observations[1] in weeks 3 and 4 (high space allowance) and weeks 5 and 6 (low space allowance)

High space allowance	Days 1-7			Days 8-14		
	S	C	sem	S	C	sem
Lying	65	35	9.1ns	91	9	5.1***
Standing on bed	54	46	8.8ns	87	13	6.1***
Eating TMR	56	44	6.4	59	41	5.8ns
Drinking	47	53	8.1ns	52	48	7.9ns
Ruminating	66	34	6.6*	79	21	4.2***
Low space allowance	**Days 1-7**			**Days 8-14**		
	S	C	sem	S	C	sem
Lying	81	19	8.1**	91	9	5.1***
Standing on bed	79	21	7.0**	82	18	5.4***
Eating TMR	52	48	6.7ns	54	46	5.9ns
Drinking	59	41	7.0ns	70	30	7.4*
Ruminating	78	22	6.9***	85	15	4.1***

One sample t-test (two tailed = significantly different from 50%)

[1] from 24h observations recorded on one day each week

The actual total time spent lying for days 1-7 and 8-14 were respectively for the high allowance 480 and 474 minutes/ 24h, and for the low allowance, 690 and 664/ 24h. The lower lying times at the high allowance appeared to be associated with higher environmental temperatures in the building in weeks 3 and 4 compared with weeks 5 and 6 (23.5°C at high and 18.5°C at low allowance).The greater occupancy of the strawyard area compared with the cubicle area led to a higher percentage of standing on the bed and passageway areas taking place in the strawyard area. This was significant for all weeks apart from the first week of the preference tests.

The choice of site for eating and drinking was associated with the placement of the feed bins and the water bowls. There was one feed space per animal, with half of the spaces in the strawyard area and half in the cubicle area, which at peak feeding times meant that cows had to divide equally between the two areas. Although more eating and drinking took place consistently in the strawyard area, this was only significant for drinking in the final 7 days of the experiment. Ruminating behaviour was associated with where the cows were lying. The proportion of total ruminating time taking place whilst the cows were lying was 49% at the high and 71% at the low space allowance. It is likely that this difference was due to the reduced total time spent lying at the high space allowance associated with the high environmental temperature.

3. Social hierarchy

The dominance values of the 16 cows ranged from 0.93 (most dominant) to 0.07 (most submissive cow). The social rank order (1 to 16) and the dominance values were subjected to regression analysis with parity (lactation number) and liveweight. The equations and correlations were as follows:

Social rank order =
$21.3 - 7.67L + 0.723L^2$ $R^2 = 0.74$***

Dominance value =
$0.224 + 0.351\text{Ln}(L)$ $R^2 = 0.64$***

Social rank order =
$30.8 - 0.0371W$ $R^2 = 0.33$*

Dominance value =
$-0.88 + 0.0023W$ $R^2 = 0.40$**

where L is lactation number, W is liveweight (kg) and Ln is $\log_e$.

The regression equations and correlations indicate that age, represented by lactation number was more closely associated with social rank order and dominance value than size, represented by liveweight. The four first parity animals occupied the bottom four places in social rank and dominance value, and the six second parity animals occupied six out of the next seven places. Cows with three or more lactations occupied the top five places.

The bottom eight and top eight cows in dominance value had similar total lying times (Table 5). There was however a tendency for the low dominance value cows to spend a higher proportion of the total lying time in the strawyard system than the high dominance value cows. For low and high dominance value cows respectively, 87 and 66% of total lying time at the high space allowance, and 91 and 81% at the low space allowance took place in the strawyard.

Table 5. Total lying and ruminating times (min /day)[1] spent in strawyard (S) or cubicle (C) housing systems for low dominance value (LDV) and high dominance value (HDV) cows in high and low space allowance.

	High space allowance						Low space allowance					
	S			C			S			C		
	LDV	HDV	sem	LDV	HDV	sem	LDV	HDV	sem	LDV	HDV	sem
Lying	409	317	44.0ns	64	163	55.0	619	546	64.0ns	58	131	59.0ns
Ruminating	405	331	34.5ns	101	164	33.7ns	475	455	41.8ns	71	142	35.8ns

Two sample t-test (two tailed = not equal)
LDV and HDV are bottom and top eight cows in dominance value

[1] from two 24h observations recorded at each space allowance

4. Feed intake and milk production

The TMR diet had an analysis of 302gDM/kg fresh weight, 11.5MJ metabolisable energy (ME)/ kgDM and 184g crude protein(CP) /kgDM. The concentrate fed in the milking parlour contained 883gDM/kg, 11.5MJ ME/kgDM and 267g CP/ kgDM. The TMR diet was equally available in the strawyard and cubicle areas, and mean intakes were 9.5kgDM/day in the strawyard and 9.0kgDM/day in the cubicle area. The mean rate of intake of the TMR estimated from the recordings of time spent eating, was 71gDM/min.

The mean milk production level of the cows during the six week experiment was 22.8kg/day containing 43.4g fat/kg and 33.0g protein/kg. The mean liveweight was 606kg and mean condition score 2.02. The mean somatic cell count of the milk was low averaging 83,000 cells/ml, which reflects a low level of mastitis incidence during the period of the experiment. The mean recorded heart rates were 78 and 73 beats/min (P = 0.14) in the high and low space allowances respectively which indicated no increase in stress at the low space allowance.

Discussion

1. The preference test

A preference test is one means of obtaining information on how animals perceive their environment (FRASER; PHILLIPS; THOMPSON, 1993). It may also be an indirect method of assessing animals' feelings (DUNCAN, 1993; ARAVE,1996). Nonetheless, the methodology has short-comings, and care must be taken with interpretation of the results. Duncan (1978) cited three areas where care is required, a) the test only provides information on the relative properties of two environments, b) minority choices are difficult to interpret, and c) short-term preferences may not be in the best interests of long-term welfare of the animal.

The results of this experiment showed that there was a significant preference by lactating dairy cows for a strawyard rather than a cubicle system. This was true both for general occupancy of the two areas over 24h (Table 2) which was in the ratio of 67:33, and for lying activity (Table 4) which averaged 82:18 for strawyard and cubicles respectively. This preference may have been related to different degrees of comfort offered by the physical environment of the two systems for standing and lying, and/or to the social environment, which might have satisfied the behavioural needs of the animals differently.

2. Influence of the physical environment

Cows have an aversion to hard surfaces (METZ; WIERENGA, 1987; NILSSON, 1992), and the bedded area of the strawyard was both larger and softer than the cubicle lying area. The concrete passageway areas at both space allowances totalled 45m^2 for the strawyard and 68m^2 for the cubicle system, and therefore about 50% less hard surface was available in the strawyard system. Nevertheless, the time spent standing on the beds relative to the concrete passages was small in both housing areas, indicating a preference for standing on the concrete passage area rather than the bed area in both systems. The mean total standing time per animal in the housing areas for the four 24h observation periods was 485 min/day (excluding feeding time). The proportions spent standing on the passageway and bed were 80% and 20% respectively, and they were similar for the two housing systems (78 and 83% for strawyard and cubicle systems respectively). This preference for standing on the concrete passages as opposed to the beds, suggests that hardness of flooring was not influential on the choice of area to stand, and therefore was unlikely to be a factor influencing the preference for the strawyard area. Normally animals spend more time standing on the bed, particularly in strawyard systems (FREGONESI, 1999). In this experiment the high environmental temperatures during the daytime may have contributed to the preference for standing on the passages.

There was a strong preference for lying in the strawyard as opposed to lying on cubicle beds. The deep straw bedding of the strawyard compared with the thin layer of chopped straw over the concrete cubicle beds, may have been influential on choice. Hard lying surfaces can disturb the normal pattern of lying behaviour (METZ; WIERENGA, 1987). The differences in total mean lying times of 477min/day at the high space allowance and 677min/day at the low space allowance appeared to be due to the differences in environmental temperature in the two periods. The high temperatures within the building during the high space allowance period led to standing replacing lying behaviour, probably to dissipate heat particularly during the daytime. The duration of resting is known to be negatively correlated with environmental temperature (SUMNER, 1991; VARLYAKOV *et al*, 1995). Total lying times in loose-housing systems have been reported to be 540 to 720 min/day (HENDLUND; ROLLS, 1977). The lying time of 477min recorded at the high space allowance was therefore well below the normal duration of lying for lactating dairy cattle, and provides some confirmation that the high environmental temperature was the cause of the reduced lying time in that period.

Studies comparing cows in separate systems have generally found that lying times are longer in strawyards than cubicles (SINGH et al, 1993; PHILLIPS; SCHOFIELD, 1994). This might also indicate a greater comfort level in strawyards than cubicles. However, the results of such comparisons can be influenced by the management level afforded to each system (FREGONESI, 1999).

3. Influence of the social environment

Preference for standing and lying in the strawyard area rather than the cubicle area, may have been due to the strawyard providing the preferred social environment. Phillips and Schofield (1994) concluded that cows are both more comfortable (have longer lying times) and have greater opportunities to display normal behaviour in strawyards than in cubicles. The preference for standing on the smaller concrete passage in the strawyard area rather than the larger concrete passage in the cubicle area tends to confirm that social factors were important in the preference.

The choice of site to lie down in strawyards is informal compared with the formality of cubicles where the animals have to lie in lines with animals parallel to each other. It is possible that this informal social environment is as important in influencing preference as the physical nature of that environment.

The cows showed similar diurnal patterns of lying in both systems with most lying taking place between 21-00 and 05-00h. On a number of occasions all cows in the strawyard were seen lying at the same time, but not in strawyards and cubicles at the same time. Synchrony of lying behaviour is an indicator of welfare (MILLER; WOOD-GUSH, 1991; KROHN; MUNKSGAARD; JONASEN, 1992), and the preference for strawyards may have been influenced by the need for this synchronous herd activity.

4. Influence of prior experience

The prior experience of an animal is considered to be a factor influencing the interpretation of preference tests (DAWKINS, 1983; FRASER; MATHEWS, 1997). The cows used in this test had historical experience of both strawyard and cubicle systems, the former as calves and the latter as lactating cows. Whether the experience of strawyards when young had a long-term effect on preference is not known.

The preference test included a one week period prior to commencing, with half the animals in strawyards and half in cubicles. This was intended to remove any short-term influence of prior experience. On day 1 of the test there was movement between housing systems and no clear preference was shown (Table 3). However on day 2 the cows showed a preference for the strawyard irrespective of the housing system which they had occupied in the previous week. A similar response was observed on day 7 at both high and low space allowances when the housing systems were geographically reversed. On each occasion preference for the strawyard area became clear on the second day after the change. There was no indication therefore that experience immediately prior to the experiment was a factor influencing preference.

5. Influence of social hierarchy

There was a clear relationship between age (parity), liveweight and social behaviour expressed either as social rank order or dominance value. The correlation coefficients were greater for age than liveweight indicating that experience or maturity was an additional factor to size in determining social positioning. The confounding of size and age in such groups of animals makes a more detailed interpretation of their relative importance very difficult.

There was a clear preference for strawyards by both low and high-ranking cows (Table 5). There was a tendency for high-ranking cows to spend more time than low ranking cows lying in cubicles, although the difference was not significant. This tendency occurred at both high and low space allowances. Low-ranking cows may use cubicles to avoid competitive social interactions (Potter and Broom, 1987), but in this experiment they preferred to be in the strawyard area. Other authors (WIERENGA, 1990; ALBRIGHT; ARAVE, 1997) have reported that access to the resting area is not dependent on social rank. In strawyards first parity cows often avoid lying next to the highest ranking cows, although there are a range of factors that influence the inter-individual distance between animals (POTTER; BROOM, 1987). Nevertheless with 91% of the total lying activity taking place in the strawyard in week 6, there would have been only 2.9m^2 per cow lying space when all animals observed to lie in the strawyard were lying down. This is slightly below the considered minimum requirement of 3.0m^2 /cow (LEAVER, 1999). Animals were therefore making a choice to minimise their personal space in order to lie in the strawyard.

6. Minority preferences

Three cows showed a preference to lie down in cubicles, two of them consistently throughout the two tests and one animal spent time lying in the strawyard intermittently. Preference tests are a means of allowing the animal to indicate what is comparatively better welfare (DAWKINS, 1983; DUNCAN, 1993). The fact that these minority-

choice animals preferred cubicles can be interpreted as an indication that their welfare was better served by the cubicle system. When preference tests are used as indicators of animal welfare therefore, such minority choices must also be taken into account. Application of preference test results could therefore lead to the development of systems which do not provide the best welfare conditions for all animals.

Conclusions

The two tests showed there was a clear preference of dairy cows for the strawyard system compared with the cubicle system, both for occupancy of the area and for lying down. This was apparent at both high and low space allowances. The preference was not affected either by experience of housing system immediately prior to starting the tests, or by social rank of the animals. There were minority preferences for the cubicle system. Using the preference test as an indicator of welfare could therefore lead to the development of new systems which are intended to improve the welfare of cows, but which for a minority might not be the ideal.

Further research is necessary to determine to what extent the physical and social environments are influential in the preference for the strawyard system. The two environments were confounded in these tests. An understanding of the elements within the environments which influence preference will be beneficial in developing housing systems for dairy cows which lead to higher standards of animal welfare.

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