The effect of different pen partition configurations on the behaviour of sheep

GRETE HELEN MEISFJORD JØRGENSEN, INGER LISE ANDERSEN AND KNUT EGIL BØE.

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

Corresponding author: Grete Helen Meisfjord Jørgensen, (grete.meisfjord@umb.no, telephone: +47 64965142, fax; +47 64965101)

Abstract

The aim of our experiment was to test if different configurations of additional walls would increase total resting time and synchrony of resting behaviour while decreasing displacements from the resting area in small groups of sheep. A total of 24 adult pregnant ewes of the Nor-X breed were rotated between five treatment pens and one control pen (each with four ewes) in a Latin Square design. In five treatment pens solid walls were mounted on the resting area in different configurations (parallel wall: PAR; cross wall: CRO; perpendicular wall, PER; resting cubicles: CUB and three walls: THR), while one pen was kept without additional walls (control: CON). The ewes were acclimatized to each treatment pen for six days before 24 hour video recordings were performed. Social interactions were scored continuously for six hours during daytime while resting behaviour was scored using instantaneous sampling every 10 minutes during the entire 24 hours. No significant differences were found between

treatments in total resting time, resting synchrony or displacement behaviour. However, when housed in the CUB configuration the ewes performed more blocking behaviour ($P<0.0001$), consequently resulting in more ewes resting in the activity area ($P<0.05$). More head butting was observed in the THR treatment than in the CRO treatment ($P<0.05$). In conclusion, additional walls did not increase the resting time, reduce aggressive social interactions or increase the synchrony of resting behaviour in ewes. It is probably more important for sheep to have enough resting space to lie simultaneously and the ability to keep within visual contact with group mates.

Keywords: sheep; resting behaviour; partition; wall

1.0 Introduction

In areas with cold winter climate, sheep are often housed indoors during winter. The typical way of housing sheep in Norway is in pens with slatted flooring and a space allowance of 0.7-0.9 m^2 per animal (Bøe and Simensen, 2003). In contrast, new regulations for organic sheep farming demands a minimum of 1.5 m^2 total area per animal, and half of this should be a resting area with a solid floor (0.75 m^2 per sheep) (Council Regulation (EC) No. 1804/1999).

In a production environment, animals often have to compete for resources. This may have major negative effects on feed intake (goats: Jørgensen et al., 2007), weight gain (e.g. sows: Brouns and Edwards, 1994), reproduction (e.g. Sinervo et al., 2000; Smith and Dobson, 2002) and disease (e.g. Hessing et al., 1994). Marsden and Wood-Gush (1986) found that next after feed, limited lying space caused most of the displacements in sheep. Moreover, a reduction in

resting space from 1.0 to 0.5 m^2 /ewe not only resulted in more displacements but total resting time and the degree of resting synchrony were also reduced (Bøe et al., 2006).

Domestic sheep and goats show a preference for lying next to a wall when resting (sheep: Marsden and Wood-Gush, 1986; Færevik et al., 2005; goats: Andersen and Bøe, 2007). One could argue that this preference for lying against a wall may only be a result of the animals' wishes to maximise the individual distance between them (Stricklin et al., 1998). Resting time also increases with increasing perimeter length (Bøe and Nyhammer, 2004). In general, increasing the pen area only involves a minor increase in available perimeter length, and hence large pens have a low proportion of accessible wall length per animal (e.g. Bøe et al., 2006). Partitions or walls between the animals at the feeding place have successfully been used to decrease food competition (pigs: Andersen and Bøe, 1999; cattle: DeVries and von Keyserlingk, 2006). Furthermore, partitions in the middle of a pen have been used to distribute animals more equally (e.g. Cornetto and Estevez, 2001). Providing additional walls not only serves to increase the overall vertical surface area in which the sheep could lay against but also decrease visual contact between individuals when available space is limited. We expect that "out of sight – out of mind" is a relevant explanation for what is occurring, since physical barriers create ways to flee and visually disappear from an attacker.

The aim of this experiment was to investigate how different configurations of additional pen walls in the resting area would affect resting pattern, overall use of the resting area and competition for resting space in small groups of ewes. We predicted that additional walls will increase resting time and the synchrony of resting, that fewer individuals will be resting in the activity area, and that the amount of aggressive interactions will decrease.

2.0 Materials and methods

Six groups of four animals were systematically rotated in a Latin Square design between six pens with different layouts of additional walls in the resting area (Figure 1). One of the pens had no additional walls and served as control (CON). All groups were kept for one week in each of the experimental pens, of which six days was the time to get accustomed to the pens before the ewes' behaviour was recorded.

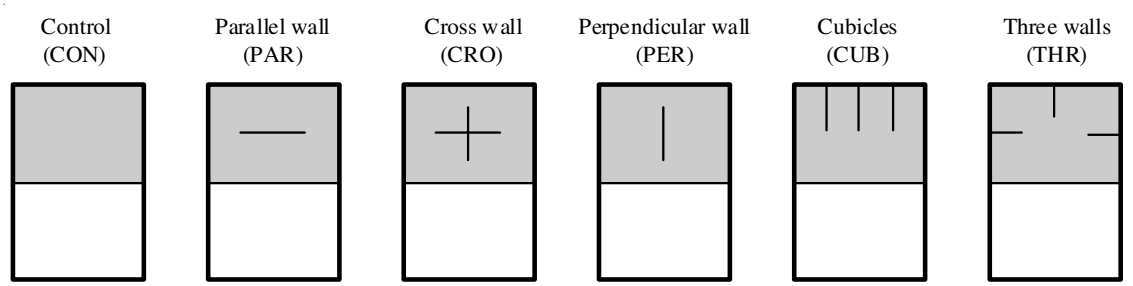

Figure 1. The different configurations of the additional walls on the resting area in the 6 treatment pens.

2.1 Experimental pens and additional walls

The experiment was conducted in an insulated building with mechanical ventilation, at the Norwegian University for Life Sciences, for six weeks in January and February 2007. Each experimental pen measured 3.0 m x 2.0 m (6.0 m^2), giving a total area per animal of 1.5 m^2, which equals the demand for space allowance in organic farming (Council Regulation, EC No. 1804/1999). The pen had a concrete floor, but half of the pen (3.0 m^2) served as resting

area with solid wooden floor elevated 10 cm from the ground (Figure 2). The activity area in front of the feed barrier was covered with wooden grids (approx. 5.0 cm high and 15.0 cm openings between beams) to make this area provide less support if the sheep should choose to use this as an alternative resting place.

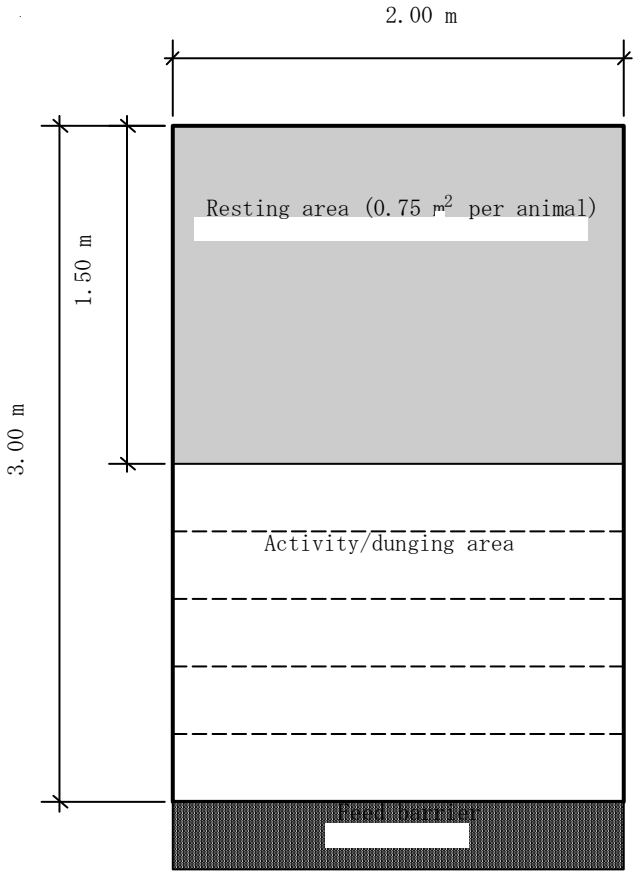

Figure 2. The experimental pen with resting area (grey), feed barrier and activity area with wooden grids on the floor.

For diagrams and further details on the treatment pen configurations, see Figure 1.

2.2 Animals and management

A total of 24 adult, pregnant ewes were divided into groups according to body weight so that the mean weight did not differ between groups (mean ± SE weight per group: 65.8 ± 0.7 kg; range: 65.0–66.7 kg). Each group was placed in an experimental pen and given *ad libitum*

access to good quality hay and free access to water from buckets. Along the length of the front pen wall (2.0 m) there was a horizontal feed opening (post and rail design), which gave the ewes 0.5 m feed space per animal and ensured easy access to the feed. Once a day hay residues were removed and the sheep were fed a standard concentrate pellet feed (approximately 0.2 kg per ewe) before fresh hay was administered. In addition to this, ewes had *ad libitum* access to mineral blocks.

Faeces and urine was removed from the resting area twice a day and a thin layer of sawdust was administered to ensure a dry and non-slippery surface. The activity/dunging area was cleaned out twice a week, so that the level of faeces always was kept below the wooden grids.

2.3 Observations

Within each group the animals were marked with a number (1-4) on their back using a marker spray for animals.

A wide angle videocamera mounted above each pen was directly connected to a computer using the MSH video system ® (www.guard.lv). We recorded the ewes' behaviour for 24 hours (from 10:00 a.m. to 10:00 a.m. the next day), at the 7th day in each experimental week. In the video analysis we used instantaneous sampling every 10 minutes to score the following behaviours:

- Lying in contact with an original pen wall
- Lying in contact with an additional wall
- Lying in the resting area without any wall contact

- Lying in contact with an additional wall, but blocking access to resting area for other sheep (occupying half or more than half of the opening needed to enter the resting area)
- Lying in the activity area

In order to determine if sheep were lying resting against a wall or just accidentally in contact with it, we defined 'lying in contact' when a sheep was lying resting in physical wall contact with at least its front half of the body (neck to belly). If the ewe was lying with its hind half of the body in contact with the wall, the behaviour was categorized in relation to how much of the body was in physical contact with the wall. A sheep resting with its shoulder in contact with an additional wall but also with its hindquarters touching an additional wall was scored as resting against the original pen wall.

All observations of resting behaviours were later summed to give the percent of total observations lying, and for each observation we also calculated how many ewes were resting simultaneously.

The following social interactions were scored continuously for six hours during daytime (10 a.m. to 4 p.m.):

- Displacing (a ewe has to leave her feeding or resting place after being physically pushed, butted or kicked by another ewe)
- Unsuccessfully attempting to displace (one ewe tries to use physical force either by pushing or kicking another ewe that is feeding or resting, but the receiving ewe does not give up her place)
- Head butting (using forehead to forcefully push or clash against another ewe's head)

In addition, we identified the initiator and receiver of the social interactions.

2.4 Statistical analysis

A mixed model of analysis of variance was applied to test the effects of additional wall configuration on all types of behaviours with wall configuration (six different types) and group (1 to 6) as class variables. Group was specified as a random effect (Hatcher and Stepanski, 1994).

The LS MEANS procedure was used to test the differences between means. Mean values per group were used as statistical unit.

3.0 Results

3.1 Resting behaviour

There was no significant effect of the treatments on the mean resting time (Mean ± SE for all groups: 70.3 ± 0.4 % of observations; Table 1).

On average 2.8 ± 0.02 animals rested simultaneously on the resting area. The highest number of animals resting simultaneously was found in the cross wall pen (CRO: 2.9 ± 0.03) and in the parallell wall treatment (PAR: 2.9 ± 0.04), but synchrony of resting did not differ significantly between treatments (CON: 2.8 ± 0.05; PAR: 2.8 ± 0.06; CUB: 2.8 ± 0.04; THR: 2.8 ± 0.05).

Ewes spent significantly more time resting in the activity area in the cubicle (CUB) treatment than in the other treatments (Table 1). Total resting time, time spent resting in the activity area and resting synchrony did not differ significantly between groups.

Table 1. Resting behaviours and use of additional walls in the resting area (mean ± SE).

Resting behaviours	**Control (CON)**	**Parallel wall (PAR)**	**Cross wall (CRO)**	**Perpendicular wall (PER)**	**Cubicles (CUB)**	**Three walls (THR)**	**$F_{5,25}$**	**P-value**
Total lying (% of total observations)	69.5 ± 1.0	70.1 ± 1.0	71.2 ± 1.0	71.3 ± 1.1	69.5 ± 1.0	70.0 ± 1.1	0.94	ns
Lying in the activity area (% of resting observations)	18.0 ± 6.9 [a]	17.2 ± 4.9 [a]	15.8 ± 2.9 [a]	12.0 ± 3.5 [a]	30.6 ± 5.7 [b]	19.1 ± 3.0 [a]	3.6	<0.05
Lying in the resting area without wall contact (% or resting behaviours)	8.9 ± 3.9 [a]	0.23 ± 0.1 [b]	0.8 ± 0.6 [b]	4.4 ± 1.3 [ab]	0.3 ± 0.1 [b]	3.8 ± 1.4 [ab]	3.2	<0.05
Lying against original pen wall (% of resting behaviours)	72.2 ± 4.2 [a]	55.5 ± 4.8 [b]	55.0 ± 5.0 [b]	62.8 ± 2.7 [ab]	5.0 ± 2.4 [c]	41.5 ± 2.5 [d]	51.9	<0.0001
Lying against additional wall (% of resting behaviours)	-	25.5 ± 0.5 [ab]	25.3 ± 3.8 [ab]	17.8 ± 2.8 [a]	32.3 ± 5.4 [b]	29.6 ± 4.4 [ab]	11.9	<0.001
Lying against additional wall blocking for others (% of resting behaviours)	-	1.5 ± 0.9 [a]	2.9 ± 1.2 [a]	2.8 ± 0.8 [a]	31.6 ± 3.4 [b]	5.8 ± 3.0 [a]	41.8	<0.0001

3.2 Resting against additional walls

In 2.1 ± 0.6 % of all resting observations, ewes were lying without wall contact and this occurred more often in the control than in the PAR, CRO or CUB treatments (Table 1).

The ewes spent 34.3 ± 2.2 % of observations resting against an original pen wall. A mean of 15.4 ± 1.5 % of observations were spent resting against an additional pen wall. The additional walls were used significantly more in CUB compared to in PER (Table 1). The behaviour: 'lying against an additional wall blocking access to resting area for other sheep' was observed significantly more in CUB than in any other treatments (Table 1). There was no significant effect of ewe group on the proportion of time spent resting against a wall.

3.3 Social interactions

In general, there were few social interactions. Therefore we only used observations of ewes initiating social interactions. There was no significant effect of the treatments on the number of displacements (Table 2). Unsuccessful displacement attempts were rare (Mean ± SE: 0.7 ± 0.09 instances per ewe) and none of these behaviours differed significantly between treatments. We observed significantly more head butting in the THR treatment compared to in the CRO treatment (Table 2). The amount of social interactions did not differ between ewe groups.

Table 2. Social interactions in the different treatments (mean ± SE).

Social interactions (total number per ewe)	**Control (CON)**	**Parallel wall (PAR)**	**Cross wall (CRO)**	**Perpendicular wall (PER)**	**Cubicles (CUB)**	**Three walls (THR)**	$F_{5,25}$	**P-value**
Displacements in total	6.3 ± 1.4	3.8 ± 0.7	4.7 ± 1.2	5.2 ± 0.4	5.4 ± 0.9	3.2 ± 0.6	1.6	ns
Displacements from the resting area	1.8 ± 0.3	1.1 ± 0.4	2.1 ± 0.8	0.9 ± 0.3	1.6 ± 0.4	0.9 ± 0.3	1.9	ns
Unsuccessful displacement attempts	0.7 ± 0.3	0.5 ± 0.3	0.9 ± 0.2	0.8 ± 0.05	0.9 ± 0.2	0.5 ± 0.2	0.78	ns
Head butting	1.8 ± 0.3 [ab]	1.2 ± 0.4 [ab]	0.4 ± 0.2 [a]	1.2 ± 0.4 [ab]	2.2 ± 0.6 [ab]	3.8 ± 1.6 [b]	2.6	<0.05

4.0 Discussion

Contrary to what was predicted, provision of additional walls in the resting area did not significantly affect total resting time or synchrony of resting. The total resting time in the present experiment was somewhat longer than in previous, comparable experiments with sheep (Færevik et al., 2005; Bøe et al., 2006). Deep pens of the same size as the one used in our experiment are also reported to give a similar resting time as pens with a wide shape (Bøe et al., 2006). However, a smaller sized resting area may limit the effects of additional walls since these walls may allow some individuals to block others from resting. It is still unlikely that a larger resting area will be used under commercial conditions. Unfortunately, to our knowledge, few if any have looked at the effects of providing additional walls on the resting patterns of farm animals. When the ewes were offered cubicles on the lying area, they rested more in the activity area. This effect is most certainly due to some ewes blocking the entrance, and thus preventing others from lying in the resting area. An alternative explanation for the low success of the cubicle configuration is that the ewes did not prefer to rest in cubicles with solid walls that strongly limited the opportunity for vigilance and visual contact with the other group members. However, even in this inappropriate configuration, the total lying time was maintained. The fact that total resting time is very similar in all treatments, confirm the results found in cattle that resting is a high priority and an inelastic behavioural need (Jensen et al., 2005). In the present experiment, the synchrony of lying was relatively high. Often complete synchrony of resting was achieved by some individuals lying in the less attractive activity area. This is probably due to a general high level of synchronisation of maintenance behaviours like resting and feeding in sheep (Rook and Penning, 1991).

The provision of additional walls did not decrease the number of displacements from the resting area compared to the control treatment, and the number of displacements did not differ between treatments. This shows that additional walls did not decrease competition for lying space. Head butting was less commonly observed in the CRO (cross wall) than the THR (three wall) treatment, possibly due to a greater opportunity to monopolize the resting area in the latter or that the CRO treatment function better as a hide area. The same could be true for the cubicle configuration where the most blocking behaviour was observed. Comparatively, the use of partitions in the feeding area successfully reduces displacements and other aggressive interactions both in pigs (e.g. Andersen and Bøe, 1999) and cattle (DeVries and von Keyserlingk, 2006).

Sheep have been observed to lie very close to each other in up to 70 % of total resting observations (Bøe et al., 2006) whereas dairy goats only rest in contact with another goat in 5 % of resting observations (Andersen and Bøe, 2007). Furthermore, the number of sheep resting close together was still high (59.4 %) even when given 1.0 m^2 per animal resting space (Bøe et al., 2006), while goats decreased this behaviour to only 2.9 % of total resting observations when given the same resting space (Andersen and Bøe, 2007). This indicates that the need for visual separation on the resting area is less for sheep than for goats. From earlier experiments we know that sheep prefer to lie against a wall when resting (e.g. Færevik et al., 2005), and that they prefer to rest simultaneously even when the resting area is limited (this experiment).

In conclusion, additional walls did not increase the resting time, reduce aggressive social interactions or increase the synchrony of resting behaviour in ewes. It is probably more

important for sheep to have enough resting space and the ability to rest simultaneously than the ability to avoid visual or physical contact with other sheep.

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