LYING AND FEEDING BEHAVIOUR OF DAIRY COWS AT PASTURE AND HOUSED IN FREE STALLS FITTED WITH SAND AND WATER FILLED MATTS

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Introduction

Dairy farming in New Zealand is recognized as a major contributor to the national economy, earning an estimation of NZ$ 13.0 billion. In 2010/11 the New Zealand dairy industry processed 17.3 billion liters of milk from over 4.5 million cows in approximately 11,735 herds containing an average of 386 cows (Livestock Improvement, 2011). The annual growth has been an increase in cows per farm rather than a growth in hectares per farm and stocking rates on farms has increased over the last ten years. The growing cow numbers and increased stocking rates, creates greater environmental consequences which include pollution of waterways due to fertilizer and effluent application practices (Clark et al., 2007), soil contamination through deposition of urine and faeces by grazing animals either directly or indirectly into the waterways (Collins et al., 2007; de Klein & Ledgard, 2001)

In New Zealand dairy cows have traditionally been grazed all year round, however the expansion of the land area being utilized for airy production and intensification of existing milk production systems has led to increased nitrogen losses (de Klein, and Ledgard, 2001. Luo *et al.,* 2007) into ground and surface water, which can be reduced by limiting the amount of time that cows have acces to pasture during wet and dry soil conditions, by standing cows on feed pads (de Klein, 2001; Christensen et al., 2012). These cows are now more frequently being kept in houses, which is an approch that is particualry important during inclement weather, in protecting soil structure (Moller et al., 2008) and pasture from treading damage (Arnold, 2009) and in dry condititions to prevent nitorgen build up and loss during periods of subsequent rain fall.

The provision of housing in New Zealnd can allow farmers to retain more non-lactating cows at the dairy unit over the winter, providing animals shelter from excssive rain and cold, (Young, 1981; Broucek et al., 1991; Kadzere et al., 2002) and eliminating the need for alternative grazing and transport of live animals between farms. Cow housing can also provide shade and protection from heat stress during the summer, which minimises the negetive response cows show to high temperatures and humidity, which include a reduction in time spent lying down, reduced dry matter intake (DMI), and seeking shade (Zahner et al., 2004; Tao et al., 2011; Blackshaw & Blackshaw, 1994). This generally have a negitve effect on animal prodcutivty and body condition. Other behavioural responses include increased respiration rates and sweating which indicate evaporative heat loss (West, 2003; Verkerk et

al., 2006). Unfortunately, many New Zealand dairy farmers and the majority of cows have little or no experience of cow housing. This experiment was completed to assess the acceptance and use of differing free stall bed types by adult dairy cows, with no previous experience of housing, and to compare this with cows that continued to be kept at pasture. The evening and night behaviour patterns of these cows are reported and discussed in this paper.

Materials and methods

This work was completed in accordance with the ethical procedures of Massey University (MUAEC 11/82), Palmerston North, between November 2011 and May 2012, using 36 adult non-lactating Holstein Friesian and Jersey cross bred dairy cattle (5 to 13 years of age), which were selected at random from the Massey dairy herds and allocated according to age and live weight to one of three groups of 12 cows, such that the groups were balanced for animal age and live weight. During the bed comparison periods all groups of cows were grazed for a restricted period of 4 h/d (11.00 to 15.00 h), stood on concrete for two hours simulated milking periods (9.00 to 11.00 & 15.00 to 17.00 h) and for 16 hours/d (17.00 to 9.00 h). At night Group 1 and Group 2 were housed on free stalls, while Group 3 was kept at pasture. Housed cows were offered (*ad libitum*) 10 kg DM/cow grass silage while housed (feed trough – freestall distance of 4.5 m, 0.7 m/cow feeding width at trough). Initially, cows in groups 1 and 2 were acclimatized to earth beds and readily used freestall beds for a period of five consecutive nights (17.00 and 9.00 h). Following this period cows were rested on pasture for five days, while the two adjacent individual pens that were fitted with 13 free stalls each had either 13 dual chamber water filled rubber matts or 13 deep litter sand beds put in place. The cows (n 12) were offered one bed type and were then were offered the alternative bed type. This was achieved acclimatizing the cows to the night bed type and grazing routine for 3 days, prior to each period of detailed behavior observation. The behavior of all cows (lying, walking, feeding, standing, drinking, standing & lying bouts, bed used) was recorded manually by scan sampling (Daylight: 5 minute intervals; Darkness: 15 minute intervals) on 3 consecutive days for a 24 hours per day (72 hours in total for each bed type). After the behavior observations the cows were rested on pasture for five days and then the cows were offered the other pen fitted with the alternative bed type and the acclimatization and observation procedure was repeated. The individual cows were offered and assessed on both bed types. Activity meters (Ice Tags ^{TM}) were fitted to seven cows, in each group, and used to validate the manual observation data. Much of the behavior data was found to be not normally distributed and was analyzed using the non-parametric Kruskal Wallis procedure in Minitab (16.0) with lying surface (water, sand or pasture) type included in the model as a fixed effect, while differences between medians were assessed, using individual standard deviations and a confidence interval of 95%.

Results

The cows with access to water filled matts had a significantly lower total lying ($P<0.001$) and greater standing time ($P<0.001$) than when the cows were offered access to sand beds and compared with cows kept on pasture (Table 1). In contrast, the total lying time did not differ significantly ($P>0.05$), between cows kept overnight at pasture compared with cows that had access to sand beds.

Table 1 Median time (hours) spent lying, standing, walking and grazing/feeding (St Dev) by cows offered access to dual chamber water filled rubber matts or deep liter sand beds, and compared with pasture for the period overnight (17.00 and 9.00 h)

	Bed type			
Total /d	**Pasture**	**Sand**	**Water**	**P value**
Housed period (16 hours)				
Lying, hours	10.4 (2.64) [a]	10.4 (2.17) [a]	7.3 (3.51) [b]	<0.0001
Standing, hours	1.5 (2.46) [b]	1.7 (1.44) [b]	2.9 (2.60) [a]	<0.0001
Feeding / grazing, hours	4.0 (0.92) [a]	3.1 (1.19) [b]	3.1 (1.00) [b]	<0.0001
Walking, hours	0.04 (0.044)	0.00 (0.043)	0.00 (0.056)	0.300
Grazing period (4 hours)				
Lying, hours	0.75 (0.569) [c]	1.17 (0.632) [b]	1.67 (0.620) [a]	<0.0001
Standing, hours	0.33 (0.367) [a]	0.08 (0.314) [b]	0.08 (0.296) [b]	<0.0001
Grazing, hours	2.67 (0.565) [a]	2.50 (0.647) [a]	2.00 (0.648) [b]	<0.0001
Walking, hours	0.12 (0.092)	0.12 (0.082)	0.12 (0.135)	0.843
Total daily (24 hours)				
Lying, hours	11.5 (2.77) [a]	11.2 (2.76) [a]	9.6 (3.43) [b]	<0.0001
Standing, hours	5.6 (2.41) [a, b]	5.6 (1.45) [b]	6.7 (2.66) [a]	<0.0001
Feeding / grazing, hours	6.7 (1.14) [a]	5.6 (1.23) [b]	5.2 (1.11) [b]	<0.0001
Walking, hours	0.42 (0.156)	0.42 (0.137)	0.50 (0.244)	0.076

[a, b] Medians in the same row followed by differing superscript letters differ significantly

Discussion

In this study cows adopted sand bed free stalls readily (2 ±0.5 days), however the overall lying times for all cows in this study (Table 1) were slightly below the 12 hours proposed for lactating cows by Jensen et al. (2005). However, the housed lying times were in agreement with Haley et al. (2000) and similar to the 10.9 hours found in recent studies of cows lying times on pasture (Hernandez-Mendo et al., 2007; Olmos et al., 2009; Dalley et al., 2012) and daily lying times were between 8.3 and 13.3 hours spent lying in free stalls (Norring et al., 2008 & 2010; Dalley et al., 2012). In this study, which was completed during the summer, when the cows were kept on water filled matts, the lying time was lower than when the cows were kept on sand beds and compared with the cows kept on pasture. The lying times on

water filled matts were within the 7 to 10 hours described by Phillips (2010), who clearly states that early lactating cows lay for less time than late lactation and dry cows. In this study, when cows were housed on water filled rubber matts, lay for significantly less time each day, spending significantly less time lying on beds and more time lying during the grazing period, which significantly reduced grazing time. Whereas lying times were significantly greater on sand beds and at pasture. These greater lying times found in cows at pasture and in sand beds and were consistent with those of Herlin (1997), Chaplin et al. (2000), Haley et al. (2000), and Boone et al. (2010) who found that cows were more inclined to lie down on softer materials (sand, mattresses), resulting in increased in lying time and a reduction in standing time. The cows in this study showed a willingness to adopt and lye on sand beds, but when offered water filled rubber matts these cows were more likely not to use the stalls, lying outside of the stalls and lye in the stalls for less time and standing in and outside of the stalls for longer. This is supported in previous studies, which compared sand and water filled matts and reported that sand beds had greater occupancy percentages (Wagner-Storch et al., 2003), with sand bed free stalls being found to have the highest overall percentage (52.9%) of cows lying and a greater percentage of empty stalls (49.0%) were found in stalls fitted with water filled rubber matts (Boone et al., 2010).

There is an overall agreement that pasture is considered a more comfortable surface (Hernandez-Mendo et al., 2007) and no difference was observed between time spent standing indoors on free stall bed fitted with sand and on pasture (Table 1). Interestingly, standing behaviour of dairy cows changed in response to the type of bed surface used. The duration of standing on sand beds were within the range of standing times reported in Cook et al. (2004) and Manninen et al. (2002), but when cows were offered water filled rubber matts the standing time was greater compared to those on sand beds and at pasture. Similarly, a recent study carried out in USA reported that cows were observed more frequently standing or lying in the alleys when housed in free stalls fitted with water filled rubber matts compared with deep litter sand beds (Boone et al., 2010). In this study a reduction in lying time and increase in standing time observed was found in cows kept on water filled rubber matts, which typically reduces animal productivity and health, particularly increased lameness (Cook et al., 2004; Phillips, 2010).

Conclusions

Dry dairy cows transitioning from fully pasture based to partially housed lay on pasture and sand beds for similar periods of time. When cows had access to free stalls fitted with dual chamber water filled rubber matts, their lying time was shorter and standing time was greater, compared with when the cows had access to sand beds. Cows with no experience of housing readily and quickly adapted to lying in free stalls fitted with sand beds. However, the type of free stall bed lying surface that farmers select is of great importance to the productivity, health and welfare of dairy cattle, due to its direct effect on bed up take, occupancy and the amount of time cows spend lying and standing over 24 h periods.

Acknowledgements

Authors would like to acknowledge funding from Pastoral 21, which is a collaborative venture between; DairyNZ, Fonterra, Dairy Companies Association of New Zealand, Beef + Lamb, NZ and the Ministry of Business, Innovation and Employment. Its goal is to provide accessible systems-level solutions for profitably increasing pastoral production, while reducing farms' environmental footprint.

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