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Nest size effects on incidence of floor eggs and on eggshell quality in commercial deep litter systems for laying hens

Wirkung von Nestgrößen auf Frequenz verlegter Eier und auf Eischalenqualität in kommerziellen Tiefstreusystemen für Legehennen

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Introduction

In deep litter egg production systems with access to slatted floor, litter, and nests, eggs laid outside the nests (floor eggs) may constitute a big problem both from a working point of view (Ehlhardt et al., 1989) as well as from a hygienic point of view, as floor eggs more frequently are dirty (Nørgaard-Nielsen et al., 1993).

Genetical, rearing and environmental factors are known to influence the hens' nesting behaviour and thus the frequency of floor eggs (see Appleby, 1984, for a review).

The influence of the nest size on the frequency of floor eggs in a given house is sparsely elucidated. In a work by Petersen (1989) White Leghorn hens were given 3 choices with the following result; 1) single nests: 79% of the eggs; 2) community nests: 14% of the eggs; 3) floor eggs: 7%.

In the present study the specific effects of nest size on incidence of floor eggs and eggshell quality were sought determined in commercial deep litter systems for laying hens.

Material and methods

4 experiments were carried out in 3 commercial houses as follows:

Experiment	House	Dimensions	Pens
1 + 2	A	12 × 75 m	4
3	B	12 × 23 m	2
4	C	19 × 18 m	2

The arrangement in all houses was nests in the middle of the house, manure pits covered with 1″ × 2″ wire mesh and with perches in front of the nest and litter towards the outer walls. 30% of the accessible area in house A and 50% of the area in houses B and C were litter areas. Besides a longitudinal division of house A, it was also crosswidely divided and the treatments were crossed over so that each treatment took place in each side and end of the house. Replications in experiments 3 and 4 were not possible, but the results are stated as additional information. For a review of the experimental houses and their arrangements, see table 1.

Collection of eggs was done by hand in experiments 1 and 3, and by automatic collection belts in experiments 2 and 4. An approximately 1 m wide passage was arranged in the middle of the house in experiments 1 and 3, making collection of eggs possible from both sides.

All houses were equipped with chain feeding and round water troughs. The hens were fed ad libitum with a commerical diet: pellets crossed, 1140-1155 MJ ME per 100 kg, 17.0–17.4% crude protein.

The hens were of medium heavy strains laying eggs with brown shell; in experiments 1, 2, and 3 Lohmann Brown[a] and in experiment 4 ISA Brown[b]. The chickens for one experiment were reared in the same house without access to perches, however, the chickens for experiment 3 had access to perches during the entire rearing period (approximately 5 cm perch per chicken; see Petersen, 1989). Feeding, vaccination etc. during rearing were as recommended by the respective breeding companies. The chickens were transferred to the laying houses 1–2 weeks before onset of lay and distributed randomly to treatments and replications, respectively. The registration of data was initiated at 20 weeks of age and lasted 12 months – experiment 2, however, only 11 months. In total 15,519 hens formed part of the experiments.

Each day, the number of eggs in nests, number of floor eggs and number of dead hens were recorded for each replication. Furthermore an investigation of the shell quality of the nest eggs (cracked and dirty eggs) during the last third of the test period was carried out. 4–7 samples of 300 eggs from each replication were candled and graded clean and dirty according to the criteria used in the Danish egg packing stations.

The light in the houses was recorded with a lux meter[c] on selected places, see table 2.

Data concerning mortality were subject to a χ^2-test. Other data were analysed with the General Linear Model (GLM) procedure (SAS Institute, 1988). Data are stated and analysed

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[a] Lohmann Tierzucht GmbH, D-27454 Cuxhaven, Germany
[b] ISA, 69427 Lyon, France
[c] Gossen Mavolux digital

Table 1. Experimental plan
Versuchsplan

Experiment	House	Nest sizes (width × dept, cm)	No. of replicates	No. of hens per replication	Nesting area m^2 per 100 hens	No. of hens per nest	No. of hens per m^2 house	Nesting material
1	A	23 × 30	2	1500	1.334	5.2	7.3	Artificial grass[A]
		40 × 30	2	1460	1.430	8.4	7.1	Artifical grass
2	A	23 × 30	2	1140	0.881	7.9	5.1	Rubber mats[B]
		115 × 45[C]	2	1600	0.971	53.3	7.1	Rubber mats
3	B	23 × 30	1	859	1.607	4.3	6.2	Artificial grass
		40 × 30	1	860	1.674	7.2	6.2	Artificial grass
4	C	23 × 30	1	1200	0.862	8.0	7.0	Artificial grass
		60 × 55[D]	1	1200	0.825	40.0	7.0	Artificial grass

A) Astro Turf®
B) VencoMat®, reg. trademark of VencoMatic, see C)
C) VencoMatic®, Postbus 160, 5520 Ad Eersel, The Netherlands
D) Landmeco A/S, DK-6870 Ølgod, Denmark

without transformation. Averages are stated as arithmetical averages.

Results and Discussion

Floor eggs. The frequency of floor eggs (number of eggs collected on the floor in relation to the total number of collected eggs) as mean for the entire egg laying period (13 periods of 4 weeks, in experiment 2, however, 12 periods), can be seen in table 3.

In experiment 1 the difference between treatments was only the width of the nest respectively (23 cm) and (40 cm). The frequency of floor eggs, which in general was very low with 1.3 to 2.1%, was not affected by this difference (P = 0.3484).

In experiment 2, the average percentages of floor eggs were 8.7 in treatment (23 cm) and 3.7 in (115 cm). This difference was not significant (P = 0.0787). However, it should be noted that the nests (23 cm) in this experiment were arranged in one level, but in two levels in experiment 1. The capacity of the nests was adjusted in order to avoid influence from this factor. From table 1 can be seen that the capacity of nests in (23 cm) was 7.9 hens per nest, equivalent to the capacity of nests in experiment 4 — treatment (23 cm) — with 8.0 hens per nest. In this treatment the result was less than 1% floor eggs. The reason for the high frequency of floor eggs in experiment 2 — (23 cm) in relation to the same nest size in experiment 1 — is rather to be found in the rearing and/or in the management. Some general recommendations to management routines for minimizing the number of floor eggs are: the litter layer should be as small as possible; litter in the nests until used frequently; collection of floor eggs as often as possible as well as instruction of the hens in sleeping on the perches on the wire frames near the nests (JOHANSEN, 1990; ANONYMOUS, 1990). It is difficult to have exact identical care from one batch of hens to another. The hens for experiments 1 and 2 were as mentioned earlier of identical breed, reared in the same house and by the same staff. The rearing period is very important for the nesting behaviour, see among others PETERSEN (1984) and MIROSH et al. (1986) and not identified factors may anyway be responsible for an inferior nesting behaviour in experiment 2.

The result in experiment 3 showed an almost twice as high frequency of floor eggs in (23 cm) (10.2%) as in (40 cm) (4.2%) and was thus not in agreement with the result in experiment 1.

In experiment 4 the frequency of floor eggs in (23 cm) was only 1.0% compared to 3.5% in (60 cm). The result in (60 cm) levelled the result in (115 cm) in experiment 2, whereas (23 cm) showed a rather large divergence from experiment 2 (8.7%). As shown in table 2, a tendency towards a slightly lower light intensity in experiment 3, treatment (23 cm) compared to treatment (40 cm) and in experiment 4, treatment (60 cm) compared to treatment S, was found. In both cases a high frequency of floor eggs in treatments with the darkest nests occurred. The hens in

Table 2. Light measurements in the experimental houses, lux
Lichtmessungen in den Versuchshäusern, lux

Experiment	Treatment	Litter	Slats	In front of nests	Inside nests
1 and 2	23 cm + 40 cm + 115 cm	6–12	4–9	1	<1
3[A]	23 cm	2–6	7–12	3–24	<1
3[A]	40 cm	6–12	12–24	8–50	4–5
3[B]	23 cm	1–6	8–12	1	<1
3[B]	40 cm	1–12	3–21	7–26	1
4	23 cm	4–23	4–48	2–3	1
4	60 cm	2–20	1–12	1	<1

A) From onset of lay to peak of lay
B) The rest of the egg laying period

these experiments seemed to prefer light nests, which is confirmed by APPLEBY et al. (1984a). These authors found that medium heavy hens (RIR) preferred light nests. On the contrary, White Leghorn hens seem to prefer dark nests (APPLEBY et al., 1982a; DORMINEY, 1974). WOOD-GUSH and MURPHY (1970) found that Brown Leghorn hens prefer light nests.

The 4 experiments show a large variation in the frequency of floor eggs in treatment (23 cm) compared to the other treatments 0.8–1.2% (s = 4.6) and 1.32–4.19% (s = 1.2). An expectation of a less stable and generally inferior nesting behaviour in nests with room for more than 1 hen ((40 cm), (60 cm), and (115 cm)), based on a varying level of social behaviour in the different flocks, as described among others by APPLEBY et al. (1984b) and NØRGAARD-NIELSEN et al. (1993), cannot be confirmed in these investigations.

PETERSEN's results (1984) mentioned before or observations by PARNELL and QUIESENBERRY (1951) stating that the hens preferred single nests to community nests cannot be pointed out. Both authors used White Leghorn hens and as the nesting behaviour definitely has a genetical component (SØRENSEN & KJÆR, 1992; MCGIBBON, 1976), the results achieved with light and medium heavy hybrids cannot immediately be compared.

It is concluded that the size of the nest within the range of 23 to 115 cm had no effects on the hens' nesting behaviour measured as the frequency of floor eggs.

Egg shell quality

Cracked eggs. In table 4 the average frequency of cracked nest eggs in the different replications is seen.

In experiment 1 between 4.9 and 8.1% cracked eggs in average were found in the samples, and no difference between (23 cm) and (40 cm) occurred. In experiment 2 11.4% in average was found in (23 cm) compared to 14.5% in (115 cm). However, this difference was not significant. In experiments 3 and 4 no difference was found between (23 cm) and (40 cm), respectively, and (23 cm) and (60 cm), respectively, with 5.6–7.4% cracked eggs.

The high level of cracked eggs in (115 cm) may partly be due to a bad adjustment of the nest bottom slope. The bottom tips up and closes the nest before the light is turned off and when the light is turned on in the morning, the bottom tips down and the nest opens. If the ropes holding the nest bottom are not correctly adjusted, the nest bottom slope will either be too steep or too flat resulting in an increased risk of cracked eggs. This adjustment is thus very important. The registration of more cracked eggs in (23 cm) in experiment 2 compared to experiment 1 can be due to the fact that some of the rubber mats were loose and slid out of the egg channel.

It is concluded that the nest size did not influence the frequency of cracked eggs, but other factors such as adjustment of the nest bottom slope among other things, are more important.

Dirty eggs. In table 5 the average frequency of dirty eggs in the different replications is seen. In experiment 1, between 5.0 and 8.5% dirty eggs independent of nest type (23 cm) or (40 cm) was found ($P < 0{,}6459$).

In experiment 2 a significant difference ($P < 0{,}0321$) between (23 cm) with 10.1% dirty eggs and (115 cm) with 4.3% dirty eggs was observed. The nest mats should be blamed for this difference. As mentioned earlier the bottom in (115 cm) tips up for the night to an approximate slope of 80° disabling the hens to sit in the nests during the night and enabling possible dirt to fall off. The mats in this experiment were rubber mats without perforation (holes). Use of this type of mat in nests without closing for the night or in nests without tipping up of the nest bottom for the night cannot be recommended.

In experiment 3 a somewhat higher frequency of dirty nest eggs was observed in (40 cm) than in (23 cm) as well as twice as many dirty eggs were observed in (60 cm) than in (23 cm) in experiment 4.

The conclusion is that a tendency towards a higher frequency of dirty nest eggs with increasing nest size is present, however, it has not been possible to point out any statistical significance under the given experimental conditions. It was possible to achieve a fairly low frequency of dirty eggs in (115 cm) community nests with nest closing for the night.

Table 3. Floor eggs, % of all collected eggs
Verlegte Eier, % von allen gesammelten Eiern

Experiment	Replication	Nest size				
		23 cm	40 cm	60 cm	115 cm	P<
1	1	1.3	1.3			0.3484
	2	1.1	2.1			
2	1	7.4			3.1	0.0787
	2	10.0			4.2	
3		10.2	4.2			
4		0.8		3.3		

Table 4. Cracked eggs % of collected nest eggs (mean of samples)
Brucheier, % von gesammelten Nesteiern, (Durchschnitt von Proben)

Experiment	Replication	Nest size				P value
		23 cm	40 cm	60 cm	115 cm	
1	1	4.9	5.4			0.6699
	2	8.1	6.1			
2	1	10.3			12.4	0.3238
	2	12.5			16.6	
3		5.6	6.1			
4		6.8		7.4		

Table 5. Dirty eggs, % of collected nest eggs (mean of samples)
Schmutzige Eier, % von gesammelten Nesteinern, (Durchschnitt von Proben)

Experiment	Replication	Nest size				P value
		23 cm	40 cm	60 cm	115 cm	
1	1	7.5	6.0			0.6459
	2	5.0	8.5			
2	1	9.5			5.1	0.0321
	2	10.8			3.4	
3		9.1	13.8			
4		4.2		8.0		

Summary

Nest sizes of 40 cm × 30 cm (40 cm) (width × depth), 60 cm × 55 cm (60 cm), and 115 cm × 45 cm (115 cm) were compared to 23 cm × 30 cm (23 cm) single nests in four experiments in commercial deep litter houses for laying hens. No clear effect was evident of nest size on frequency of floor eggs and frequency of cracked nest eggs. There was a non-significant tendency towards a higher frequency of dirty eggs in (60 cm) than in (23 cm) and (40 cm). (115 cm) nests with a closing system for the night had fewer dirty eggs than (23 cm) without closing.

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Zusammenfassung

Nestgrößen von 40 cm × 30 cm (40 cm) (Breite × Tiefe), 60 cm × 55 cm (60 cm) und 115 cm × 45 cm (115 cm) wurden mit 23 cm × 30 cm (23 cm) Einzelnestern in vier kommerziellen Tiefstreuhäusern für Legehennen verglichen. Die Nestgrößen hatten keine klare Wirkung auf Frequenz verlegter Eier und Frequenz der Brucheier im Nest. Eine nichtsignifikante Tendenz zu einer höheren Frequenz schmutziger Eier in (60 cm) als in (23 cm) und (40 cm) kam vor. In (115 cm) Nestern mit einem nächtlichen Schließsystem kamen weniger schmutzige Eier vor als in (23 cm) Nestern ohne Schließsystem.

Stichworte

Legehenne, Haltung, Tiefstreu, Nest, Größe, Eiablage, Schalenqualität

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