Resting behaviour and displacements in ewes - effects of reduced lying space and pen shape

Knut Egil Bøe, Synne Berg and Inger Lise Andersen

University of Life Sciences, Department of Animal and Aquacultural Sciences, P.O. Box 5003, N-1432 Ås, Norway

ABSTRACT

Increased space allowance is usually considered to improve welfare and performance in farms animals. The aim of this experiment was to investigate the effect of lying space and pen shape on the resting behaviour and displacements in ewes. A 2 x 3 factorial experiment was conducted with lying space (0.5, 0.75 and 1.0 m^2/ewe) and pen shape (deep and wide) as main factors. A total of 24 adult ewes were randomly assigned to six groups. All groups were exposed to all the treatments and each treatment period lasted for seven days. The ewes were videotaped for the two last days of each treatment period, and the general activity, position in the pen and lying close to other ewes were scored every 15 minutes. In addition, all displacements were scored continuously.

Total lying time was reduced from 70 % to 63 % when the lying area was reduced from 1.0 m^2 to 0.5 m^2 ($P < 0.05$), and the lying time in the deep pens (67.0 %) was longer than in the wide pens (64.5 %) ($P < 0.05$). Synchronization of lying (all 4 ewes lying simultaneously) was reduced from 45.4 % to 5.9 % ($P < 0.001$) whereas the number of displacements of lying ewes (per ewe and 24 h) increased from 6.4 to 28.9 ($P < 0.001$) as the lying area was reduced. The lowest ranked ewe in each group were lying significantly less ($P<0.01$) and were

significantly more active ($P<0.05$) than the other ewes. Except for lying time, pen shape had no significant effects on the behaviour of the ewes. In conclusion, reducing the lying space from 1.0 to 0.5 m^2/ewe, resulted in a reduction in lying time, less synchronized resting and a large increase in the number of displacements. Except for a lower lying time in wide than deep pens, there were no significant effects of pen shape.

Key words: sheep, space allowance, resting behaviour, displacement

INTRODUCTION

In most production systems, farm animals compete for resources like food distributed from a limited space, access to water and attractive lying places and freedom of moving around in itself. Increased space allowance is generally considered to improve the welfare of farm animals. In loose housed dry sows, increased space allowance (from 2.0 to 4.8 m^2/sow)has been shown to decrease aggression and lesion score (Weng et al., 1998), and in finishing pigs the average daily gain was significantly reduced when space allowance was reduced from 0.56 m^2 to 0.25 m^2 (Hyun et al., 1998). In cattle, increased space allowance is associated with an increased weight gain, increased lying time, more synchronous lying, and fewer aggressive interactions (e.g. Zeeb et al., 1988; Fisher et al., 1997; Mogensen et al., 1997; Nielsen et al., 1997). In sheep, Gonyou et al. (1985) found that a reducing space allowance from 0.48 m^2/lamb to 0.32 m^2/lamb resulted in a lower daily gain, whereas Arehart et al. (1969) did not find any relation between space allowance and daily gain when increasing the space allowance from 0.37 m^2/lamb. Space reduction also appears to result in more rigid dominance relationships (Dove et al., 1974).

Even if there is enough physical lying space, we know that some individuals may monopolize more of the attractive space than others. Ewes kept in pens show a strong preference for lying next to a wall (Marsden and Wood-Gush, 1986; Færevik et al., 2005). Hence, perimeter length appears to be of great importance.

In the European regulations for organic farming (Council Regulation (EC) No 1804/1999) there is a demand for a comfortable, clean and dry lying/resting area of solid construction at a minimum of 0.75 m^2 per ewe and a total pen area of 1.5 m^2 per ewe. Both regulations (Sweden: 1.1 – 1.7 m^2/ewe, Switzerland: 0.8 –1.0 m^2/ewe) and recommendations (e.g.,

Loynes, 1983, 1.1 m^2; Midwest Plan Service, 1987, 0.74 m^2) for space allowance in commercial confinement sheep production vary a lot.

A general view in the past was that aggression rarely occurred among female sheep, especially on pasture (Geist, 1971; Arnold and Dudzinski, 1978) and that dominance relationships did not exist. However, both Eccles and Shackleton (1986) and Festa-Bianchet (1991) found aggressive interactions among female Bighorn sheep and Lynch et al. (1985) found corresponding results in Scottish Blackface ewes, especially in the restricted area of shelter. Hence, limited resources seem to enhance aggressive interactions also in sheep, as would have been expected from the data on other ruminants. Although Arnold and Maller (1974) did not observe any fighting in competition for supplementary feed between ewes, they reported that level of disturbance (displacements) increased with decreasing trough length. Further, Marsden and Wood-Gush (1986) found that next after feed, limited lying space caused most of the displacements in sheep. Resting pattern can be used as an indication of social stress in animal husbandry (Fraser and Broom, 1997), and sheep show a consistent and synchronous pattern of activities and resting (Rook and Penning, 1991; Fraser and Broom, 1997). The number of displacements increases and the lying time decreases with decreasing lying space in dairy heifers (Nielsen et al., 1997; Mogensen et al., 1997), but this has not yet to our knowledge been studied in sheep. Since lying space is an attractive resource in the environment for ewes kept indoors, it is likely that the amount of lying space will influence the resting behaviour and aggressive interactions between ewes.

The aim of this experiment was to investigate the effect of lying space and pen shape on the resting behaviour and displacements during resting in ewes.

MATERIALS AND METHODS

Experimental design

A 2 x 3 factorial experiment was conducted with pen shape (deep and wide) and lying space (small: 0.5, medium: 0.75 and large: 1.0 m^2/ewe) as the main factors. Six groups with four ewes in each group were assigned to the experiment. All groups were exposed to the different treatments, and the order was rotated systematically. Each treatment period lasted for seven days.

Experimental pens

The six experimental pens had a space allowance of 1.5 m^2 per ewe (according to the demands in the regulations for organic farming). The deep pen was designed so that the width of the pen allowed all ewes to eat simultaneously (Figure 1). Hence, the pen width equalled the mean width of the ewes (0.45 m) multiplied by the number of animals in the pen (0.45 m x 4 = 1.80 m). In the wide pen, the width of the pen was doubled (3.60 m). The lying area in the pen consisted of a platform made of solid wood 200 mm above the level in the activity area. The platform had a thin layer of sawdust as bedding material. To prevent the sheep from lying in the activity area, wooden beams (1.5” x 2.0”) were laid on the floor at c/c 400 mm.

The experimental pens were located in an insulated, mechanically ventilated room where the average air temperature varied between 0°C and 4°C. Air temperature and air humidity were recorded by a thermo hygrograph.

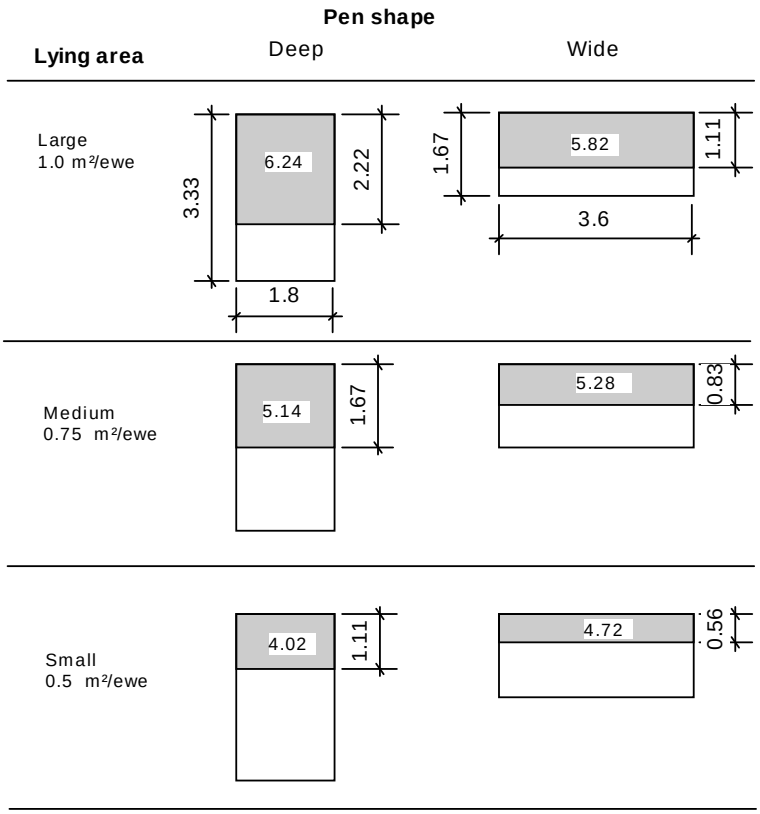

Figure 1. Experimental pens with dimension (in meters). Shaded areas represents lying space. Perimeter length (m) of lying area is shown on each pen.

Animals and feeding

24 medium sized (80 to 85 kg), two to six years old, pregnant ewes of the Norwegian Dala breed were chosen from the resident flock at the Agricultural University of Norway in early January, and randomly divided into the six experimental groups. The sheep are normally kept indoors in pens with expanded metal floor during the wintertime (October - April) and are shorn and mated in the beginning of November. The ewes were allocated to the experimental pens 14 days before the experiment started.

The ewes had free access to hay at the feeding barrier in front of the pen and water from buckets also in front of the pen. A small ration of standard concentrates (0.1 kg/ewe) was provided at 09:30 h every day. At the same time the pens were cleaned and new sawdust

provided. The lying area was also cleaned at 17:30 h, and new sawdust provided. It was necessary to clean twice a day in order to keep the lying area acceptably dry.

Behavioural observations

The individually marked sheep were video recorded for 48 hours at the end of each experimental period. Video cameras (Panasonic WV – BP 310 G) were suspended over the pens, and connected to a multiplex (Robot MV99P) and a time-lapse video recorder (Panasonic AG 6720). When analysing the videotapes, using instantaneous sampling at 15 minutes intervals, the following behavioural classes were scored for each sheep:

- activity (lying, standing, walking) and location of activity (lying area or activity area)
- lying position in the lying area (next to pen wall (< 15 cm) or in the middle)
- lying close to one or several ewes (< 15 cm), with or without head-to head position

Displacements or attempts to displace lying ewes were recorded continuously during the 48 hours period and scored according to the following categories:

1. A lying ewe stands up and leaves the location because another ewe is pushing her with the head or stamping on her with the front legs
2. A lying ewe stands up and leaves the location because another ewe is approaching her (no physical contact)
3. A lying ewe stands up because another ewe is pushing her with the head or stamping on her with the front legs, but lies down again in the same location
4. A lying ewe stands up because another ewe is approaching her (no physical contact), but lies down again in the same location

5. A lying ewe does not respond/ignores the attempts of another ewe to displace her

Food competition test

The social rank order in each group was determined by performing a feed competition test at the end of the experiment. Rank order from pair-wise feed competition test is reported to be highly correlated to the social rank order determined by observing social interactions in groups of ewes (Erhard et al., 2004). On the test day the ewes did not receive any concentrates in the morning. Each group was moved to an unfamiliar pen (2.5 x 3.7 m^2), where a small bucket was placed in the middle of the pen. One of the stock people, who were normally feeding the ewes, went into the pen and put 0.2 kg of concentrate in the bucket. The ewe that first claimed access to the food and displaced the others was given the top rank position (rank 1) and removed from the pen. The test was then repeated on the three ewes that were left in the pen, and the next ewe displacing the others were given rank 2 etc.

Statistical analysis

To analyse effects of size and shape of the lying area on lying time, lying position, displacements and synchronisation of lying periods, a cross-classified, mixed analysis of variance model, including lying space, pen shape and ewe group, were used (GLM-procedure; Hatcher and Stephanski, 1994). Ewe group was specified as a random effect in the model. Differences between means were calculated by using the Student Newman Keul`s test. To analyse the effect of rank (based on the feed competition test) on behaviour, a mixed analysis of variance, including the factors rank and ewe group (random effect) within each pen were conducted.

RESULTS

Lying time

Mean lying time decreased significantly when the lying area was reduced from 0.75 m^2/ewe to 0.5 m^2/ewe, but there was no significant difference between 1.0 m^2/ewe and 0.75 m^2/ewe (Table 1). The ewes were lying significantly less in the wide pen with the smallest lying area than in the deep pen with the smallest lying area. Lying time per group ranged between 56.1% in the wide pen with the smallest lying area to 76.6% in the deep pen with medium lying area.

Individual lying time varied between 41.2 and 80.7%, and some of this variation could be explained by social rank in the group. The effect of rank on lying time differed between pens. When kept in the wide pen with the small lying area, the lowest ranked ewes (rank 4) were lying significantly less than the higher ranked ewes in the group (Fig. 2; $F=5.8$, $P < 0.01$). The same tendency occurred in the deep pen with the small lying area (rank 1: 67.2 ± 2.1, rank 2: 65.8 ± 2.5, rank 3: 66.4 ± 0.9, rank 4: 61.3 ± 0.9; $F=2.5$, $P=0.10$) and the medium, wide pen (rank 1: 68.0 ± 2.5, rank 2: 68.0 ± 2.6, rank 3: 68.2 ± 1.9, rank 4: 60.4 ± 2,8; $F=3.1$, $P=0.06$).

There was no significant relationship between the individual lying time and the number of displacements.

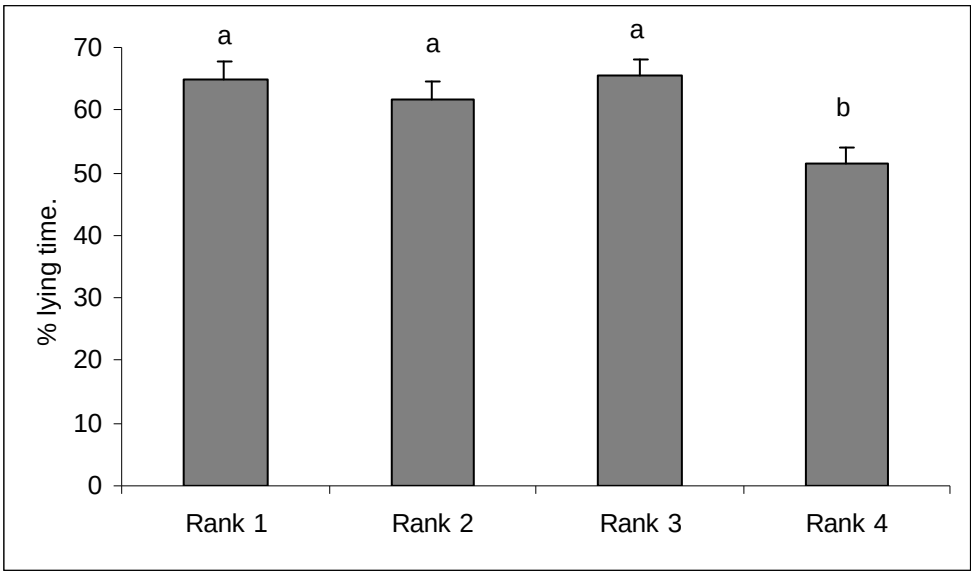

Figure 2. Lying time (percent of observations) in the smallest wide pen for ewes with different social rank. Bars with different superscripts differ significantly (F=5.82, P<0.05).

Synchronization of lying

Synchronization of lying (all ewes lying at the same time) decreased dramatically when the lying area was decreased (Table 1), but there was no significant effect of pen shape. In the pens with the smallest lying area, and especially the wide shaped pen, lying simultaneously was rarely observed (deep: 9.5 ± 5.2, wide: 2.2 ± 1.7 % of total observations), and in fact never observed in groups 4 and 5.

Table 1: Lying behaviour and displacements (mean ± standard error).

Observation	Size of lying area (m^2/ewe)			Shape of lying area	
	Small 0.50	**Medium 0.75**	**Large 1.00**	**deep**	**wide**
Lying time (% of tot. obs.)	63.0 ± 1.1 [a]	67.4 ± 1.3 [b]	66.9 ± 1.1 [b]	67.0 ± 1.0 [a]	64.5 ± 1.0 [b]
Lying simultaneously in lying area (% of tot. obs.)	5.9 ± 2.8 [c]	37.7 ± 3.0 [d]	45.4 ± 1.9 [e]	30.3 ± 4.4	29.0 ± 4.9
Lying in lying area (% of lying obs.)	94.3 ± 2.2 [a]	99.5 ± 0.3 [b]	99.9 ± 0.1 [b]	96.9 ± 1.4	98.8 ± 0.8
Lying in activity area (% of lying obs.)	5.6 ± 2.1 [a]	0.5 ± 0.3 [b]	0.1 ± 0.1 [b]	3.1 ± 1.4	1.1 ± 0.8
Displacements, total number (ewe/24 h)	28.9 ± 5.5 [c]	13.4 ± 1.0 [d]	6.4 ± 0.7 [d]	14.5 ± 2.3	17.9 ± 4.3
Displacements, ewe stand up and leave location (ewe/24 h)	23,3 ± 5,1	10,5 ± 0,7	5,3 ± 0,7	11,2 ± 1,9	14,9 ± 3,8
Displacements, ewe stand up but lies down again (ewe/24 h)	1,9 ± 0,4	1,1 ± 0,3	0,3 ± 0,1	1,3 ± 0,3	0,9 ± 0,2
A lying ewe ignores attempts (ewe/24 h)	3,7 ± 0,6	1,9 ± 0,3	0,7 ± 0,1	2,0 ± 0,4	2,1 ± 0,5
Lying close to wall (% of lying in lying area)	96.9 ± 1.6	93.2 ± 1.8	97.4 ± 1.2	94.7 ± 1.5	97.0 ± 1.0
Lying in the middle of lying area (% of lying in lying area)	3.1 ± 1.6	6.8 ± 1.8	2.6 ± 1.2	5.3 ± 1.5	3.0 ± 1.0
Lying close to one ore more ewes (% of lying in lying area)	81.8 ± 2.5 [c]	69.3 ± 3.8 [d]	59.4 ± 2.6 [e]	68.3 ± 3.7	72.1 ± 2.8
Standing (% of total observations)	7.7 ± 0.5 [a]	8.7 ± 0.9 [b]	10.6 ± 1.0 [b]	8.6 ± 0.7	9.4 ± 0.7
Walking (% of total observations)	8.5 ± 0.7 [a]	3.7 ± 05 [b]	1.3 ± 0.2 [b]	4.4 ± 0.8	4.6 ± 0.9

Means with different superscript differ significantly ([a,b] $P < 0.05$, [c,d,e] $P < 0.001$)

Lying in activity area

Lying time in the activity area increased when the size of the lying area was reduced, but it was not significantly affected by pen shape (Table 1). Mostly the ewes were trying to avoid lying in the activity area, but three particular ewes from three different groups were observed lying there on several occasions, and especially in the pens with the smallest lying areas. These ewes were ranked as 2, 3 and 4 respectively. There was no significant effect of social rank on percent of observations lying in the activity area in any of the pens. In the wide pen with the small lying area the ewes were often observed lying with one or both hind legs outside the narrow lying area.

Displacements

When the size of the lying area decreased, the number of displacements (all categories) increased significantly, but pen shape had no significant effect on the number of displacements (Table 1). A main part of the displacements were successful as the ewe actually stood up and left the location (Table 1). However, sometimes the ewe only stood up and lay down again in the same location, or did not respond at all. In one group there was an exceptionally high number of displacements (mean number of displacements irrespective of pen: 113.8 ± 47.5), compared to the other 5 groups (mean number of displacements irrespective of pen: 55.1 ± 6.1, range 41.2 to 65.3).

Number of displacements were not affected by rank order, but ewes with social rank number 2 were significantly more exposed to displacement attempts than ewes with rank 3 (rank 1: 7.5 ± 2.3, rank 2: 10.2 ± 1.9, rank 3: 4.0 ± 1.2, rank 4: 5.5 ± 1.8; $F=4.38$, $P<0.05$).

Location in lying area

Regardless of pen shape and size, the ewes showed a strong preference for lying close to a wall, and they were hardly ever lying in the middle of the lying area (Table 1). In the wide pen with the small lying area, there was not enough space to lie in the middle of the lying area, and all the ewes were thus lying close to a wall.

There was no significant effect of social rank on percent of observations lying close to a wall in any of the pens.

Lying close to other ewes

Proportion of observations where ewes were lying close to other ewes increased significantly when the size of the lying area decreased (Table 1), but this behaviour was not significantly affected by pen shape. In the pens with medium and large lying areas (both wide and deep) the ewes were lying significantly less in head-to-head position than in the small pens (wide and deep; small: 9.1±1.3, medium: 3.8±0.5, large: 5.1±1.0; $F=13.2$, $P<0.001$), but there was no significant difference in this lying posture between the two pen shapes.

Percent of observations lying close to other ewes did not differ significantly between ewes with different social rank order.

Activity

The percent of observations walking increased significantly when the size of the lying areas decreased, whereas the percent of observations standing decreased (Table 1). Pen shape did not affect the activity significantly in any way.

The lowest ranked ewes were more active (both standing and walking) in the wide pen with the small lying area (Fig. 3, F=3.6; P<0.05), but this relationship was not significant in the other pens.

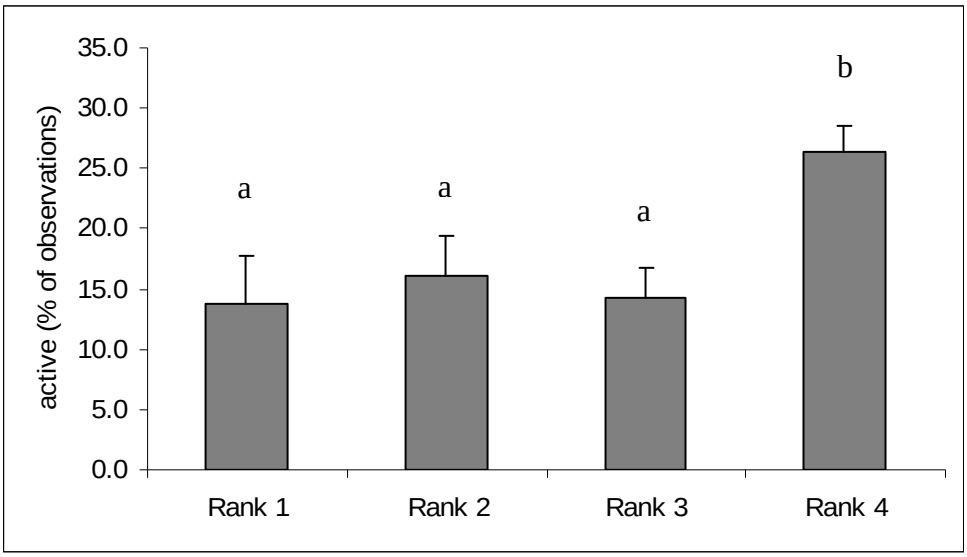

Figure 3. Activity (percent of observations) in the smallest wide pen for ewes with different social rank. Bars with different superscripts differ significantly (F=3.61, P<0.05).

DISCUSSION

This experiment showed that the sheep significantly reduced their lying time when the lying space was decreased from 0.75 m^2 to 0.50 m^2 per ewe. In comparison, Mogensen et al. (1997) found that also heifer responded by reducing their lying time when the space allowance was decreased from 3.0 m^2 to 1.5 m^2 in slatted floor pens, but a similar effect could not be found in deep bedded pens. Correspondingly, Nielsen et al. (1997) found no effect on lying time in heifers when the lying area with deep bedding was reduced from 3.6 to 1.8 m^2/heifer. Hence, it seems that offering a separate bedded lying area reduced the effect of space allowance on lying time. In order to compensate for the reduced access to adequate lying space, the synchronization of lying was dramatically reduced. In some groups the ewes in fact never rested simultaneously in the smallest lying areas. Sheep have a strong social motivation, and

synchronize their grazing and resting periods on pasture (e.g. Rook and Penning, 1991). Hence, a low degree of synchronised resting can be regarded as a negative indicator of welfare. Also in cattle the synchronization of resting behaviour was significantly reduced when the lying area was decreased (Nielsen et al., 1997).

As expected, low-ranked ewes were more active and spent less time lying than the other ewes in the group. Individuals being often displaced did not spend less time lying than the ewes that were seldom displaced. Instead, a large number of displacements appeared to increase the overall restlessness in the group. The importance of being able to rest was clearly demonstrated by the increased time spent lying in the uncomfortable activity area in the pens with the lowest lying space allowance. Three particular ewes used the activity area for lying, but there was no effect of social rank on this behaviour. In confinement sheep production, feeding space and lying space are important and limited resources. Marsden and Wood-Gush (1986) found that lying space, next after feed, was the most important resource involved in displacement incidents in sheep. Correspondingly, Lynch et al. (1985) found that in grazing sheep most fights occurred in the restricted area of shelter. In the present experiment, the number of displacements increased dramatically as the lying space decreased. This may be one of the reasons for the reduction in lying time in the 0.5 m^2 lying space treatment. Low-ranked ewes were not displaced more often than the others, probably because they avoided competing for lying space.

Both Marsden and Wood-Gush (1986) and Færevik et al. (2005) found that sheep in pens have a strong preference for lying next to a wall. This shows that it is not only the space allowance per see that is important, but also the perimeter length, as pointed out by Wiegand et al. (1994). In the present experiment, the perimeter length varied from 4.02 m to 6.24 m, and the variation was least in the wide pens (4.72 m to 5.82 m). This may explain why there

was a tendency to a larger proportion of ewes lying next to the pen partitions in these pens. The available perimeter length may also explain why there was no difference in the proportion of ewes lying next to the walls in the three lying space treatments. In the wide pens with 0.5 m^2 lying space, the only option for the ewes were to lie next to the wall, as the width of the lying space was only 0.56 m. However, in the 0.75 m^2 lying space treatment, the ewes were also lying in the centre. Here the available perimeter length restricted the possibility for all four sheep to lie next to the pen walls, but it was possible to lie in the middle of the pen. When the lying space was increased to 1.0 m^2, the perimeter length increased and made it possible for all four ewes to lie next to the pen wall simultaneously.

A small lying space forced the ewes to lie closer together. When lying space is larger, the ewes preferred not to lie in contact with neighbouring ewes.

In conclusion, reducing the lying space from 1.0 to 0.5 m^2/ewe, resulted in a reduction in lying time, less synchronized resting and a large increase in the number of displacements. Except for a lower lying time in wide than deep pens, there were no significant effects of pen shape.

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