Perch Arrangements in Small-Group Furnished Cages for Laying Hens

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Primary Audience: Advisors, Researchers, Quality Assurance Personnel, Plant Managers

SUMMARY

In 2 trials, including 2,768 birds in total, 3 different perch arrangements were evaluated in furnished 8-hen cages for laying hens. The hybrids used were Lohmann Selected Leghorn and Lohmann Brown in trial 1 and Hy-Line White and Hy-Line Brown in trial 2. The furnished cages were identical in all other respects than the arrangement of perches. A perch was either fitted across the cage, providing 12 cm of perch per hen, or 2 perches were installed in a cross, implying 15 cm per hen. Although the perches arranged in a cross provided more perch per hen than the single perch fitted across the cage, perch use at night by the birds was similar or lower as compared with the single perch. Hence, the way perches are arranged in the cage may be as important as perch length itself to achieve a high use at night. Perch arrangement did not affect production, mortality, or egg quality. Compared with a conventional battery cage, also included in the trials, hygiene was inferior in the furnished cages, but there was no difference in proportions of dirty eggs. Differences in proportions of cracked eggs were found between furnished and conventional cages in 1 of the trials. However, on the whole, production, mortality, and egg quality were at similar levels in all cage models. Genotype differences were found in production traits, egg quality, hygiene, and in the use of perches and nests.

Key words: furnished cage, conventional cage, egg quality and production, perch, hygiene, nest, genotype

2007 J. Appl. Poult. Res. 16:322–330

DESCRIPTION OF PROBLEM

In Sweden, conventional cages have been banned since 1999 [1], and at present, about 40% of the 6 million laying hens in Sweden are housed in furnished cages (i.e., in cages furnished with nests, litter, and perches). The most frequently used furnished cage in Sweden at present is a cage for 8 hens with the nest positioned at one end of the cage and the litter box placed on top of the nest. This cage model has its origin in the Edinburgh modified cage concept [2]. During the development of this concept of cage, before standards regarding perch length were prescribed, a practical perch arrangement was to fit a perch across the width of the cage (i.e., parallel to the feed trough). Perch length per hen then corresponds with the required length of 12 cm of feed trough per hen in Sweden [3, 4]. However, since 2003, hens in furnished cages must have 15 cm of perch per hen according to a European Union Council Directive [5]. Therefore, in the present concept of furnished cage, the required perch length can no longer be achieved by a single perch fitted across the width of the cage.

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When new perch arrangements are introduced, it is of great importance that cage hygiene is not impaired. It is important that birds can move over all areas in the cage to efficiently trample manure down through the cage floor [6]. Otherwise, not only bird hygiene but most likely also hygiene of eggs will be impaired. Furthermore, it is essential that perches are perceived attractive to the hens and enable a simultaneous use at night. A high use of perches at night reduces the risk of hens spending the night inside nests, causing poor nest hygiene. With the exception of Sweden, washing of table eggs is not allowed in the European Union [7]. Therefore, producing clean eggs is very important to get as high an economic yield as possible.

The objective of this study was to compare 3 arrangements of perches in furnished cages identical in all other respects. The study, comprising 2 trials on entire production cycles, focused on production, egg quality, hygiene, and use of perches by hens at night. Genotype differences were also considered. Furthermore, a conventional 4-hen cage was included as comparison.

MATERIALS AND METHODS

Housing

In 2 consecutive trials, a furnished cage and a conventional battery cage were used in 3 vertical-tier batteries in the same experimental building. The conventional cage was a 4-hen metal cage measuring 48 × 50 × 38 cm (width × depth × height). The furnished cage was the comfort cage design for 8 hens [8] based on the Edinburgh modified cage [2, 9] (Figure 1). The cage, nest and litter box excluded, measured 96 × 50 cm (width × depth) and was 45 cm high at the rear. A nest box, 27-cm high in the front, 24-cm wide and 50-cm deep, was positioned at one end of the cage. On top of the nest was a litter box. A time-controlled closing mechanism enabled birds to visit the litter box only in the period from 8 h after lights on until 30 min before dark. All cages fulfilled the Swedish Animal Welfare Directives of a minimum of a 600-cm^2 cage floor area per hen, with areas of nest and litter box excluded [4].

The nest, lined with brown artificial turf, was partitioned from the cage area by a metal sheet. Birds entered the nest through an opening at the front of the partition, near the feed trough. In the front, nests were enclosed by plastic black curtains hanging behind the gates of the cages. These curtains ended about 1 cm above the cage floor.

In the furnished cages, perches were arranged in 3 ways (Figure 2). One-third of the cages had a perch parallel to the feed trough, providing 12 cm of perch per hen (A). In the second perch arrangement, a transverse perch was added to the perch parallel to the feed trough (B). In the third perch arrangement, the perch parallel to the feed trough was shortened by 10 cm and the transverse perch lengthened correspondingly (C). The perch arrangements with a transverse perch added (cage models B and C) provided 15 cm of perch per hen.

Birds, Management, and Feeding

All pullets were reared in conventional rearing cages in the same building and, in accordance with prohibition in Sweden, without beak-trimming. Trial I comprised 1,608 hens, of which half were Lohmann Selected Leghorn (**LSL**) hens and half were Lohmann Brown (**LB**) [10]. These birds were transferred to the experimental building, where they received 9 h of light per d at 16 wk of age. The light was successively increased to 15 h at 22 wk of age.

Trial 2 included 1,160 hens—580 Hy-Line White birds and 580 Hy-Line Brown (**HYB**) [11] birds. These hens were 17 wk old when transferred to the experimental building. Light was then on for 12 h per day and was successively increased to 16 h at 25 wk of age.

In both trials, light was increased for 6 min at lights-on in the morning to imitate dawn and dimmed for 6 min in the evening—dusk. Manure was removed twice a week with belts, and litter boxes in the furnished cages were filled by hand with sawdust. During rearing, the pullets were fed a conventional grower crumbled diet. At arrival to the experimental building and continuing until slaughter, the birds received a normal layer crumbled diet. In trial 1, the diet had a calculated content of 16.0% CP, 2,700 kcal/kg of ME, 3.6% Ca, and 0.6% P. In trial 2, the calculated content of the diet was 16.1% CP, 2,680 kcal/kg of ME, 3.8% Ca, and 0.6% P. The

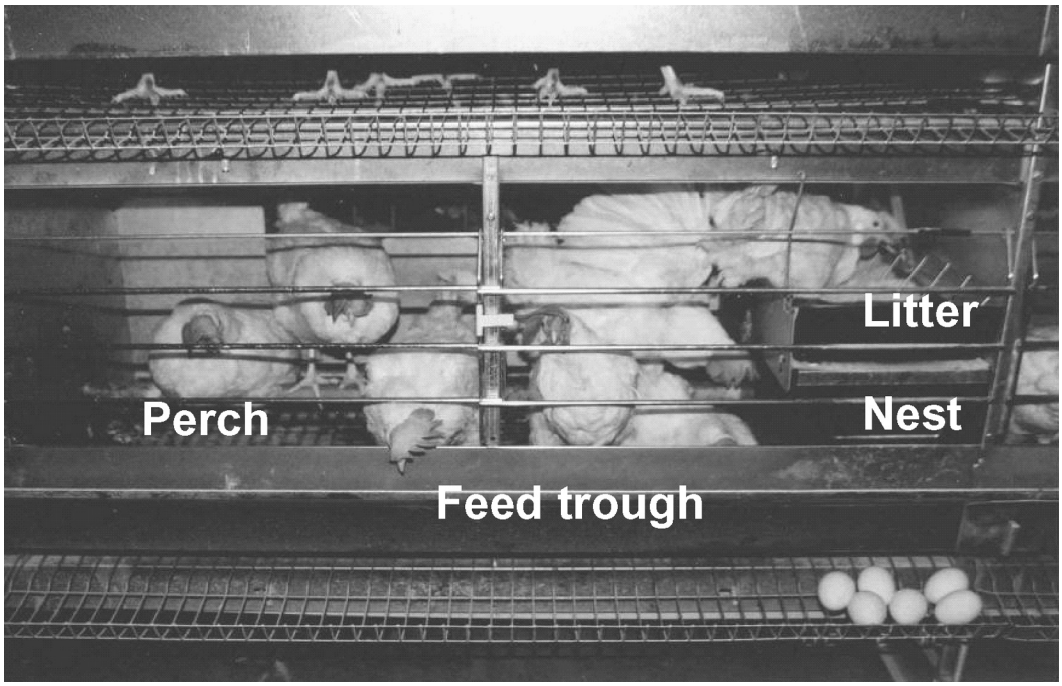

Figure 1. The comfort cage for 8 hens stocked with Lohmann Selected Leghorn hens. A perch was positioned in the cage area, and at the right end of the cage, a litter box was positioned on top of a nest box. Water was provided by nipple drinkers positioned in the rear of the cage, and feed was available in a trough at the front of the cage.

feed was distributed by automatic chain feeders 4 times a day.

Recording and Statistical Analysis of Data

In trial 1, there were 18 replicates of conventional cages in total, each replicate comprising 9 cages (i.e., 36 birds). In trial 2, the total number of replicates of conventional cages was 10, each replicate comprising 5 cages (i.e., 20 birds). In both trials, the total number of replicates of furnished cages was 24 (i.e., 4 replicates for each combination of furnished cage design and hybrid). Each replicate in the furnished cages consisted of 5 cages (i.e., 40 birds).

Production and mortality were recorded daily per replicate from 20 to 80 wk of age in trial 1 and from 20 to 78 wk of age in trial 2. Hens that died during the study were subjected to autopsy and were not replaced. There were no egg collection belts in the egg cradles, and eggs were collected manually. Egg weight was recorded weekly. A small version of a commercial egg-candling machine was used to detect cracked and dirty eggs. All eggs collected during 5 consecutive days were candled on 5 occasions in trial 1 (at 22, 32, 45, 57, and 77 wk of age) and on 6 occasions in trial 2 (at 24, 35, 51, 56, 64, and 73 wk of age).

Scoring of hygiene of plumage and foot was carried out at 55 wk of age in trial 1 and at 39 wk of age in trial 2. The scoring system assigned 1 to 4 points for each character, in which a higher score indicated a better condition [12]. Scoring was performed on all birds in 2 furnished cages per replicate (trial 1 and trial 2) and in all birds in 3 (trial 1) or 2 (trial 2) conventional cages per replicate.

At the end of trial 1, when birds had been removed from the cages, scoring of hygiene of nests and cage floors was conducted in all cages. The scoring comprised 1 to 4 points, in which a higher score indicated a cleaner condition.

The location of all birds in the furnished cages was recorded 1 h after lights-out on 3 occasions (at 21, 41, and 76 wk of age) in trial 1 and once (at 75 wk of age) in trial 2. The position of all eggs in the furnished cages before egg collection was recorded on 4 occasions in

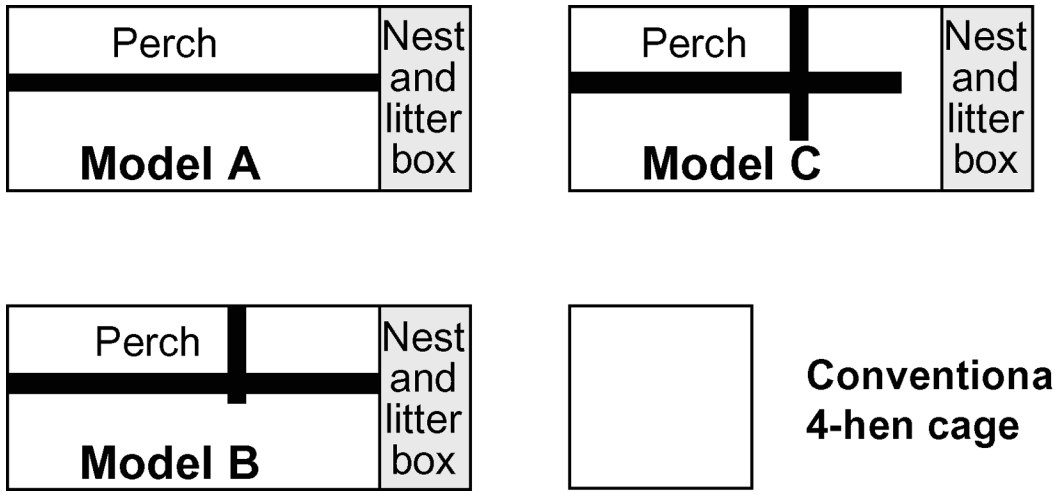

Figure 2. Schematic illustration of the 4 cage models included in the trials, view from above. Apart from perch arrangements, the 3 furnished cage models were identical. The furnished cages housed 8 hens and had nest and litter facilities at one end of the cage. Perch length per hen was 12 cm in model A and 15 cm in models B and C.

trial 1 (at 21, 33, 46, and 56 wk of age) and on 6 occasions in trial 2 (at 23, 35, 51, 56, 65, and 74 wk of age).

Before statistical analysis, traits given in proportions (mortality, cracked eggs, dirty eggs, egg position, and bird location) were subjected to arcsine transformation [13]. Statistical analyses were performed using the GLM procedure of SAS software [14]. To analyze individual differences among treatments, Fisher's protected least-significant difference test was used. In the statistical models hybrid, cage design and battery tier were considered fixed. Two-way interactions between fixed effects were included in all analyses.

RESULTS AND DISCUSSION

Production and Mortality

In trial 1, the LSL hens were affected by leucosis, causing a considerable loss of birds. However, mortality rates were not significantly affected by hybrid in any of the trials. Cage model had no effect on mortality in trial 1 (Table 1), whereas in trial 2, there was a tendency ($P \leq 0.09$) of mortality being higher in the conventional cage model as compared with the furnished models (Table 2). This fairly high mortality in the conventional cages was mainly due to problems with cannibalism in a limited number of cages. In the present study, the group size can be considered as small in the furnished cages. If furnished cages for larger groups of hens had been used, it is possible that the mortality rate would have been different [15]. In trial 2, there was an interaction between battery tier and hybrid (not in table). The interaction occurred because the mortality of HYB hens was higher in the top battery tier than in the other tiers.

In trial 2, there was a tendency ($P \leq 0.07$) of egg weight being higher in the conventional cages than in the furnished cages (Table 2). However, cage model did not affect laying percentage or egg mass produced per hen housed, either in trial 1 or in trial 2, which agrees with earlier studies on furnished cages very similar to the ones presently used [16]. Although not significantly different in trial 2, egg production per hen housed was variable among treatments, perhaps due to the rather high mortality in some of the conventional cages.

In trial 1 (Table 1), there were differences in production between the hybrids LSL and LB. Compared with LSL, LB hens had a lower laying percentage but higher egg weight and higher egg mass production per hen housed. A higher weight of eggs from LB hens compared with LSL has been found in several other studies [17, 18]. Genotype differences in production capacity are a common finding and not surprising [19, 20]. In trial 1, an interaction between hybrid and battery tier was found (not in table). This

Table 1. Production, mortality, hygiene, and use of facilities as influenced by cage model, hybrid, and battery tier, from 20 to 80 wk of age (trial 1)

	Cage model				Hybrid[1]		Battery tier			Statistical significance		
Trait	FC[2] model A	FC model B	FC model C	Conventional cage	LSL	LB	Top	Middle	Bottom	Cage model	Hybrid	Battery tier
Laying, %	87.8	88.3	87.6	87.9	89.2[a]	86.6[b]	88.7[a]	87.1[b]	87.9[ab]	NS[3]	***	*
Egg weight, g	65.1	65.1	64.7	65.4	63.7[b]	66.5[a]	64.8	65.1	65.4	NS	***	NS
Egg mass, kg/hen housed	23.4	23.6	23.3	23.4	23.0[b]	23.8[a]	23.5	23.4	23.3	NS	**	NS
Mortality,[4] %	6.6	5.0	4.1	5.4	6.1	4.5	5.5	4.3	6.1	NS	NS	NS
Cracked eggs,[4] %	3.2[a]	3.2[a]	3.6[a]	2.2[b]	2.2[b]	3.4[a]	2.8	2.5	3.1	***	***	†
Dirty eggs,[4] %	6.4	6.3	6.5	7.1	9.0[a]	4.3[b]	6.4	6.6	7.1	NS	***	NS
Cage floor hygiene[5]	3.1[b]	3.0[b]	2.6[c]	3.9[a]	3.1	3.3	3.4[a]	3.1[b]	3.1[b]	***	†	**
Nest hygiene[5]	3.0	3.2	2.9	—	2.6[b]	3.5[a]	3.5[a]	2.7[b]	2.9[b]	NS	***	*
Plumage hygiene[5]	3.90[ab]	3.80[bc]	3.79[c]	3.94[a]	3.74[b]	3.98[a]	3.88	3.83	3.86	**	***	NS
Foot hygiene[5]	3.38[b]	3.45[b]	3.34[b]	3.93[a]	3.53	3.51	3.46	3.55	3.56	***	NS	NS
Birds on perches after dark,[4] %	84.9	85.0	80.6	—	85.9[a]	81.1[b]	82.5	84.1	83.9	†	*	NS
Birds in nest after dark,[4] %	4.9	3.8	4.9	—	6.7[a]	2.3[b]	5.0	4.1	4.6	NS	**	NS
Eggs in nest,[4] %	96.4	96.1	93.7	—	97.4[a]	93.4[b]	96.2	94.4	95.5	NS	**	NS

[a–c]Values within treatment followed by codes without any common letter are significantly different, at least on a $P \leq 0.05$ level.
[1]LSL = Lohmann Selected Leghorn; LB = Lohmann Brown.
[2]FC = furnished cage.
[3]NS = $P > 0.10$.
[4]Presented as mean values instead of least-squares means because of the arcsine transformation.
[5]Scores from 1 to 4, in which higher scores indicate better condition.
†$P \leq 0.10$; *$P \leq 0.05$; **$P \leq 0.01$; ***$P \leq 0.001$.

Table 2. Production, mortality, hygiene, and use of facilities as influenced by cage model, hybrid, and battery tier, from 20 to 78 wk of age (trial 2)

	Cage model				Hybrid[1]		Battery tier			Statistical significance		
Trait	FC[2] model A	FC model B	FC model C	Conventional cage	HYW	HYB	Top	Middle	Bottom	Cage model	Hybrid	Battery tier
Laying, %	84.2	84.0	83.8	83.4	83.9	83.9	84.4	84.4	82.9	NS[3]	NS	†
Egg weight, g	66.1	66.2	66.6	67.0	66.6	66.4	66.5	66.3	66.6	†	NS	NS
Egg mass, kg/hen housed	22.6	22.3	22.2	21.6	22.4	21.9	22.0	22.4	22.1	NS	NS	NS
Mortality,[4] %	2.8	3.8	4.7	10.5	4.0	7.5	8.5	4.3	4.2	†	NS	NS
Cracked eggs,[4] %	3.0	2.7	2.7	2.8	2.2[b]	3.4[a]	3.0	2.3	3.0	NS	**	NS
Dirty eggs,[4] %	4.2	4.2	4.5	5.1	5.7[a]	3.4[b]	4.3	4.6	4.8	NS	***	NS
Plumage hygiene[5]	3.32[b]	3.43[b]	3.43[b]	3.97[a]	3.39[b]	3.68[a]	3.56	3.52	3.54	***	***	NS
Foot hygiene[5]	3.27[ab]	3.17[b]	3.11[b]	3.50[a]	3.56[a]	2.96[b]	3.16	3.30	3.32	*	***	NS
Birds on perch after dark,[4] %	88.9[a]	85.8[a]	82.5[b]	—	84.4	87.1	89.1[a]	83.5[b]	84.6[ab]	*	†	*
Birds in nest after dark,[4] %	6.3	7.4	7.7	—	10.5[a]	3.8[b]	7.0	7.0	7.4	NS	***	NS
Eggs in nest,[4] %	95.5	96.0	96.9	—	98.0[a]	94.3[b]	96.2	96.5	95.7	NS	**	NS

[a,b]Values within treatment followed by codes without any common letter are significantly different at least on a $P \leq 0.05$ level.
[1]HYW = Hy-Line White; HYB = Hy-Line Brown.
[2]FC = furnished cage.
[3]NS = $P > 0.10$.
[4]Presented as mean values instead of least-squares means because of the arcsine transformation.
[5]Scores from 1 to 4, in which higher scores indicate better condition.
†$P \leq 0.10$; *$P \leq 0.05$; **$P \leq 0.01$; ***$P \leq 0.001$.

interaction occurred because the weight of eggs from LB hens was lower in the top battery tier compared with the other tiers, whereas battery tier did not affect the weight of eggs from LSL. In trial 2, there were no differences in production between the genotypes Hy-Line White and Hy-Line Brown.

Laying percentage was higher in the top battery tier than in the middle in trial 1, and in trial 2, there was a tendency of lower laying percentages in the bottom tier. These differences are difficult to explain but may have been caused by differences in lighting in the battery tiers. However, no effect of tier was found for the other production traits.

Exterior Egg Quality and Hygiene

Perch arrangement in the furnished cages had no effect on proportions of cracked eggs. In trial 1 (Table 1), the proportion of cracked eggs was lower in the conventional cage than in the furnished cage models, whereas there was no difference in trial 2 (Table 2). Higher proportions of cracked eggs in furnished cages compared with conventional cages have been reported in several earlier studies [16, 21, 22]. However, the furnished cages used in the present trials have developed in this respect, showing that it is possible to achieve similar results in furnished and conventional cages. In conventional cages, eggs rolling out from the cage are spread over the whole cage width, whereas in furnished cages, there is an accumulation of eggs in the cradle in front of the nest, especially when the nest is narrow and most eggs are laid in there. Furthermore, when the nest is deep, an egg laid in the rear of the nest accelerates on its way out of the nest and rolls with a rather high speed into the egg cradle. If it rolls into other eggs already positioned in the cradle, there is a considerable risk that the shells of some eggs will crack. Devices stopping eggs or reducing the speed of them on their way out of the nest have proven to be very efficient in reducing the proportion of cracked eggs in this concept of furnished cages [16]. The nest curtain hanging in the front of nests in the furnished cages used in the present trials is an example of an efficient egg-saving device [16].

The difference regarding cracked eggs found between the furnished and conventional cages in trial 1 and between genotypes in both trials may be related to the behavior of the genotypes. For example, a hen preferring to stay close to the egg cradle or in the rear of the nest when laying its egg may have affected incidence of cracked eggs. Possible genotype differences (e.g., in egg weight, egg shape index, or in other eggshell characteristics) may also affect proportions of cracked eggs [22].

In general, hygiene of the feet and plumage of birds was inferior in the furnished cages as compared with the conventional cage, which agrees with an earlier study [21]. Interactions between hybrid and cage model in plumage hygiene were found in both trials. These occurred because differences in plumage hygiene between the cage models (conventional vs. furnished cages) were larger in the white genotypes than in the brown. However, most likely these interactions as well as the superior hygiene of the plumage of brown birds, found in both trials, occurred because dirt is easier to detect on white feathers than on brown.

Cage floor hygiene (measured only in trial 1) was better in the conventional cages than in the furnished, but no difference in dirty eggs was found between the cage models. In both trials, the brown hybrids had lower percentages of dirty eggs than the white ones, which is a common finding [16]. The grading of cage hygiene in trial 1 showed that LSL hens had dirtier nest linings and a tendency to have dirtier cage floors than LB hens. The inferior nest hygiene may have contributed to the higher levels of dirty eggs produced by LSL, but likely, eggshell color influenced the result, because dirty spots are easier to detect on white egg shells than on brown.

Hygiene of nests and cage floors was better in the top tiers than in the middle and bottom tiers (trial 1; Table 1). It is possible that birds in the top tiers were more active, because they received more light than birds in cages below and kept the cage floor clean by increased movement. The superior hygiene of nests in top tiers is surprising, because those nests were occupied by hens resting in them at night to the same extent as nests in the other tiers. However, no effect of tier was found in proportions of dirty eggs.

Use of Facilities

There was a significant effect of perch arrangement on the use of perches by birds in trial 2 (Table 2) and a tendency ($P \leq 0.07$) of effect in trial 1 (Table 1). Interestingly, in both trials, simultaneous use at night was lower with perch C than with the other 2 arrangements. Thus, although perch A provided only 12 cm of perch per hen, which means 3 cm less space per hen than with perch B or C, use was as high as with perch B and higher than with perch C. In the present trials, both perch arrangements providing 15 cm per hen were constructed by 2 perches forming a cross. Only 1 hen could sit where the perches crossed each other, and this hen then occupied a considerable perch length. This may explain why perch use was not higher in the 15-cm perch arrangements than with the perch providing only 12 cm per hen. Hence, the way perches are arranged in the cage may be as important as perch length itself to achieve a high use of perches at night.

Several studies have shown that hens are motivated to rest on perches at night [23, 24], and in housing conditions in which perching is not possible, hens may experience reduced welfare [23]. In the present study, we do not know the reason why some hens did not rest on the perches at night, and, in fact, it is possible that they preferred to spend the night on the cage floor or in the nest. However, if all hens in a cage are motivated to rest on perches at night, it is important from a bird welfare point of view that there is enough room to allow simultaneous use.

The risk of hens defecating in the nests due to spending the night in there may be lower with a high use of perches. In the present trials, averages of 83.5 and 85.7% of the birds rested on the perches at night, which agrees well with earlier experiences in research [16, 22] and in practice [25]. Although perches were used to a fairly high extent after dark, it is possible that an even higher use can be achieved with alternative perch arrangements if the cross formation can be avoided. However, in the present concept of a furnished cage with the litter box located on top of the nest, it is important that the perch is not located too far away from the litter box, because birds make use of the perch when entering the litter box. If the litter box is perceived as difficult to enter, hens may not use it [26].

Genotype differences in the use of perches after dark were found in both trials. In trial 1, use was higher for LSL compared with LB, and in trial 2, HYB hens tended to use perches to a higher extent than Hy-Line White hens. Hens not resting on perches spent the night either on the cage floor or in the nest. Interestingly, in both trials, the proportions of hens spending the night in nest were higher for the white genotype than for the brown. Likely, the unintended use of nests at night caused the inferior hygiene of nest linings in cages with LSL hens (measured only in trial 1). In the present trials, the proportions of hens spending the night in nests were high, especially in the white genotypes. In other studies, conducted in similar cages with either a higher [21] or a lower [16] use of perches than in the present trials, proportions of hens staying in nests overight were lower.

On average, 95.5 and 96.0% of all eggs were laid in nests in trial 1 and 2, respectively. This indicates a high acceptance of nests, which agrees with other studies on furnished cages with well-designed nests [27, 28]. Due to the time-controlled closing of the litter boxes, no eggs were laid in the litter boxes.

CONCLUSIONS AND APPLICATIONS

1. Perch arrangement affects the use of perches at night by hens. The way perches are arranged in the cage may be as important as perch length itself to achieve a high use of perches at night.
2. Perch arrangement does not affect production or mortality. With furnished cages for small groups of hens, production and mortality are at similar levels as in conventional cages.
3. Hygiene of cage environment and birds is better in conventional than in furnished cages. However, with perch arrangements allowing birds to move over all areas in the cage, the difference in hygienic condition is moderate and does not affect proportions of visible dirty eggs.
4. With well-designed furnished cages, proportions of cracked and dirty eggs are at similar levels as in conventional cages.

5. There are obvious effects from genotypes on production, egg quality, and hygiene in conventional and furnished cages and on use of facilities in the latter housing system.

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Acknowledgments

This study was made possible through sponsorship by the European Union project, Egg Defence, and by the Swedish Farmers Foundation for Agricultural Research. We also wish to thank Bröderna Victorsson AB for providing the furnished cages requested for the study.