THE EFFECT OF CUBICLE AND STRAW YARD HOUSING ON THE BEHAVIOUR, PRODUCTION AND HOOF HEALTH OF DAIRY COWS

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An experiment is described where 40 spring-calving dairy cows were allocated to be housed in a deep straw yard or a cubicle house from November to April, in order to examine the effects on behaviour, milk production and hoof health. Cows in straw yards spent longer lying down and feeding, except during oestrus when they increased their time spent standing proportionately more than cows in cubicles. In the straw yard cows spent longer in associative behaviour during oestrus and had fewer unsuccessful mounting attempts. There were no differences in milk production or composition but cows in the straw yard lost more weight after calving. Cows in the cubicles had a reduction in heel depth, which is a predisposing factor to lameness. It is concluded that a straw yard system for dairy cows allows greater opportunity to display normal behaviour, leads to better hoof health and provides acceptable levels of production.

Keywords: *animal welfare, behaviour, cattle housing, dairy cow, hoof health*

Introduction

The welfare of housed dairy cows is directly dependent on the physical environment provided for them. Although it is now becoming widely accepted that tethering cattle reduces their welfare because of the lack of freedom of movement, it is not known which of the two alternatives for loose housing of dairy cows, cubicles and deep strawed yards, is preferable. In a cubicle system the cows are given access to raised lying beds of *c* 2m x 1m with some absorbent bedding on the surface. The beds are separated from each other by dividers, usually of metal bars. In deep strawed yards there are no individual lying areas and straw is added regularly to absorb the excreta and provide a soft lying surface. Usually a greater area per cow is provided in a straw yard (Maton *et al* 1985). The major differences between the two systems are therefore first in the amount and quality of personal space given to each cow, with cows in cubicles having less total space but potentially more privacy. Second there are differences in the floor type, with cows in cubicles either standing in concrete covered with excreta or lying on a relatively hard bed, and those in a straw yard spending nearly all their time lying or standing on soft straw.

The differences in the quality and quantity of space given to cows in the two systems may influence their ability to perform normal behaviours, and hence their welfare. In particular the interactive behaviours between cows are likely to be affected eg social and oestrous behaviours, with the latter having possible inferences for reproductive rate.

The difference in floor type may also affect behaviour, particularly lying, and is likely to have effects on hoof health. Lameness is one of the biggest factors reducing the welfare of housed dairy cows, and is of multifactorial origin. A significant predisposing factor to lameness is the hoof conformation, with an increased incidence of hoof disorders, especially laminitis, occurring where the heel bulb has been eroded due to abrasion and/or standing in wet conditions (Phillips 1990). Hoof wear has been shown to be twice as rapid on a wet surface compared to a dry one because of softening of the horn tissue (Spindler 1973).

A study was therefore conducted to examine the effects of the two housing types on the behaviour, foot health and production of dairy cows.

Materials and methods

Forty British Friesian multiparous cows that calved in January and February 1986 were paired according to projected calving date, mean previous lactation yield, current milk yield, live weight, condition score and lactation number. One cow in each pair was allocated to be housed in a covered straw yard (S) and the other in a cubicle house (C). Both buildings were portal-framed structures with a 3m wide concrete feeding passage that was scraped twice daily. The straw yard contained a bedded area 6m x 15m and the cubicle house contained 20 cubicles 2.09m x 1.17m with tarmacadam bases and classic divisions (Maton *et al* 1985). Stocking rates in the straw yard and cubicle house were 0.12 and 0.17 cows/m^2 respectively. Stocking rate and quantity of bedding provided were similar to those recommended by Maton *et al* (1985) and were selected as the levels required to give similar degrees of cow cleanliness in the two systems. It should be noted however that both Leaver (1983) and Castle and Watkins (1984) recommend a higher stocking rate of 0.18 cows/m^2 for a straw yard, but in a survey of UK dairy farmers higher stocking rates have been recorded in cubicles than straw yards (Lawton 1987).

The experiment was conducted from 15 November 1986, when the cows were not lactating and were removed from pasture, until 22 April 1987 when they were returned to pasture. From housing until calving (mean 27 January + 1.9 days) cows were offered daily grass silage *ad libitum*, and after calving they were offered a complete diet mix that contained (g dry matter /100g total mix dry matter) 60.5 silage, 23 barley, 9 soyabean meal, 4 wheat, 3 fishmeal and 0.5 minerals/vitamins. Both silage and the complete diet were available *Ad libitum* and group intakes were recorded daily using a mixer wagon with weigh cells for the entire dry period and from March 3-17 during lactation. Feeds were sampled weekly for chemical analysis and milk was sampled on a consecutive afternoon and morning milking once each fortnight for fat and protein analysis and thrice weekly for progesterone analysis. Milk yield, live weight and subcutaneous fat score (Mulvaney 1977) were recorded weekly.

Approximately two weeks before calving, cows in both treatments were removed to a straw yard, and at two days post-calving were returned to identical treatment areas to those that they were in whilst non-lactating.

Cows were observed for behaviour for 30-minute periods starting at 0500h, 1030h, 1400h and 2000h. At five-minute intervals each cow was recorded as lying, standing, feeding or walking. Incidences of oestrus-related behaviours - successful and unsuccessful mounting, being mounted with and without the standing reflex, chin-rubbing and licking or sniffing the anogenital region of another cow - were recorded within five-minute periods, with no behaviour recorded more than once in each period. Oestrus was determined as the exhibition of standing-to-be-mounted behaviour and confirmed by a milk progesterone assay of less than 2.5ng/ml (Ovucheck, Cambridge Life Sciences). All cows were artificially inseminated at the first observed oestrus confirmed by milk progesterone, provided that it occurred at least 40 days post-partum. Subsequent oestrus detection was on the basis of herdsman recording of standing-to-be-mounted behaviour. Pregnancy rate was calculated as the proportion of cows conceiving to an insemination and subsequently calving *c* 280 days later.

Sixteen cows (nine in C and seven in S) were selected at the start of the experiment in November as suitable for the recording of hoof toe length and heel depth changes, because they had claws of good conformation and no clinical disorders. All cows with misshapen, overgrown or darkly pigmented claws were rejected for this recording. At monthly intervals the distance between the periople line and the longest point of the outer claw (toe length) was measured with dividers, and the vertical distance from the floor to the hairline at the back of the heel was measured with a ruler (heel depth) for each cow. All cows were scored for locomotion disorders at three-week intervals starting in November whilst walking on level concrete, using the following four-point scale (modified from Manson & Leaver 1988):

1. Perfect locomotion with minimal abduction and adduction.
2. Uneven gait but not lame.
3. Lame but not affecting normal behaviour pattern.
4. Severely lame affecting normal behaviour pattern.

Statistical analysis

Milk production and hoof measurement data were analysed by analysis of variance. The interval from calving to first oestrus, first service and pregnancy, and the incidences of oestrous behaviour, were analysed using a generalized linear model with a Poisson error distribution because of the discrete nature of the data (Lawes Agricultural Trust 1980). Pregnancy rate was analysed using a goodness of fit test giving a Chi Square statistic.

Results

Cow behaviour

Results are presented separately for non-oestrous and oestrous days and the day before and after oestrus, since oestrus had some major effects on behaviour. At all stages of the oestrous cycle, cows in the straw yard spent more time lying and feeding and less time standing or walking than those in the cubicles (Table 1). On the day of oestrus cows in the straw yard reduced their lying and feeding time more than those in the cubicles, and compensated more on the day after oestrus by increasing lying time. Both groups of cows increased their walking time at oestrus. Cows in oestrus in the straw yard showed more associative behaviour in the form of sniffing and licking the genital area of other cows, but they had fewer incidences of unsuccessful mounting than those in the cubicles (Table 2).

Table 1 **Time (in minutes, per 100 min) spent by cows in the straw yard and cubicles in lying, standing, feeding and walking behaviour on non-oestrous days, the day of oestrus (0), day before oestrus (-1), day after oestrus (+1).**

Behaviour	Straw yard				Cubicles				Standard errors and significance		
	Non-oestrous	-1	0	+1	Non-oestrous	-1	0	+1	Treat-ment	Oestrous period	Inter-action
Lying	52	46	36	72	34	37	29	39	2.8***	3.9***	5.4**
Standing	18	17	43	10	44	43	43	35	2.1***	3.0***	4.2***
Feeding	29	37	17	18	20	18	22	24	2.2NS	3.1NS	4.4***
Walking	0.8	0.3	3.1	0.3	1.7	1.9	5.5	1.3	0.4***	0.6***	0.8NS

* $P<0.05$, ** $P<0.01$, ***$P<0.001$, NS = not significant

Table 2 **Incidences per 30 minutes of oestrous-specific behaviour on the day of oestrus for cows in the straw yard or cubicles.**

Behaviour	Straw yard	Cubicles	Significance
Mounted with standing reflex	0.48	0.42	NS
Mounted without standing reflex	0.36	0.30	NS
Successful mounting	0.54	0.36	NS
Unsuccessful mounting	0.42	0.54	*
Sniffing/licking genital area	0.30	0.18	**
Chin-rubbing on rump	0.30	0.24	NS

The interval from calving to first oestrus and first service were not affected by treatment, but the pregnancy rate to first service was greater, and as a result the calving to pregnancy interval less, in the straw yard (Table 3).

Production

There were no differences between the two treatments in the feed intake (cubicles 12.8kg dry matter/cow/day; straw yard 11.6kg dry matter/cow/day) or milk yield or composition (Table 3). However cows in the straw yard tended to lose more weight and body fat during the lactation period. This may have been due to straw consumption, which they were observed

doing. Straw is of lower metabolizable energy concentration than the other feeds available and, if eaten in substantial amounts, would reduce the cows' energy intake.

Table 3 **Reproduction and milk production of the cows in the straw yard or cubicles.**

	Straw yard	Cubicles	SED	Significance
Reproduction				
Calving - 1st oestrus interval (days)	35.1	33.1	2.87	NS
Calving - 1st service interval (days)	88.3	83.6	7.56	NS
Pregnancy rate to 1st service (%)	90	55	-	***
Calving - pregnancy interval (days)	90.4	101.2	7.56	***
Milk production				
Milk yield (kg/day)	25.6	25.3	1.24	NS
Fat content (g/kg)	36.2	38.0	2.15	NS
Protein content (g/kg)	30.2	31.0	0.54	NS
Liveweight change (kg/day)	-0.82	-0.40	-0.44	*
Fat score change (units)	-0.72	-0.22	5.95	NS

Hoof conformation

Mean heel depth, toe length and locomotion score at the start of the experiment were 2.39cm, 4.74cm and 1.60 respectively. No clinical lameness occurred during the experiment. Cows in the straw yard increased their heel depth during the experiment (Table 4), whereas those in the cubicles decreased it. Toe length increase was not significantly affected by treatment, although it tended to be greater in the straw yard, and there were no significant differences in locomotion score change.

Table 4 **Effect of cubicle or straw yard environment on hoof dimension changes and locomotion changes.**

	Straw yard	Cubicles	SED	Significance
Heel depth change (μm/day)	+42.4	-27.2	10.22	**
Toe length change (μm/day)	+68.6	+45.0	+15.25	NS
Locomotion score change (units)	-0.06	-0.14	0.202	NS

Discussion

Behaviour

The straw yard appeared more conducive to adequate lying and feeding behaviours than the cubicles. In view of the similarities in feed intake the data suggest that cows had a slower rate of intake in the straw yard, probably because of less competition at the feeding barrier. Cows in the cubicles lay down for less time probably because of the hardness of the lying surface. Difficulties in standing/lying caused by the cubicle divisions could also have reduced lying time.

Cows in the straw yard demonstrated greater behavioural changes during oestrus (the proportional increase in standing time was 1.45 for cows in the straw yard, 1.0 for cows in cubicles and the corresponding reductions in lying time were 0.39 and 0.15 respectively). Apart from being of greater value to the herdsman to indicate the correct time of insemination, it demonstrates the greater behavioural flexibility of cows in the straw yards. The conclusion that from a behavioural aspect the welfare of the cows in the straw yard was greater than that in cubicles, is also supported by first the fact that cows in the straw yard were able to perform more associative behaviour during oestrus (sniffing and licking each other), and second the fact that there was less unsuccessful mounting during oestrus. Unsuccessful mounting usually occurs because the mounted cow refuses to accept the mounter and attempts to escape. She does this either because she is not in oestrus or because the floor is too slippery for a safe mounting. Both could have been prevalent in the cubicles and would constitute an unpleasant experience for the cow being mounted.

Hoof conformation

It was not possible in this study to distinguish between growth and wear of the hoof, but it is unlikely that growth differed between the two housing systems, and treatment differences therefore reflected differences in rate of wear. The cubicle house contains conditions conducive to hoof wear: a wet floor and long periods spent standing both lead to softening of the horn, and a hard, abrasive surface leads to erosion of the soft tissue. In the straw yard more time is spent lying down and the floor surface is dry and resilient, giving rise to minimal hoof abrasion. No effect of environment was found on cow locomotion and further research is needed to identify the optimum changes in heel depth and toe length over the winter, which clearly must depend to some extent on changes during the summer. Hahn *et al* (1986) found that hoof wear was greater on a concrete than on earth. Other researchers (Bell & Miller 1977; Rowlands *et al* 1983) have found a greater incidence of lesions in

cubicle-housed cows than cows in a straw yard. Excessive walking on hard surfaces stretches the white line and wears the sole, thus weakening the wall/sole bond (Baggott & Russell 1981). On the other hand the bacterial infection between the claws caused by the organism *Phlegmona interdigitalis* may be more common in straw yards where straw is pushed up between the claws and causes a lesion, or where excessive claw growth closes the interdigital space, trapping dirt and causing infection.

Animal welfare implications

Cows in the straw yard were more comfortable (longer lying times) and had greater opportunity to display the normal behavioural changes at oestrus than the cows in cubicles. There were no detrimental effects of the straw yard system on milk production, but the possibility of weight losses of cows in straw yards should be investigated further.

The erosion of cows' heels when they were housed in cubicles could predispose them to painful lameness, particularly that caused by laminitis. By contrast the depth of cows' heels in the straw yard increased over the winter, giving them a firm structure with which to cushion impact during locomotion.

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