SSPE-CT-2004-502315

LAYWEL

Welfare implications of changes in production systems for laying hens

Specific Targeted Research Project (STReP)

Thematic Priority: Integrating and strengthening the ERA, Area 8.1.B.1.4, task 7

Deliverable 4.6

Behavioural function of production systems for laying hens

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PP	Restricted to other programme participants (including the Commission Services)	x
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

Introduction

For task 4.6 the main activity was collecting data on behaviour in a range of egg production systems, with focus on furnished cages, as well as investigations of more specific parts of these systems, i.e. area for roosting and dustbathing. In this report these most recent data is presented under the headings, use of perches, use of dustbathing areas and activity of dustbathing, frequencies of pecking behaviour and preening and use of the nests.

Material and Methods

The main source of data was stored in the LayWel database, in explicit data entered into the Behaviour-sheet and Laying housing-sheet. Where applicable variables were transformed (arcsine) to obtain normal distribution before analysis of variance is applied using the SAS statistical analysis system. Models included where appropriate housing system, hen breed or type, season and relevant interactions. In case of non normal data a Kruskal-Wallis test was used. Not all data were possible to analyse statistically and for these data arithmetic means are given. For the data from partner Univbris (University of Bristol) statistical evaluation will be published elsewhere during the spring, 2006. Additionally data were provided from partner Unizar (University of Zaragoza, Spain) regarding the use of space and facilities by hens housed in furnished cages. These data were analysed separately by Unizar. So was unpublished data from Institut National de la Recherche Agronomique (INRA) regarding effect of rearing and size of the nest and dustbath on behaviour. A few older papers have been used in Table 1 for reference to the newer data.

Results and discussion

Use of perches

In Table 1 some recent data from the LayWel database as well as earlier publications are given. Results from the LayWel database have been subjected to statistical analysis and these results are shown in Figure 1. The use of perches at night is higher in the smaller compared to medium or larger furnished cages. All data from FCL and FCM are from one partner only (PV) and for this partner the use of perches were 64, 64 and 74% on average for FCL, FCM and FCS respectively. For the other partners, SLU and UZ, resp. 87 and 82% of hens used perches at night in FCS. In non-cage systems the LayWel data is sparse, but there seems to be a better use of perches in multi-tier systems (comparable to the level seen in small furnished cages) than in single-tier systems. The main part of the data was on White Leghorn (LSL) hens. The data in Table 1 come from quite different experimental setups and there is not made any statistical comparisons, but use of perches does not seem to differ between furnished cages and non cage systems.

Effects of rearing and genotype on perch use

The relative use of perches (and other areas/facilities) by ISA Brown and Hyline White hens in furnished cages (AVIPLUS and MEC) are shown in Figures 2 and 3 and Tables 2 and 3 below. There is a relative high use of the perches during the day (40 to 50%) and about 80-90% use at night. ISA Brown hens used the perches more than Hyline in the morning and evening but not at night.

ISA Brown hens reared in cages used the perches slightly more compared to birds reared on floor, see Table 3.

Table 1 Percent of birds observed using a given facility in different housing systems during daytime or night.

	Daytime		Nighttime	
	FC	NC	FC	NC
Perch area	37 (unizar, fcs) 44 (unizar, fcs) 14.1 (Weits., fcs/m) 16.3 (Weits., fcm) 15.4 (Weits., fcl)	22 (Oden, mt) 10 (Oden, st) 47 (Carmichael, st) 32 (Hansen, mt) 29 (Hansen, mt) 30 (Hansen, mt)	65 (lw, fcl) 64 (lw, fcm) 80 (lw, fcs) 75 (unizar, fcs) 74 (unizar, fcs)	78 (lw, mt) 48 (lw, st) 67 (Oden, mt) 90 (Oden, st)
Dustbath area	5.3 (unizar, fcs) 5.7 (unizar, fcs) 20 (unizar, fcs) 16 (Abrah., fcs) 8.1 (Wall, fcs)			
Performing dustbathing	18 (unizar, fcs) 9 (Abrah., fcs) 2 (Abrah., fcs) 6 (Abrah., fcs) 0.4 (Weits., fcs) 2.1 (Weits., fcm) 3.0 (Weits., fcl) 1.2 (Wall, fcs)	4 (Oden, nc narrow) 8 (Oden, nc broad) 3 (Carmichael, st)		
Litter area		27 (Oden, mt) 25 (Oden, st) 23 (Carmichael, st) 8 (Hansen, mt) 26 (Hansen, mt) 14 (Hansen, mt)		

Abbreviations :

Abrah.	*Abrahamsson et al., 1996. Br. P. Sci. 37:521-540*
Carmich.	*Carmichael et al., 1999. Br. P. Sci. 40:165-176*
Hansen	*Hansen, I., 1994. Br. P. Sci. 35:491-508*
lw	*LayWel database*
Oden	*Odén et al., 2002. Br. P. Sci. 43:169-181.*
unizar	*University of Zaragoza, partner in lw*
Wall	*Wall H., 2003. Laying hens in furnished cages. Acta Universitatis Agriculturae Sueciae - Agraria (No.406): 36 pp.*
Weitz.	*Weitzenbürger, D., 2005. Inaugural-dissertation, Tierärtzliche Hochschule, Hannover, Germany*
fcs	*furnished cages, small <15 hens*
fcm	*furnished cages, medium, 15 -30 hens*
fcl	*furnished cages, large >30 hens*
fcs/m	*furnished cages, small, 10 and 20 hen groups*
mt	*multi tier*
st	*single tier*

Figure 1 **The percentage of hens (ls-means) using the perches at night in furnished cages (FCL = large, FCM = medium and FCS = small group size) and multi tier, non-int. nests (MT-NN) or single tier (ST-NC) non cage systems. N=114 obs. (Swedish (Swedish University of Agriculture, SLU), Dutch (Research Institute for Animal Husbandry, PV) and Spanish (Unizar) data)**

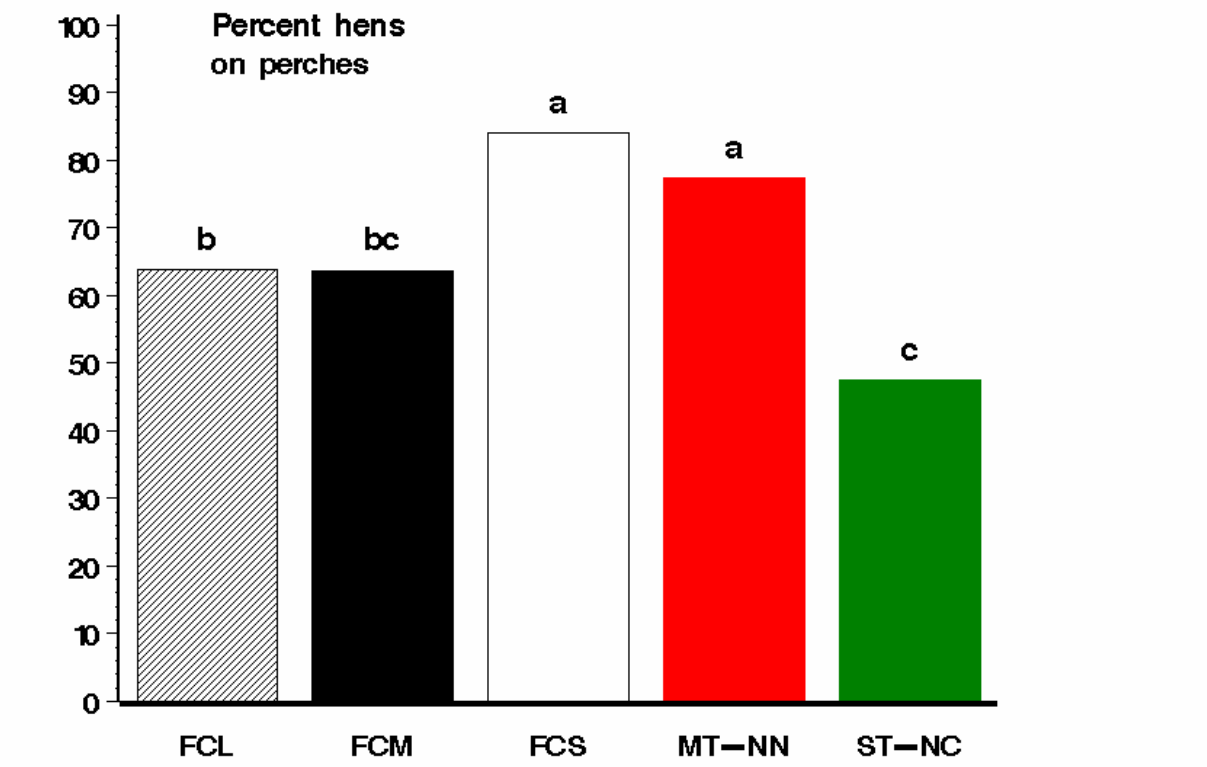

Table 2 **Use of space in hens housed in furnished cages during morning, evening and night (least squared means ± s.e). Data from Spain, UNIZAR**

	Morning		Evening		Night	
	ISA Brown	Hyline	ISA Brown	Hyline	ISA Brown	Hyline
Perches	37,3 ± 0,05[a]	30,8 ± 0,05[b]	44,2 ± 0,06[a]	35,2 ± 0,06[b]	75,6 ± 0,13[a]	73,9 ± 0,13[a]
No perches	58,4 ± 0,05[a]	63,2 ± 0,05[b]	54,3 ± 0,06[a]	64,1 ± 0,06[b]	22,3 ± 0,13[a]	26,3 ± 0,13[a]
Nest	3,9 ± 0,01[a]	5,9 ± 0,01[b]	0,6 ± 0,02[a]	0,67 ± 0,02[a]	1,2 ± 0,03[a]	0,4 ± 0,03[b]
Dust bath*	0,3 ± 0,004[a]	0,02 ± 0,004[b]	0,7 ± 0,004[a]	0,06 ± 0,004[b]	0,8 ± 0,009[a]	0,0 ± 0,0[b]

Means represent the percentage of hens using each area at the moment of observation.
Dust bath* was open from 12:00 to 14:00h. A design mistake allows hens going into the dust bath when close.

Use of dustbathing areas and activity of dustbathing

The use of the dustbaths in furnished cages is very variable from hen to hen and from flock to flock. In one study it was shown that 30% of the hens never used the dustbaths, while around 40 to 50% used the dustbaths very frequently (Wall, 2003). The LayWel database contained no data on individual hens but data from 20 flocks on the use of the dustbathing area (mainly

Swedish data from partner SLU on LSL hens). Only data from small furnished cages were available. These data showed an extremely variable use, from 5 to nearly 100% of the dustbathing areas occupied by hens at a given time of observation. There was a significant effect of cage model, the highest use of dustbaths being 81% in Big Dutchman Aviplus, 46% in Victorsson Trivselsbur, 22% and 21% in treatments Triotec Stimulansbur and Hellmann Miljösystem, respectively. In all types hens had 5 hour access to the dustbaths daily. No effect of season could be seen. The very high variability could partly be due to the sampling technique, as use of the dustbaths varies over the day**,** and thus is prone to sampling errors. Another explanation could be the physical size of the dustbath as this has been found to influence a range of behavioural parameters in relation to dustbathing. Small dustbaths holds a maximum of 1 or 2 hens. Lower area and especially shorter sides resulted in longer latency and lower frequency of dustbathing, shorter time spent in the dustbath, shorter dustbath and lower numbers of bouts of wing shaking and dust tossing (Guesdon, Rosseau and Faure, unpublished results). However, in the present material dustbath size varied only little, from 120 to 150 cm2 per bird, and there was no relation between litter area and use of the dustbath. Another source of variation is access or not to litter during rearing, litter type and genotype (hybrid) used. Also opening time of the dustbath can vary from a few hours to complete access.

Table 3 Breed effect on the use of the dust bath in laying hens housed in furnished cages: No. of hens present in the dust bath (hens in the dust bath area at the moment of observation), No. of hens performing dust bathing, and the intensity of dust bathing (activity level), (least squared means ± s.e) . Data from Spain, UNIZAR. Group size 10 hens.

	Breed	Age		
Parameter		45	48	72
No. of hens present in the dust bath	ISA Brown	0,41± 0,06 ^{Aa}	0,40 ± 0,02 ^{Aa}	0,90 ± 0,05 ^{Ab}
	Hyline	0,00 ± 0,00 ^{B}	0,03 ± 0,01 ^{B}	0,01 ± 0,01 ^{B}
No. of hens performing dust bathing	ISA Brown	0,22 ± 0,05 ^{Aa}	0,25 ± 0,02 ^{Aa}	0,53 ± 0,05 ^{Ab}
	Hyline	0,00 ± 0,00 ^{B}	0,00 ± 0,00 ^{B}	0,00 ± 0,00 ^{B}
Activity level[1]	ISA Brown	0,29 ± 0,06 ^{Aa}	0,41 ± 0,03 ^{Aa}	0,73 ± 0,09 ^{Ab}
	Hyline	0,00 ± 0,00 ^{B}	0,01 ± 0,00 ^{B}	0,0 ± 0,00 ^{B}

Means within rows with no common superscripts differ significantly (at least $p<0.05$)
Means within columns and each parameter with no common capital superscripts differ significantly (at least $p<0.05$)
[1]Assessed by score from 1 (very low intensity) to 3 (very high intensity).

In Table 1 data on use of dustbathing area and the percentage of birds observed dustbathing at the time of observation are presented.

The relative use of the dustbaths by ISA Brown and Hyline White hens in furnished cages (AVIPLUS) in Spain is shown in Tables 2 and 3 and Figures 2 and 3. ISA Brown hens used the dustbaths more than Hyline.

The effect of rearing conditions (floor vs. cage) influenced the dustbathing activity of ISA Brown hens kept in furnished cages. Table 4 presents the proportion of hens using each area of the furnished cage (nest, dust-bath, perches and drinker) in the morning, afternoon and night in function of the rearing system (cage versus floor). The effects of rearing system were small, but cage reared birds consistently used the perch area more and the nest area less than floor reared birds.

Table 4 Proportions (%) of Floor-reared and Cage-reared Isa Brown laying hens using each area of furnished cages in the morning. afternoon and night (mean ± SE). Data from Spain, UNIZAR

Overall Cycle	Morning[1]		Afternoon[1]		Night[1]	
	Floor-reared	Cage-reared	Floor-reared	Cage-reared	Floor-reared	Cage-reared
Perches area	51.3±3.3a	53.1±2.5b	49.6±4.5a	51.2±3.7b	83.1±2.3a	84.2±2.9b
Nest area	8.4±3a	6.3±2.7b	2.5±1.5a	1.51±1.0b	2.4±0.4a	2.9±0.5a
Drinker area	40.3±3a	40.6±3a	42.2±4.0a	41.8±3.0b	14.6±1.0a	13.2±0.9b
Dust-bath area	0	0	5.7±3.0a	5.3±3.0a	0	0

[1] Means within columns with no common superscripts differ significantly (at least $p<0.05$)

The average number of hens present in the dust bath area and the number of birds dust bathing at 15, 30, 45 and 60 min after a dust bath was opened is shown in Table 5. In general, the number of hens present and performing dust bathing decreased over the period in which the dust baths were open.

The use of the litter area in some non cage system flocks is shown in Table 1. Multi-tier systems seem to be a bit more variable than single tier systems, but this could be due to the larger design differences amongst these systems.

Given larger litter area (Figure 4) in single floor housed Shaver 579 (data from Univbris) there was an increase in the percent birds performing dustbathing. In this Figure some combinations were not available (split-plot-design) and litter area, group size and stocking density were partly confounded in the present analysis. But it is evident from the same graph that increasing litter area increase dustbathing, while given the same litter area per hen more hens perform dustbathing at the lower group size.

Dustbathing was recorded at the age of 21, 26, 40 and 72 weeks (Table 6). In general the floor reared hens had a higher dustbating activity than the cage reared birds.

Table 5 **Average number of hens present in the dust bath, average number of birds dust bathing and dust bath activity intensity at 15, 30, 45 and 60 minutes after opening the dust bath area. Data from Spain, UNIZAR. Group size 10 hens.**

	time	Rearing System	
		Cage	Floor
# Hens present at dust bath			
	15'	1,56 ± 0,06 aA	1,86 ± 0,07bA
	30'	1,39 ± 0,07aAB	1,62 ± 0,07bB
	45'	1,25 ± 0,07aB	1,46 ± 0,07bB
	60'	1,29 ± 0,06aB	1,62 ± 0,07bB
# Hens performing dust-bathing			
	15'	1,26 ± 0,09aA	1,49 ± 0,11bA
	30'	1,08 ± 0,1aAB	1,22 ± 0,1ªA
	45'	0,95 ± 0,1ªB	1,13 ± 0,11aA
	60'	1,06 ± 0,9aAB	1,16 ± 0,1aA
Dust-bathing intensity (1-3)			
	15'	1,35 ± 0,07aA	1,52 ± 0,09aA
	30'	1,10 ± 0,08aB	1,15 ± 0,08aB
	45'	1,15 ± 0,09aAB	0,93 ± 0,09aB
	60'	1,14 ± 0,08aAB	1,27 ± 0,08 aC

Means within rows (rearing effect) with no common superscripts differ significantly (p≤0,05).
Means within columns (age effect) with no common capital superscripts differ significantly (at least p≤0,05).

Table 6 **The number of hens present in the dust bath area, number of hens performing dust bath behaviour, and the intensity of dust bathing in floor-reared and cage-reared Isa Brown laying hens housed in furnished cages. Data from Spain, UNIZAR. Group size 10 hens.**

Parameter		Rearing system		
	Age	cage	floor	Total
Number of hens present in the dust bath	21	0.54 ± 0.04 [a]	1.27 ± 0.04 [b]	0.92 ± 0.03 [A]
	26	1.57 ± 0.05 [a]	1.47 ± 0.06 [a]	1.53 ± 0.04 [B]
	40	2.01 ± 0.05 [a]	2.15 ± 0.06 [b]	2.07 ± 0.04 [C]
	72	2.06 ± 0.07 [a]	2.23 ± 0.08 [b]	2.14 ± 0.05 [C]
Performing dust-bathing				
	21	0.35 ± 0.07 [a]	0.58 ± 0.07 [b]	0.47 ± 0.05 [A]
	26	0.92 ± 0.08 [a]	1.15 ± 0.09 [b]	1.02 ± 0.06 [B]
	40	1.84 ± 0.08 [a]	1.83 ± 0.09 [a]	1.84 ± 0.06 [C]
	72	2.00 ± 0.12 [a]	2.20 ± 0.12 [b]	2.10 ± 0.08 [C]
Dust-bathing activity level[1]	21	0.38 ± 0.05 [a]	0.54 ± 0.04 [b]	0.47 ± 0.03 [A]
	26	1.21 ± 0.06 [a]	1.0 ± 0.06 [a]	1.11 ± 0.04 [B]
	40	2.09 ± 0.06 [a]	2.37 ± 0.06 [a]	2.21 ± 0.04 [D]
	72	1.57 ± 0.08 [a]	1.79 ± 0.08 [b]	1.68 ± 0.06 [C]

Means within rows with no common superscripts differ significantly (at least p<0.05)
Means within columns with no common capital superscripts differ significantly (at least p<0.05)
[1] Assessed by score from 1 (very low intensity) to 3 (very high intensity).

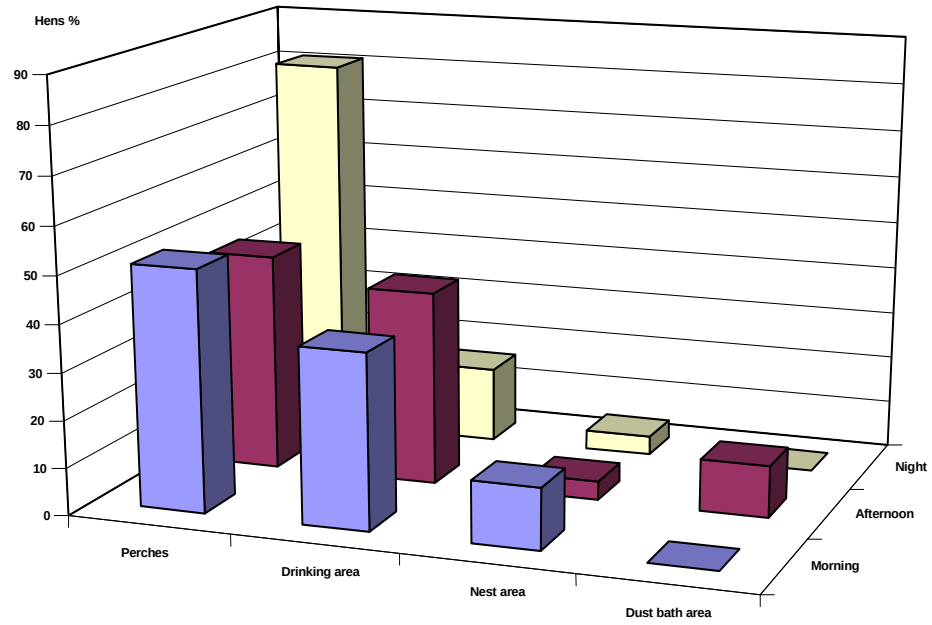

Figure 2 Use of space in furnished cages (ISA Brown). Data from Spain, UNIZAR

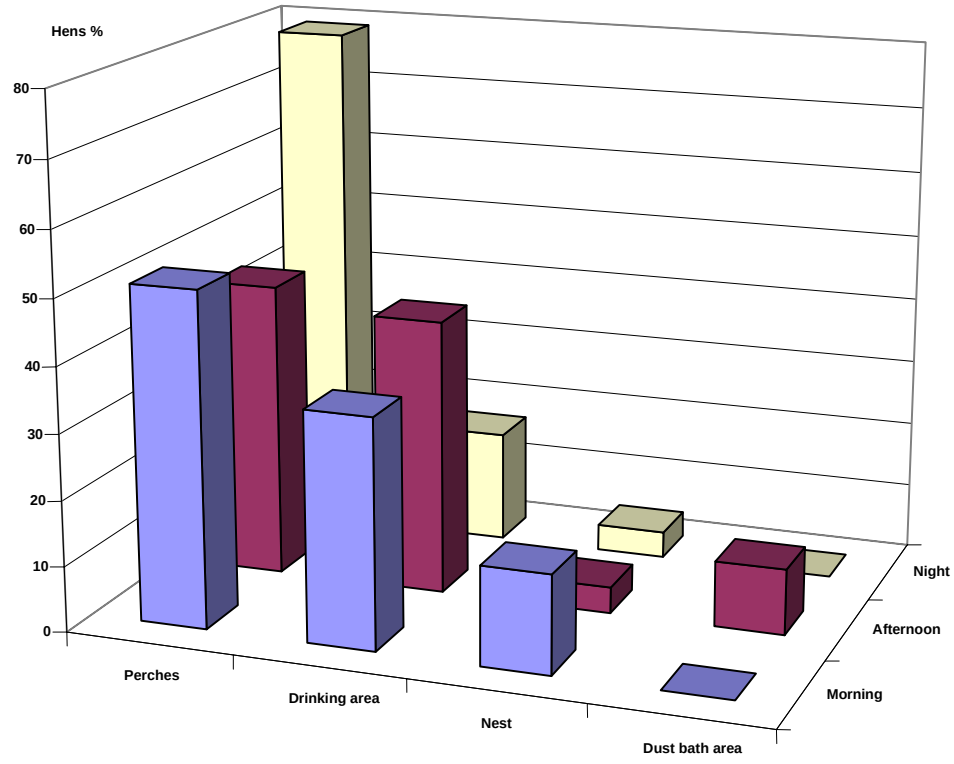

Figure 3 Use of space in furnished cages (Hyline W). Data from Spain, UNIZAR

Frequencies of pecking behaviours

The LayWel database contained data on pecking behaviours from 35 flocks of various breeds (LSL, ISA White, Hyline White and Lohmann Brown) kept in furnished cages (Sweden) and in 6 flocks kept in single tier non cage system (UK), all of the Shaver 579 hybrid.

Feather pecking

No effect of furnished cage type or breed could be found significant in the Swedish data on the level of gentle or severe feather pecking. Season, however, affected feather pecking significantly, with more severe feather pecking in the summer (0.32 pecks per bird per hour (pbh)) compared to winter, spring and autumn (0.16, 0.04 respectively 0.07 pbh). This effect could be due to heat stress affecting the level of feather pecking. The average levels of gentle feather pecking in the Shaver 579 birds kept in different group sizes and with different drinkers are shown in Figure 5.

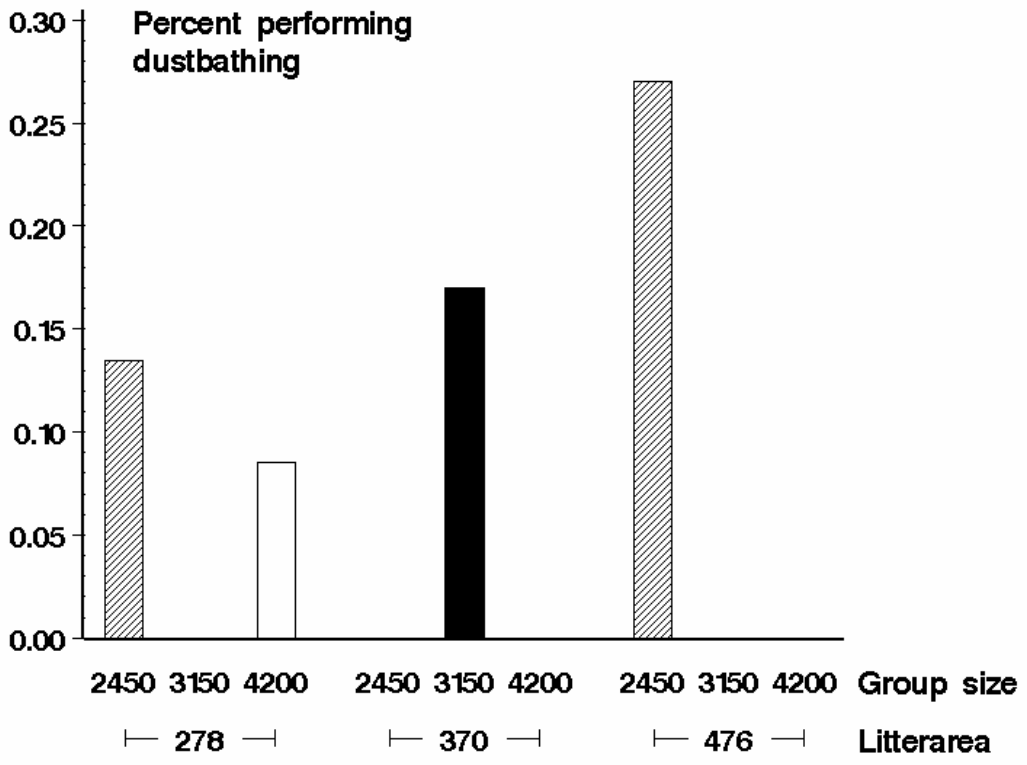

Figure 4 Dustbathing behaviour in Shaver 579 Leghorn hens as affected by litter area and group size. Data from UK, Univbris

Aggressive pecking

Aggressive pecking was not influenced by production system. But as for feather pecking an effect of season was found significant. Less aggressive pecking ($P<0.05$) was recorded in the furnished cages in the spring (0.05 pbh) compared to the other seasons (from 0.18 to 0.24 pbh).

There seemed to be (stat. test non possible) higher levels of aggressive pecking in Shaver 579 flocks kept at lower group sizes (Figure 6) and this could very well have had an influence on the level of feather pecking as shown in Figure 5 as high levels of aggression in larger groups can prevent some birds from performing feather pecking and this might influence the general level of feather pecking.

Frequencies of preening

Data on preening frequency were provided from Univbris on 6 flocks kept in single tier non cage systems, all of the Shaver 579 hybrid and results are shown in Figure 7.

Use of the nests

A total of 146 flocks were available in the LayWel-database with recordings of percentage of eggs laid in the nests. Discarding flocks with crossed line birds or mixed flocks there was 134 flocks left. These flocks were reasonably well distributed over systems with 19% in FCL, 8% in FCM, 29% in FCS, 23% in MT and 22% in ST systems. Forty two percent were White Leghorn and 58% Medium Heavy. The distribution of flocks over systems, hen types and partners can be seen in Table 7.

Because Medium Heavy birds were not represented in FCL cages a two step approach was chosen. Firstly, analysis of variance was made on the two hen types separately with a model including systems. The results are shown in Table 8. White Leghorns laid more eggs in nests in FCM compared to FCL and FCS and MT with ST in between. Medium Heavy hens laid more eggs in nests in non cage systems compared to furnished cages. Secondly, a further analysis was made using a model including system, hen type and their interaction. This time data on FCL cages were not included. The LS-means were identical to those given in Table 8 and very significant effects of system, hen type and their interaction were found. White Leghorns used the nests in FCM and FCS better than Medium Heavy hens (indicated by different capital letters in table 8), while no difference was found in non cage systems.

Table 7 **Distribution (percent) of 134 flocks a) between hen types within system (furnished cages, multi – and single tier non cage systems), b) between hen type within partner and c) between partner within system**

a)						
System	**FCL**	**FCM**	**FCS**	**MT**	**ST**	**TOTAL**
Hentype						
White Leghorn (white shell)	100	44	23	39	14	42
Medium Heavy (brown shell)	0	56	77	61	86	58
b)						
Partner	**ADAS**	**INRA**	**PV**	**SLU**	**UHOH**	
Hentype						
White Leghorn (white shell)	0	0	71	85	20	
Medium Heavy (brown shell)	100	100	29	15	80	
c)						
System	**FCL**	**FCM**	**FCS**	**MT**	**ST**	**TOTAL**
Partner						
ADAS	0	6	94	0	0	100
INRA	0	66	34	0	0	100
PV	47	9	16	14	14	100
SLU	0	0	0	100	0	100
UHOH	0	0	0	40	60	100

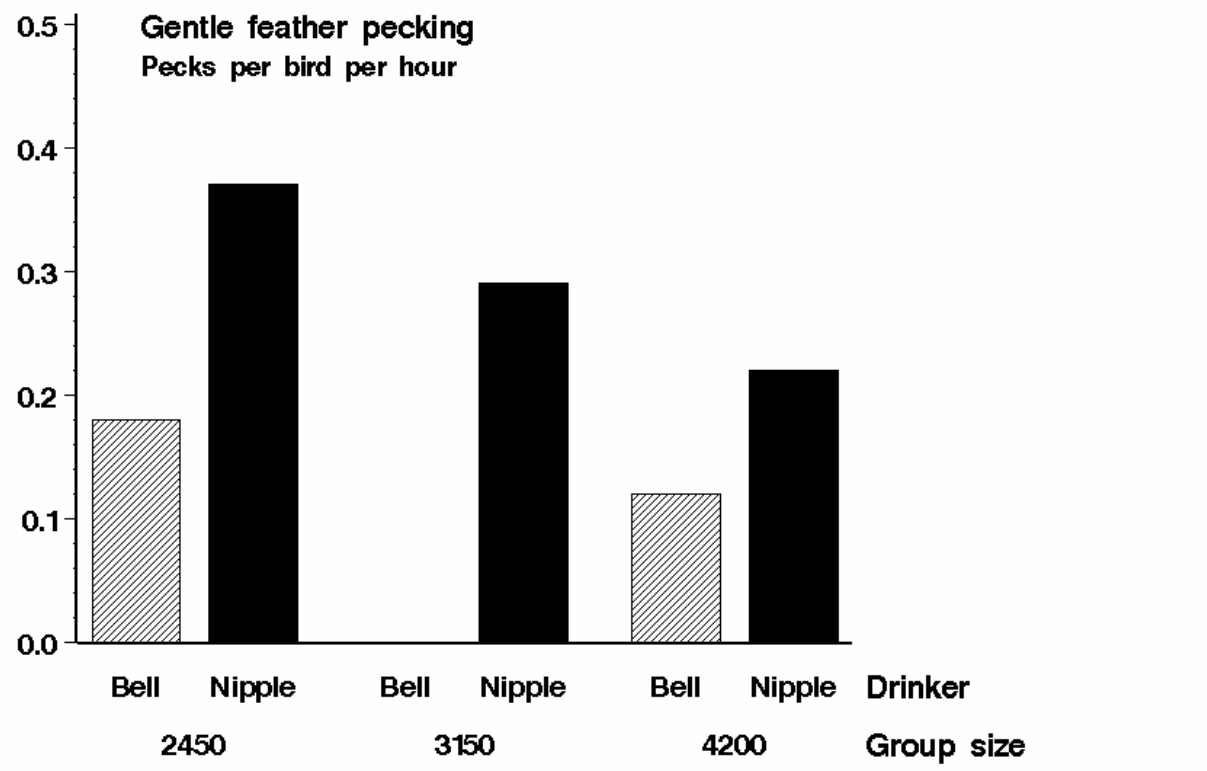

Figure 5 **Gentle feather pecking in Shaver 579 Leghorn hens as affected by drinker and group size. Data from UK, Univbris.**

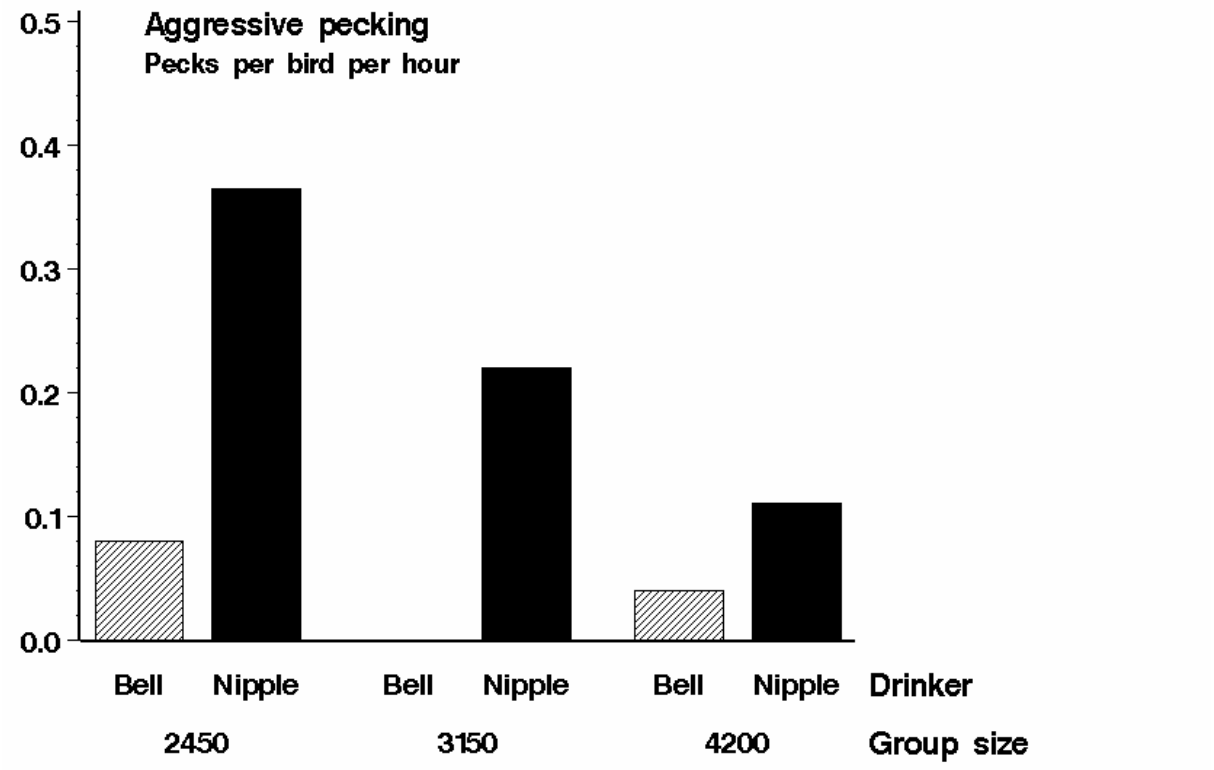

Figure 6 **Aggressive pecking in Shaver 579 Leghorn hens as affected by drinker and group size. Data from UK, Univbris.**

Table 8 **LS-means of frequency (percent) of nest eggs in various systems and two hen types. In total 56 flocks of White Leghorn and 78 flocks of Medium Heavy hybrids**

System	FCL	FCM	FCS	MT	ST	P-value
Hen type						
White Leghorn (white shell)	95.4b	99.1aA	95.8bA	94.8b	97.7ab	0.0522
Medium Heavy (brow. sh.)	-	89.4bB	86.7bB	96.7a	95.9a	<0.0001

Different letters in a row indicate sign. difference between systems within hen type (P<0.05)
Different capital letters in a column indicate sign. difference between hen type within systems (P<0.05)
There were no Medium Heavy birds in FCL cages

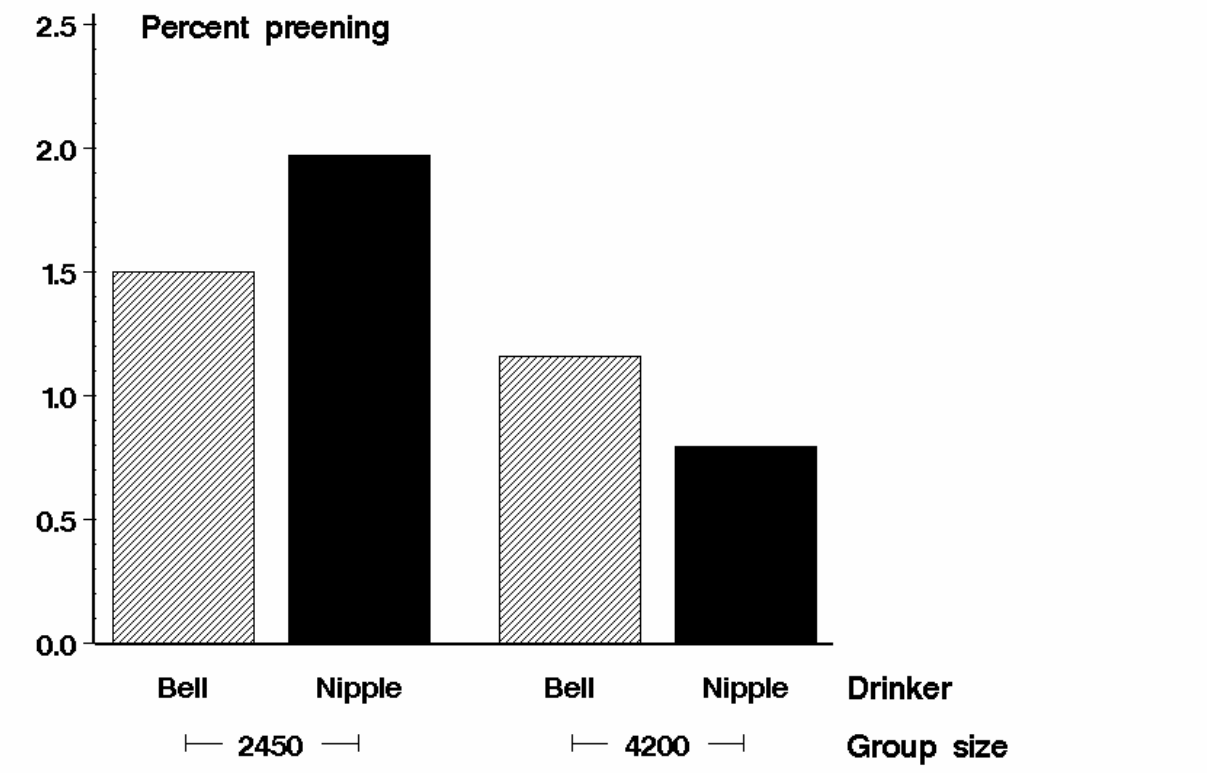

Figure 7 **Preening behaviour in Shaver 579 Leghorn hens as affected by drinker and group size. Data from UK, Univbris.**

Conclusions

- The perching area was used to a very variable extent in different studies.
- The data pointed to a higher use of perches in the smaller compared to medium or larger furnished cages, but more data is needed to draw firm conclusions
- In non-cage systems there seems to be a better use of perches in multi-tier systems (comparable to the level seen in small furnished cages) compared to single-tier systems.
- The use of the dustbathing area was very variable and also very different for the four furnished cage models that could be compared from the LayWel data. Birds reared on floor had a slightly higher dustbating activity than cage reared birds.
- Hens kept in any of the four furnished cage models compared did not differ in level of feather pecking or aggressive pecking.
- White Leghorns laid more eggs in nests in FCM compared to FCL, FCS and MT with ST in between.
- Medium Heavy hens laid more eggs in nests in non cage systems compared to furnished cages.
- White Leghorns used the nests in FCM and FCS better than Medium Heavy hens, while no difference between hen types was found in non cage systems.

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