HAL
open science

# On-farm assessment of environmental enrichment for broiler breeders

Paul Morison Hocking, Emma Jones

## To cite this version:

Paul Morison Hocking, Emma Jones. On-farm assessment of environmental enrichment for broiler breeders. British Poultry Science, 2006, 47 (04), pp.418-425. 10.1080/00071660600825074 . hal-00545298

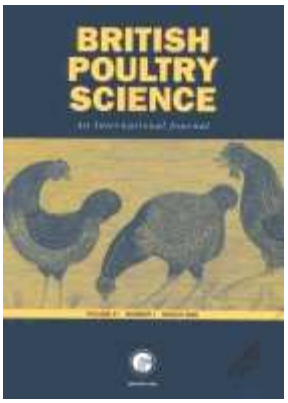
**HAL Id: hal-00545298**

**https://hal.science/hal-00545298v1**

Submitted on 10 Dec 2010

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.




# On-farm assessment of environmental enrichment for broiler breeders

| | |
|---|---|
| Journal: | *British Poultry Science* |
| Manuscript ID: | CBPS-2005-001.R1 |
| Manuscript Type: | Original Manuscript |
| Date Submitted by the Author: | 02-Feb-2006 |
| Complete List of Authors: | Hocking, Paul; Roslin Institute, Genetics and Genomics<br>Jones, Emma; DEFRA, Animal Welfare Veterinary Division |
| Keywords: | Husbandry, Behaviour, Breeders |
| | |

scholarONE™
Manuscript Central

**Table 1.** Resource use by female broiler breeders on a commercial farm at 5, 10 and 16 weeks of age: means of 24 observations at 10-minute intervals from 0830 to 1420 h. (Angular transformation with backtransformed means (%) in parentheses.) Treatments were no environmental enrichment (Control) or enrichment devices introduced at hatch (EE1) or at 8 weeks of age (EE2).

| Factor | | Total | Proportion (%) of birds using resource | | | | |
|---|---|---|---|---|---|---|---|
| Age, weeks | Treatment | (N) | Bale[1] | Wall | Drinker | Litter | Perch |
| 5 | Control | 88.4 | - | 11.0 (4) | 17.9 (9) | 66.4 (84) | 9.4 (3) |
| | EE1 | 98.6 | 32.4(28) | 6.9 (1) | 15.9 (7) | 49.5 (58) | 8.7 (2) |
| | EE2 | 91.2 | - | 9.9 (3) | 16.1 (8) | 68.7 (87) | 8.8 (2) |
| 10 | Control | 53.9 | - | 10.3 (3) | 27.6 (22) | 52.1 (62) | 20.9 (13) |
| | EE1 | 66.7 | 24.6 (17) | 7.9 (2) | 25.6 (19) | 41.6 (44) | 17.0 (9) |
| | EE2 | 81.9 | 29.8 (25) | 9.5 (3) | 24.8 (18) | 39.6 (41) | 16.3 (8) |
| 16 | Control | 49.1 | - | 6.8 (1) | 26.5 (20) | 49.3 (57) | 27.0 (21) |
| | EE1 | 64.4 | 14.2 (6) | 6.9 (1) | 25.1 (18) | 45.5 (51) | 26.2 (20) |
| | EE2 | 63.1 | 15.5 (7) | 6.4 (1) | 26.6 (20) | 43.5 (47) | 26.1 (19) |
| SEDa[2] | | 9.96 | 1.67 | 1.66 | 3.23 | 2.42 | 2.08 |
| SEDb[3] | | 10.56 | 1.23 | 1.62 | 3.16 | 2.81 | 1.97 |
| Treatment | | * | NS | NS | NS | *** | NS |
| Age | | *** | *** | * | *** | *** | *** |
| Treatment x Age | | NS | NS | NS | NS | *** | NS |

[1]Analysis of EE1 and EE2 at 10 and 15 weeks only; means for EE1 at 5 weeks are also presented (see text).

[2]Standard error of a difference between two ages.

For Peer Review Only

[3]Standard error of a difference between two treatment means.

* $P<0.05$; *** $P<0.001$; NS = not significant

For Peer Review Only

**Table 2.** Mean number of acts of aggression recorded at different pen resources on a commercial farm of female broiler breeders at 5, 10 and 16 weeks of age. Treatments were no environmental enrichment (Control) or enrichment devices introduced at hatch (EE1) or at 8 weeks of age (EE2).

| Factor | | Aggression at resource, n/b/h | | |
|---|---|---|---|---|
| Age, weeks | Treatment | Bale[1] | Drinker | Litter |
| 5 | Control | - | 0.14 | 0.44 |
| | EE1 | (0.05) | 0.00 | 0.38 |
| | EE2 | - | 000 | 0.18 |
| 10 | Control | - | 0.25 | 0.65 |
| | EE1 | 0.48 | 1.20 | 1.91 |
| | EE2 | 0.05 | 0.00 | 0.86 |
| 16 | Control | - | 4.98 | 2.23 |
| | EE1 | 1.93 | 3.19 | 1.28 |
| | EE2 | 3.48 | 2.48 | 1.07 |
| SEDa[2] | | 1.625 | 2.012 | 0.418 |
| SEDb[3] | | 1.558 | 1.908 | 0.446 |
| Treatment | | NS | NS | NS |
| Age | | NS | ** | *** |
| Treatment x Age | | NS | NS | * |

[1]Analysis of variance results for EE1 and EE2 at 10 and 15 weeks only; the mean for EE1 at 5 weeks is also presented (see text).

[2]Standard error of a difference between two ages.

[3]Standard error of a difference between two treatment means.

* = $P$<0.05; ** = $P$<0.01; *** $P$<0.001; NS = not significant

For Peer Review Only

**Table 3**. Mean score for feather damage on different areas of the body of female broiler breeders at 6, 12 and 18 weeks of age on a commercial farm. Treatments were no environmental enrichment (Control) or enrichment devices introduced at hatch (EE1) or at 8 weeks of age (EE2).

| Factor | | Feather damage score | |
|---|---|---|---|
| Age, weeks | Treatment | Wings/back | Tail/vent |
| 6 | Control | 0.72 | 0.09 |
| | EE1 | 0.75 | 0.05 |
| | EE2 | 0.86 | 0.06 |
| 12 | Control | 1.44 | 1.48 |
| | EE1 | 1.29 | 1.35 |
| | EE2 | 1.14 | 0.14 |
| 18 | Control | 1.93 | 2.55 |
| | EE1 | 1.77 | 2.58 |
| | EE2 | 1.87 | 2.78 |
| SEDa[1] | | 0.107 | 0.226 |
| SEDb[2] | | 0.117 | 0.225 |
| Treatment | | NS | NS |
| Age | | *** | *** |
| Treatment x Age | | NS | NS |

[1] Standard error of a difference between two ages.

[2] Standard error of a difference between two treatment means.

*** $P<0.001$

For Peer Review Only

**Figure 1.** Schematic plan view of one of the three pens in each of the four rooms. C = camera; = polythene covered bale of wood shavings; = batons with bunches of polypropylene string

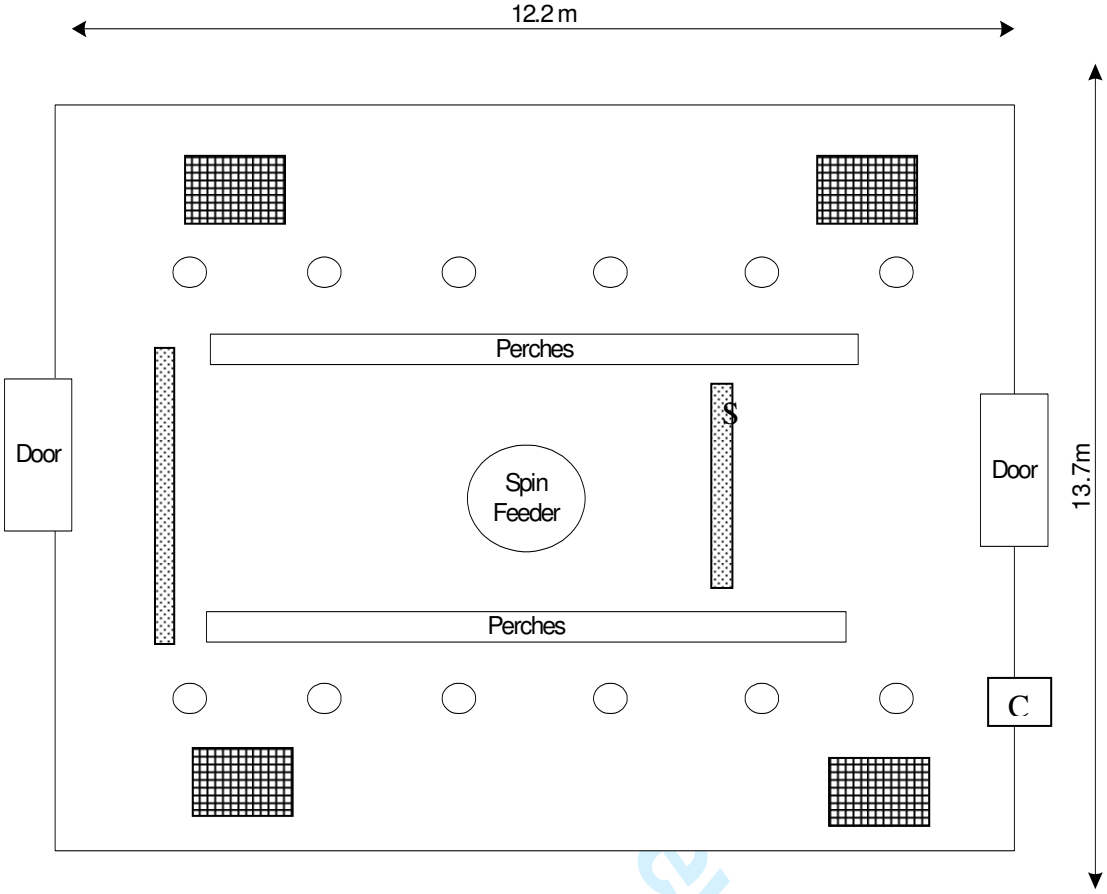
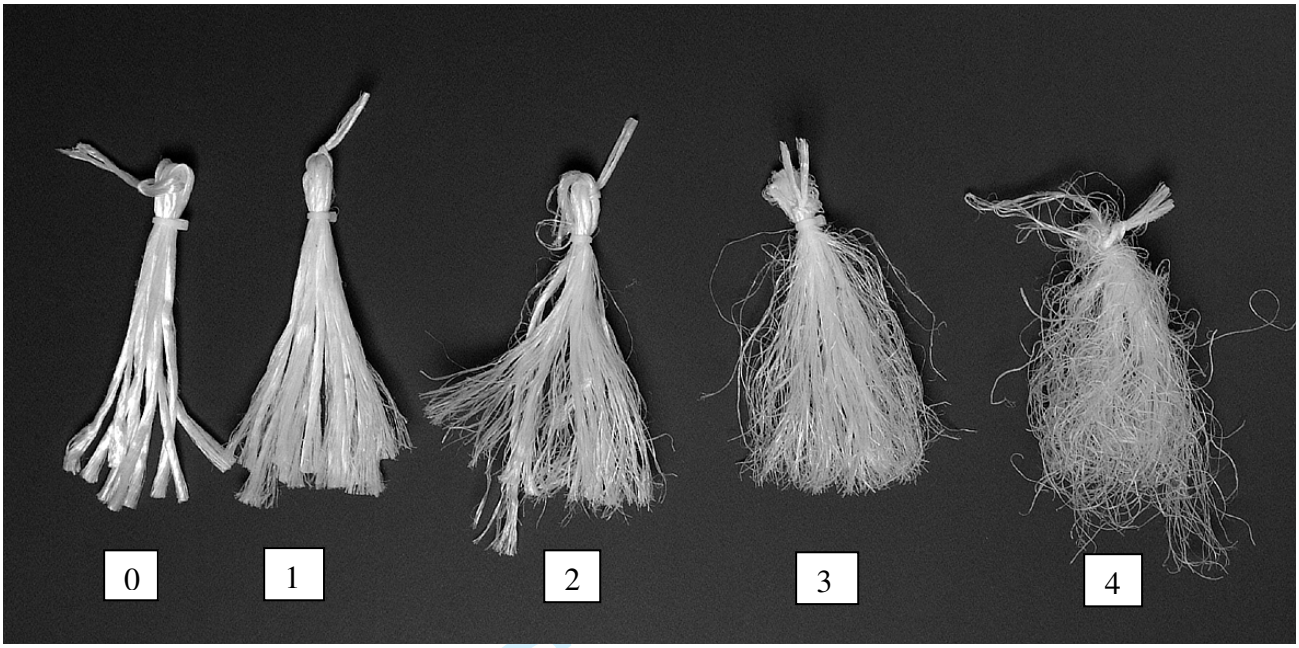


**Figure 2.** Scores for condition of string bunches.




For Review Only

# On-farm assessment of environmental enrichment for broiler breeders

P. M. HOCKING AND E. K. M. JONES[1]

Roslin Institute, Roslin, Midlothian, Scotland,

For Peer Review Only

Short Title**: Environmental enrichment for broiler breeders**

Accepted for publication 28 March 2006

Correspondence to Dr P. M. Hocking, Roslin Institute (Edinburgh), Roslin, Midlothian EH25 9PS, UK.

Tel +44 131 527 4251. Fax +44 131 440 0434.

Email: paul.hocking@bbsrc.ac.uk.

[1]Current address: Dr E.K.M. Jones, DEFRA, 1a Page Street, London, SW1 4PQ.

**Abstract** 1. A field experiment was conducted with commercial broiler

breeder females to assess the hypothesis that the provision of bunches of string and bales of wood shavings would provide attractive environmental enrichment and improve welfare by decreasing aggression and feather damage.

2. The experiment was a randomised block factorial design conducted in a commercial flock of 21 600 female broiler breeders in 12 pens of 1800 chicks. Treatments were environmental enrichment (4 plastic coated bales of wood shavings and 50 bunches of string) from hatch (EE1) or 8 weeks of age (EE2) and a control treatment with no environmental enrichment. There were 4 replicates (rooms).

3. Bird activity was videotaped at 5, 10 and 16 weeks of age and subsequently scored for the number of birds using the perch or pecking at a bale, drinker, litter and section of the wall at 10-min intervals for 4 h throughout the photoperiod (24 times/d). Aggression was assessed by determining the number of aggressive acts in 2-min intervals during 8 periods of the day. The skin and feather condition of 25 birds in each pen were scored at 6, 12 and 18 weeks and the condition of the string bunches were scored at the end of the experiment.

4. The proportion of birds pecking the bales, wall and litter declined and the proportion pecking at the drinker and using the perch increased with age.

For Peer Review Only

The number of birds pecking at the bale was similar in EE1 and EE2 at 10 and 16 weeks of age.

5. The string bunches were not extensively used. The condition of the bunches of string in EE2 was worse than in EE1 at the end of the experiment.

6. The number of aggressive acts increased with age and there was no consistent difference between treatments.

7. There was an increase with age in the damage score for feathers over the back and wings and around the tail and vent but no differences between treatments.

8. Provision of litter in the form of unopened bales of wood shavings was a commercially acceptable form of environmental enrichment, but there was no evidence that behavioural changes associated with feed restriction, including the prevalence of aggression, were improved.

## INTRODUCTION

Environmental enrichment (EE) can improve poultry welfare, productivity and profitability by reducing fear, aggression and feather pecking (Gvaryahu *et al.*, 1994; Huber-Eicher and Wechsler, 1998; Jones, 2001*b*; Jones *et al.*,

For Peer Review Only

2000*a*; Newberry, 1995). Furthermore, substrates that elicit foraging or dustbathing reduce the risk of feather pecking (Nicol *et al.*, 2001; Norgaard-Nielsen, 1997). Jones (1999*a*) showed that chicks increased their use of an environment when it was enriched. A bunch of white strings was an attractive pecking stimulus for various strains of laying hens and sustained the birds' interest in groups of adult hens and chicks (Jones and Carmichael, 1999*b*, 1999*c*). Other forms of environmental enrichment, such as compact discs (King, 2001), straw (Huber-Eicher and Sebo, 2001; Hubereicher and Wechsler, 1997; Johnsen *et al.*, 1998) and bales of wood shavings (Blokhuis and Haar, 1992; Burkhart *et al.*, 1983; King, 2001; Nicol *et al.*, 2001), also exerted beneficial effects, including reduced aggression. Kells *et al*. (2001) studied the effect of EE on the behaviour of broiler chickens on commercial farms. They found that broilers were more active in terms of walking and running and sat for less time in enriched houses, even when observed away from the EE (bales of wood shavings). King (2001), in experiments with limited replication, showed that bales of wood shavings and the provision of CDs reduced aggression in commercial broiler breeders and that bales also increased foraging in the litter and reduced pecking at the drinkers and walls.

The notion of a sensitive period for imprinting or the formation of preferences is commonly accepted, though this does not imply irreversibility

For Peer Review Only

(Jones *et al.*, 2000*a*; Sanotra *et al.*, 1995). However, the introduction of enrichment stimuli at different ages has yielded inconsistent results. Nicol *et al.* (2001), for example, suggested that provision of wood litter shavings at a range of ages during rearing reduced feather pecking in adults whereas Huber-Eicher and Sebo (2001) proposed that its provision during the first 2 weeks was the most effective. In fact, they recommended, "that laying chicks raised in aviary systems get access to litter from day 1 on". Access to string from 1 day of age caused greater reductions in feather pecking among birds from a line showing high rates of this behaviour than did later exposure but reduction of pecking-related damage in caged commercial layers was apparent, regardless of whether string was introduced at 1 day or 16 weeks of age (McAdie *et al.*, 2005).

The body weight gains of female broiler breeders are limited by feed restriction to enhance reproductive efficiency and decrease mortality (Hocking *et al.*, 2002). The degree of feed restriction relative to *ad libitum* feeding changes with age and becomes substantial from 6 to 8 weeks of age. Feed-restricted birds spend less time resting and more time foraging (scratching and pecking the litter), drinking and spot pecking at the walls than birds fed *ad libitum* (Hocking, 2004). We have shown that the provision of litter may decrease the propensity for aggression in feed-

For Peer Review Only

restricted broiler breeders (Hocking *et al.*, 2005) and we postulate that the provision of environmental enrichment will have a beneficial effect in reducing aggression and the frequency of so-called abnormal (stereotypic) wall pecking.

The aim of the present study was to identify the welfare consequences of introducing environmental enrichment (EE) at two ages in rearing flocks of female broiler breeders in a commercial setting. Two forms of EE were utilised: polythene covered bales of wood shavings and bunches of string (Jones, 2001*a*; Jones *et al.*, 2000*b*; Jones *et al.*, 2002; Jones and Rayner, 2000). In order to examine the effect of age and habituation on the use of EE they were introduced at hatch (EE1) or at 8 weeks of age (EE2), when the degree of feed restriction has become significant. The hypotheses tested were that environmental enrichment will decrease aggression by alleviating frustration of thwarted feeding behaviour caused by feed restriction and increasing the opportunities for non-damaging oral activity, and that the novelty of introducing EE at 8 weeks will elicit greater use compared with its introduction at hatch through lack of early habituation.

## MATERIALS AND METHODS

For Peer Review Only

Broiler breeder females (Ross 308, Aviagen, Newbridge, Edinburgh) on a commercial rearing farm were housed at 1-d old in two poultry sheds that were divided by a large area used for food storage and servicing the birds. Each half shed (room) was divided into 4 pens: there were three large pens approximately 14 m wide x 12 m long and a smaller pen that was used for the separate feeding of birds that were under weight. The three larger pens were randomly assigned to one of the three experimental treatments. There were 1800 1-d-old chicks placed in each of the large pens at the start of the experiment (21 600 birds in total) and birds were removed from 4 weeks of age to the small pen if under weight. The birds were returned at random to the larger pens when they were considered large enough. The placement of pen furniture and environmental enrichment devices are presented schematically in Figure 1. The A-frame perches were 83 cm high and there were three levels approximately 25 cm apart. Bird weights were recorded automatically and feed allowance was adjusted regularly to achieve the breeder's recommended target body weight gains described in the management manual. The daily allocation of feed was distributed at 08.00 h by a spin feeder suspended from the roof in the centre of each pen. A standard commercial vaccination programme was followed to protect the birds against common diseases. The photoperiod during the observation

For Peer Review Only

period was 8 h light in each 24 h period (lights on from 07.30 to 15.30 h). The birds were not beak trimmed and light intensity (mean of 5 observations in each pen) ranged from 6 to 8 lux. .

**Environmental enrichment**

Plastic covered bales of white wood shavings (79 cm long x 38 cm wide x 28 cm high) were placed in each of the 4 corners of the enriched pens (Figure 1). The bales were replaced when they were first exhausted at 6 weeks and every 2 weeks thereafter and the stockmen removed the plastic when the bale had been destroyed. Regardless of condition, fresh bales were provided to the experimental pens at the start of each week of video recording.

Ten bunches of white polypropylene string were attached to wooden batons 1.7 m long. Two batons were suspended from a roof truss at one location and three at a second (Figure 1) in each of the enriched pens. The batons could be raised and lowered by pulling on a suspending rope attached to the ends of each baton and looped through two eyelets screwed into a crossbeam. The batons were raised as the birds grew so that the top of the string bunches was just above the bird's heads and could be raised to over 2 m when necessary for management reasons. Bunches of string were made

For Peer Review Only

from 8 strands of white polypropylene string doubled to form two lengths of approximately 16 cm (see Figure 2).

**Observations**

One video camera was fixed to the wall of each pen at a height of about 2 m above the litter so that a view of all the main features in one half of the pen was visible. The lens was focussed and the angle of the camera was standardised by observing birds within a fixed area between the roof supports. Two rooms were video taped on each of two days over the entire photoperiod at 5, 10 and 16 weeks of age before the video recorders were moved to the second shed. The tapes were subsequently played back and scored as follows. Resource use was assessed by recording the numbers of birds associated with each of 5 resources: the bale of shavings, drinker and perch closest to the camera, the litter between the two middle roof supports and the wall between these two posts. The area of the drinker was defined as the circumference of the drinker plus one bird length. The observations were repeated every 10 min from 08.30 to 09.20, 10.30 to 12.20 and 13.30 to 14.20 h for a total of 24 observations at each age.

Aggression was defined as a vigorous peck aimed at the head, comb, neck or back that resulted in the immediate withdrawal of the

For Peer Review Only

recipient, usually with accompanying vocalisation, a similar aggressive threat or chasing. The numbers of aggressive interactions (pecks) performed by birds at the bale, drinker and litter areas as defined above were determined during 2 min at 30 min intervals at 8.30 and 09.00, 10.30 to 12.00, 13:30 and 14:00 h for a total of 8 observation periods for each pen at 5, 10 and 16 weeks of age.

Skin and feather condition was assessed at 6, 12 and 18 weeks. Birds were penned in one corner of each pen and 25 birds selected at random (bird nearest observer). The feathers and skin over the back and wings, tail and vent, neck (including the breast) and the head and comb area were examined and scored. Scores for feather damage were assigned according to a subjective assessment by the same person of the proportion of feathers that were broken or damaged as follows: none (score 0), 1-25% (1), 25-50% (2), 50-75% (3) and 75-100% (4).

The condition of individual bunches of string were scored at 8 and 18 weeks of age on a 5-point scale (Figure 2).

**Statistic analysis**

The experiment was a randomised block design with three treatments (Control, EE1 and EE2). The total number of birds observed at the 5 resources was calculated and the mean total number observed in each pen, age and time was analysed by a split-plot model with effects for Room, Pen within Room, Treatment and Age. The proportion of the total number of

For Peer Review Only

birds that were counted at the different resources was analysed after angular transformation of the proportion (% +1). Total counts of aggression at each resource were converted to rate/h and then transformed to rate/bird/h by dividing by the mean number of birds observed at that resource in that pen on the day of the observations. The residual errors for these data were approximately normally distributed. The effect of age on resource use and aggression around the bales was limited to data from EE1 and treatment comparisons to EE1 and EE2 at 10 and 16 weeks of age only. Feather scores for different body parts for each pen were averaged and analysed by the same model without transformation.

## RESULTS

The total numbers of birds using each resource at different ages are presented in Table 1. The total numbers of birds in each resource area declined with age (means for 5, 10 and 16 weeks respectively were 92.7, 67.5 and 58.9, sed 6.10, $P<0.001$). The mean total number of birds observed for Control, EE1 and EE2 respectively were 63.8, 76.6 and 87.7 (sed 4.99, $P<0,01$) and reflected the absence of observations (birds) around the bale in the control treatment The proportions of the total number of birds that were

For Peer Review Only

observed using each resource was therefore analysed and means are given in Table 1. There were declines with age in the proportion of birds using the bale, pecking the wall ($P<0.05$) and foraging in the litter ($P<0.001$) and an increase in the proportion of birds around the drinker and on the perch ($P<0.001$). Means (back transformed) for the proportion of birds surrounding the bale in EE1 at 5, 10 and 16 weeks respectively were 32.4 (28.8), 24.6 (17.4) and 14.2 (6.0), sed 2.81, $P<0.1$). The decline for EE2 was similar to that for EE1 and a similar proportion of birds used the bale at 10 and 16 weeks on both EE1 and EE2 (respective treatment means were 19.4 (211.1) and 22.7 (24.8), sed 1.23, $P<0.08$). The interaction of treatment x age was significant ($P<0.001$) for the proportion of birds using the litter (Table 1): the proportions were higher when bales of shavings were not present (in the control and EE2 treatments at 5 and the control at 10 weeks of age) but the differences between the control and both enrichment treatments were relatively small and not significant at 16 weeks.

The mean number of acts of aggression in birds surrounding the bale, the drinker and in the observed area of the litter increased with age (Table 2). Analysis of EE1 also showed an increase with age in aggression at the bale: means at 5, 10 and 16 weeks respectively were 0.05, 0.48 and 1.93 /h/bird, sed 0.0.371, $P<0.01$. There was no effect of treatment (EE1 vs.

For Peer Review Only

EE2) on the prevalence of aggression at the bale or the drinker but there was an age x treatment interaction ($P<0.05$) for aggression at the litter associated with high subclass means for aggression in EE1 at 10 weeks and the control at 16 weeks of age (Table 1).

Overall mortality averaged 1.5% from hatch to 18 weeks and there were no observed cases of feather loss or skin lesions at the time of assessing the condition of the integument at 6, 12 or 18 weeks of age in the sample of recorded birds. Feather damage scores for wings and back feathers and for the tail and vent areas were combined and results are presented in Table 3. There was an increase ($P<0.001$) in feather damage scores for both body areas but no differences between the three treatments.

The batons holding the string were removed from the pens before they were scored at the end of the experiment and mean scores for each baton could only be assigned to treatment. The standard error between pen means at 9 weeks (0.1503) was therefore used to estimate the standard error between treatment means. The mean scores for EE1 at 9 and 18 weeks respectively were 1.12 and 1.51 (t»2.55, $P<0.05$) and the mean score for EE2 at 18 weeks was 2.39 (t»5.86, $P<0.01$ compared with EE1 at 18 weeks).

## DISCUSSION

For Peer Review Only

The relative use of the two enrichment devices was compared by observing the proportion of birds using the bales as pecking targets and the condition of the string bunches. The increased number of birds foraging in the litter on EE1 and EE2 probably reflects the attractiveness of the bales of wood shavings and the limited area available for pecking at the bale and may also explain the interaction between treatment and age for the proportion of birds using the litter.

The evidence from this experiment is consistent with the results of an unpublished Ph.D. thesis (King, 2001) in showing extensive use of the bales of wood shavings: the bales were surrounded by active birds from at least 5 weeks of age in EE1 when the birds were able to puncture the plastic covering the bales, resulting in their destruction regular replacement. In contrast to the experiments of King (2001), there was no change in the proportion of birds perching, pecking at the drinker or wall and there was a decrease in the number of birds foraging away from the environmental enrichment devices. The differences between the studies could be associated with the lack of replication in King's research, differences in methodology or the use of twice as many bales in her experiment. Bales of wood shavings are a relatively expensive but biosecure resource and our use was additional

For Peer Review Only

to the usual farm allocation that maintained the litter in a dry friable state.

Whereas the bales attracted more birds to the total area under observation (about one third of the pen), there were more birds foraging in the litter in the control pens. This suggests that the bales have no more effect in diminishing frustrated feeding behaviour than litter elsewhere in the pen and that they may have attracted the bird's interest merely because they were clean or novel. In addition the plastic surrounding the bales of wood shavings may itself have been at attractive pecking target. The bales were available to the chicks on EE1 as soon as the brooding surrounds were removed at 14 d but little use was made of them until 4 weeks and they were first replaced at 6 weeks of age. It is likely that the birds could not make full use of the resource before 5 weeks because they were unable to puncture the plastic, as noted above.

Initially the string attaching the bunches of string to the batons became entangled and was manually freed and three birds also hanged themselves on them. Surrounding the lower part of each suspending string with 40 cm split water drinker tubing solved the problem and the devices for EE2 were fitted with these additions from their introduction at 8 weeks of age. The bunches of string introduced at 8 weeks in EE2 were initially used extensively, after which comparable and comparatively little interest in the

For Peer Review Only

bunches of string was observed in both treatments. Unfortunately the video recording of the string devices was not clearly visible and we could not accurately determine the numbers of birds using them.

The lack of sustained interest in the string bunches contrasts with the continued interest in these devices in caged laying hens (McAdie *et al.*, 2005). It is possible that the motivation to peck at these devices in feed-restricted broiler breeders is different from that in laying hens. If interest in the latter is associated with adult grooming behaviour or the need for oral manipulation of long roughage (for nest building, for example), then the relative lack of interest in sexually-immature broiler breeders could be explained.

Extensive initial interest in the string bunches in EE2 could be associated with novelty and the subsequent lack of interest due to habituation. King (2001) reported continued interest in CDs throughout her experiment but habituation has been noted for CDs and a number of other attractive pecking targets assessed commercially (D. Harrower, personal communication).

The rates of aggression in this experiment were surprisingly high, particularly at 16 weeks. The sum of the means for EE1 at 10 weeks was relatively high compared to the control and EE2 (more than 3 vs. less than

For Peer Review Only

1/h/bird). At 16 weeks the rate for the control was relatively high at the drinker and litter but was not dissimilar to EE1 and EE2 if the rates of aggression at the bale were included (total treatment means were 8.2 vs 6.3 and 7.0/h/bird respectively for control, EE1 and EE2). Statistical analyses of combined data failed to provide any support for the suggestion that environmental enrichment decreased aggression (results not shown). To our knowledge, the extent of feather damage in feed-restricted broiler breeders has not been previously reported. We expected that, with trivial numbers of culls for pecking damage, there would be little evidence of feather loss or damage and the state of the feathers was not readily apparent until the birds were handled and the plumage examined carefully.

The high rates of aggression (Table 2) could be the cause of the feather damage. Alternatively, high feather damage scores might indicate that extensive oral manipulation of feathers occurred although this was not observed in the videos. Small pieces of missing feather and abraded barbs might be associated with pecking at pellets or particles of feed in the plumage at the time of feed distribution by the overhead spin feeders. Alternatively the birds may manipulate their own feathers but this seems unlikely as it was not observed in the videos, nor has it been reported in other experiments. Furthermore, if it did occur, we would have expected

For Peer Review Only

greater use to be made of the bunches of string.

The birds in this commercial flock showed very little wall pecking or object pecking, in contrast to reports of experiments utilising small pens (De Jong *et al.*, 2005; Hocking *et al.*, 1993; Hocking *et al.*, 2001; Savory and Maros, 1993). The proportions of birds pecking the drinker were comparable whereas scratching and pecking at the litter was slightly higher than in small-scale experiments. Perches have not generally been included in the latter whereas up to 26 % of the birds used them in our commercial environment (Table 1). The results suggest that relying on behavioural assessment of welfare in small-scale experiments with feed-restricted broiler breeders may need to be re-evaluated. The extensive air pecking reported by King (2001) was not observed in our field study.

In conclusion we have shown that environmental enrichment in the form of bales of wood shavings attracted more birds to that location but the total proportion foraging in the litter and at the bale were similar to the control treatment. The proportion of birds pecking at the drinker was not affected by environmental enrichment. Bunches of string were used as pecking targets but the birds appeared to habituate to them and they were apparently not used extensively after initial interest. There was no consistent effect of environmental enrichment on aggression and rates of aggression

For Peer Review Only

were relatively high. We conclude that environmental enrichment in the form of bales of wood shavings and bunches of string had little or no effect on alleviating the frustration of feeding motivation in feed-restricted broiler breeders.

For Peer Review Only

## ACKNOWLEDGMENTS

We are grateful to David Harrower and Grampian Rearing Farms Ltd for access to the commercial site and provision of materials and to the farm staff for their co-operation and assistance. Dr R. Bryan Jones is thanked for helpful advice and Graeme Robertson and Laura Dick for technical assistance in the conduct of the experiment. The research was funded by Defra (contract AW1128). The Roslin Institute is funded by the BBSRC.

## REFERENCES

BLOKHUIS, H. J. & HAAR, J. W. V. D. (1992) Effects of pecking incentives during rearing on feather pecking of laying hens. *British Poultry Science,* **33:**17-24.

BURKHART, C. A., CHERRY, J. A., KREY, H. P. V. & SIEGEL, P. B. (1983) Genetic selection for growth rate alters hypothalamic satiety

mechanisms in chickens. *Behaviour Genetics,* **13:**295-300.

DE JONG, I. C., ENTING, H., VAN VOORST, A. & BLOKHUIS, H. J. (2005) Do low-density diets improve broiler breeder welfare during rearing and laying? *Poultry Science,* **84:**194-203.

GVARYAHU, G., ARARAT, E., ASAF, E., LEVY, M., WELLER, J. I., ROBINZON, B. & SNAPIR, N. (1994) An enrichment object that reduces aggressiveness and mortality in caged hens. *Physiology and Behaviour,* **55:**313-316.

HOCKING, P. M. (2004) Measuring and auditing the welfare of broiler breeders, in WEEKS, C. A. & BUTTERWORTH, A. (Eds.) *Measuring and Auditing Broiler Welfare,* pp. 19-35 *(*Wallingford, CABI.

HOCKING, P. M., BERNARD, R. & ROBERTSON, G. W. (2002) Effects of low dietary protein and different allocations of food during rearing and restricted feeding after peak rate of lay on egg production, fertility and hatchability in female broiler breeders. *British Poultry Science,* **43:**94-103.

HOCKING, P. M., JONES, E. K. M. & PICARD, M. (2005) Assessing the welfare consequences of providing litter for feed-restricted broiler breeders. *British Poultry Science***: 46:**, 545-452.

For Peer Review Only

HOCKING, P. M., MAXWELL, M. H. & MITCHELL, M. A. (1993) Welfare of broiler breeder and layer females subjected to food and water control during rearing. *British Poultry Science,* **34:**443-458.

HOCKING, P. M., MAXWELL, M. H., ROBERTSON, G. W. & MITCHELL, M. A. (2001) Welfare assessment of modified rearing programmes for broiler breeders. *British Poultry Science,* **42:**424-432.

HUBER-EICHER, B. & SEBO, F. (2001) Reducing feather pecking when raising laying hen chicks in aviary systems. *Applied Animal Behaviour Science,* **73:**59-68.

HUBER-EICHER, B. & WECHSLER, B. (1998) The effect of quality and availability of foraging materials on feather pecking in laying chicks. *Animal Behaviour,* **55:**861-873.

HUBER-EICHER, B. & WECHSLER, B. (1997) Feather pecking in domestic chicks: its relation to dustbathing and foraging. *Animal Behaviour,* **54:**757-768.

JOHNSEN, P. F., VESTERGAARD, K. S. & NORGAARD-NIELSEN, G. (1998) Influence of early rearing conditions on the development of feather pecking and cannibalism in domestic fowl. *Applied Animal Behaviour Science,* **60:**25-41.

For Peer Review Only

JONES, R. B. (2001*a*) Does occasional movement make pecking devices more attractive to domestic chicks. *British Poultry Science,* **42:**43-50.

JONES, R. B. (2001*b*) Environmental enrichment for poultry welfare, in WATHES, C. M., FROST, A. R., GORDON, F. & WOOD, J. D. (Eds.) *Integrated Management Systems for Livestock Production,* pp 125-131 (Edinburgh, BSAS).

JONES, R. B. & CARMICHAEL, N. L. (1999*a*) Can "environmental enrichment" affect domestic chickens' preferences for one half of an otherwise symmetrical home cage? *Animal Welfare,* **60:**11-23.

JONES, R. B. & CARMICHAEL, N. L. (1999*b*) Pecking at string by individually-cagedadult laying hens: Colour preferences and their stability. *Applied Animal Behaviour Science,* **60:**11-23.

JONES, R. B. & CARMICHAEL, N. L. (1999*c*) Responses of domestic chicks to selected pecking devices presented for varying durations. *Applied Animal Behaviour Science,* **64:**125-140.

JONES, R. B. & RAYNER, E. (2000) Chickens' interest in selected pecking devices: a longitudinal study. *Poultry Science,* **79(S1):**174.

JONES, R. B., CARMICHAEL, N. L. & RAYNER, E. (2000) Pecking preferences and predispositions in domestic chicks: implications for

For Peer Review Only

the development of environmental enrichment devices. *Applied Animal Behaviour Science,* **69:**291-312.

JONES, R. B., MCADIE, T. M., MCCORQUODALE, C. & KEELING, L. J. (2002) Pecking at other birds and at string enrichment devices by adult laying hens. *British Poultry Science,* **43:**337-343.

KELLS, A., DAWKINS, M. S. & BORJA, M. C. (2001) The effect of a 'freedom food' enrichment on the behaviour of broilers on commercial farms. *Animal Welfare,* **10:**347-356.

KING, L. A. (2001) Environmental enrichment for broiler breeders. PhD thesis, University of Oxford, Oxford.

MCADIE, T. M., KEELING, L. J., BLOKHUIS, H. J. & JONES, R. B. (2005) Reduction in feather pecking and improvement of feather condition with the presentation of a string device to chickens. *Applied Animal Behaviour Science,* (in press).

NEWBERRY, R. C. (1995) Environmental enrichment: increasing the biological relevance of captive environments. *Applied Animal Behaviour Science,* **44:**229-243.

NICOL, C. J., LINDBERG, A. C., PHILLIPS, A. J., POPE, S. J., WILKINS, L. J. & GREEN, L. E. (2001) Influence of prior exposure to wood shavings on feather pecking, dustbathing and foraging in adult

For Peer Review Only

laying hens. *Applied Animal Behaviour Science,* **73:**141-155.

NORGAARD-NIELSEN, G. (1997) Dustbathing and feather pecking in domestic chickens reared with and without access to sand. *Applied Animal Behaviour Science,* **52:**99-108.

SANOTRA, G. S., VESTERGAARD, K. S., AGGER, J. F. & LAWSON, L. G. (1995) The relative preferences for feathers, straw, wood-shavings and sand for dustbathing, pecking and scratching in domestic chicks. *Applied Animal Behaviour Science,* **43:**263-277.

SAVORY, C. J. & MAROS, K. (1993) Influence of degree of food restriction, age and time of day on behaviour of broiler breeder chickens. *Behavioural Processes,* **29:**179-190.

For Peer Review Only

**Table 1.** *Resource use by female broiler breeders on a commercial farm at 5, 10 and 16 weeks of age: means of 24 observations at 10-min intervals from 08.30 to 14.20 h. (Angular transformation with back-transformed means (%) in parentheses.) Treatments were no environmental enrichment (control) or enrichment devices introduced at hatch (EE1) or at 8 weeks of age (EE2).*

| Factor | | Total | Proportion (%) of birds using res | | | |
|---|---|---|---|---|---|---|
| Age (weeks) | Treatment | (N) | Bale[1] | Wall | Drinker | Litter |
| 5 | Control | 88.4 | - | 11.0 (4) | 17.9(9) | 66.4 (84) |
| | EE1 | 98.6 | 32.4(28) | 6.9 (1) | 15.9 (7) | 49.5 (58) |
| | EE2 | 91.2 | - | 9.9 (3) | 16.1 (8) | 68.7 (87) |
| 10 | Control | 53.9 | - | 10.3 (3) | 27.6 (22) | 52.1 (62) |
| | EE1 | 66.7 | 24.6 (17) | 7.9 (2) | 25.6 (19) | 41.6 (44) |
| | EE2 | 81.9 | 29.8(25) | 9.5 (3) | 24.8 (18) | 39.6 (41) |
| 16 | Control | 49.1 | - | 6.8 (1) | 26.5 (20) | 49.3 (57) |
| | EE1 | 64.4 | 14.2 (6) | 6.9 (1) | 25.1 (18) | 45.5 (51) |
| | EE2 | 63.1 | 15.5 (7) | 6.4 (1) | 26.6 (20) | 43.5 (47) |
| SEDa[2] | | 9.96 | 1.67 | 1.66 | 3.23 | 2.42 |

For Peer Review Only

| | | | | | |
|---|---|---|---|---|---|
| SEDb[3] | 10.56 | 1.23 | 1.62 | 3.16 | 2.81 |
| Treatment | * | NS | NS | NS | *** |
| Age | *** | *** | * | *** | *** |
| Treatment x age | NS | NS | NS | NS | *** |

[1]Analysis of EE1 and EE2 at 10 and 15 weeks only; means for EE1 at 5 weeks are also presented (see text).

[2]Standard error of a difference between two ages.

[3]Standard error of a difference between two treatment means.

* $P<0.05$; *** $P<0.001$; NS = not significant

**Table 2.** *Mean number of acts of aggression recorded at different pen resources on a commercial farm of female broiler breeders at 5, 10 and 16 weeks of age. Treatments were no environmental enrichment (control) or enrichment devices introduced at hatch (EE1) or at 8 weeks of age (EE2).*

| Factor | | Aggression at resource, n/b/h | | |
|---|---|---|---|---|
| Age (weeks) | Treatment | Bale[1] | Drinker | Litter |
| 5 | Control | - | 0.14 | 0.44 |

For Peer Review Only

| | | | | |
|---|---|---|---|---|
| | EE1 | (0.05) | 0.00 | 0.38 |
| | EE2 | - | 000 | 0.18 |
| 10 | Control | - | 0.25 | 0.65 |
| | EE1 | 0.48 | 1.20 | 1.91 |
| | EE2 | 0.05 | 0.00 | 0.86 |
| 16 | Control | - | 4.98 | 2.23 |
| | EE1 | 1.93 | 3.19 | 1.28 |
| | EE2 | 3.48 | 2.48 | 1.07 |
| SEDa[2] | | 1.625 | 2.012 | 0.418 |
| SEDb[3] | | 1.558 | 1.908 | 0.446 |
| Treatment | | NS | NS | NS |
| Age | | NS | ** | *** |
| Treatment x age | | NS | NS | * |

[1]Analysis of variance results for EE1 and EE2 at 10 and 15 weeks only; the mean for EE1 at 5 weeks is also presented (see text).

[2]Standard error of a difference between two ages.

[3]Standard error of a difference between two treatment means.

= $P<0.05$; ** = $P<0.01$; *** $P<0.001$; NS = not significant

For Peer Review Only

**Table 3**. *Mean score for feather damage on different areas of the body of female broiler breeders at 6, 12 and 18 weeks of age on a commercial farm. Treatments were no environmental enrichment (control) or enrichment devices introduced at hatch (EE1) or at 8 weeks of age (EE2).*

| Factor | | Feather damage score | |
|---|---|---|---|
| Age (weeks) | Treatment | Wings/back | Tail/vent |
| 6 | Control | 0.72 | 0.09 |
| | EE1 | 0.75 | 0.05 |
| | EE2 | 0.86 | 0.06 |
| 12 | Control | 1.44 | 1.48 |
| | EE1 | 1.29 | 1.35 |
| | EE2 | 1.14 | 0.14 |
| 18 | Control | 1.93 | 2.55 |
| | EE1 | 1.77 | 2.58 |
| | EE2 | 1.87 | 2.78 |
| SEDa[1] | | 0.107 | 0.226 |
| SEDb[2] | | 0.117 | 0.225 |

For Peer Review Only

| | | |
|---|---|---|
| Treatment | NS | NS |
| Age | *** | *** |
| Treatment x age | NS | NS |

[1]Standard error of a difference between two ages.

[2]Standard error of a difference between two treatment means.

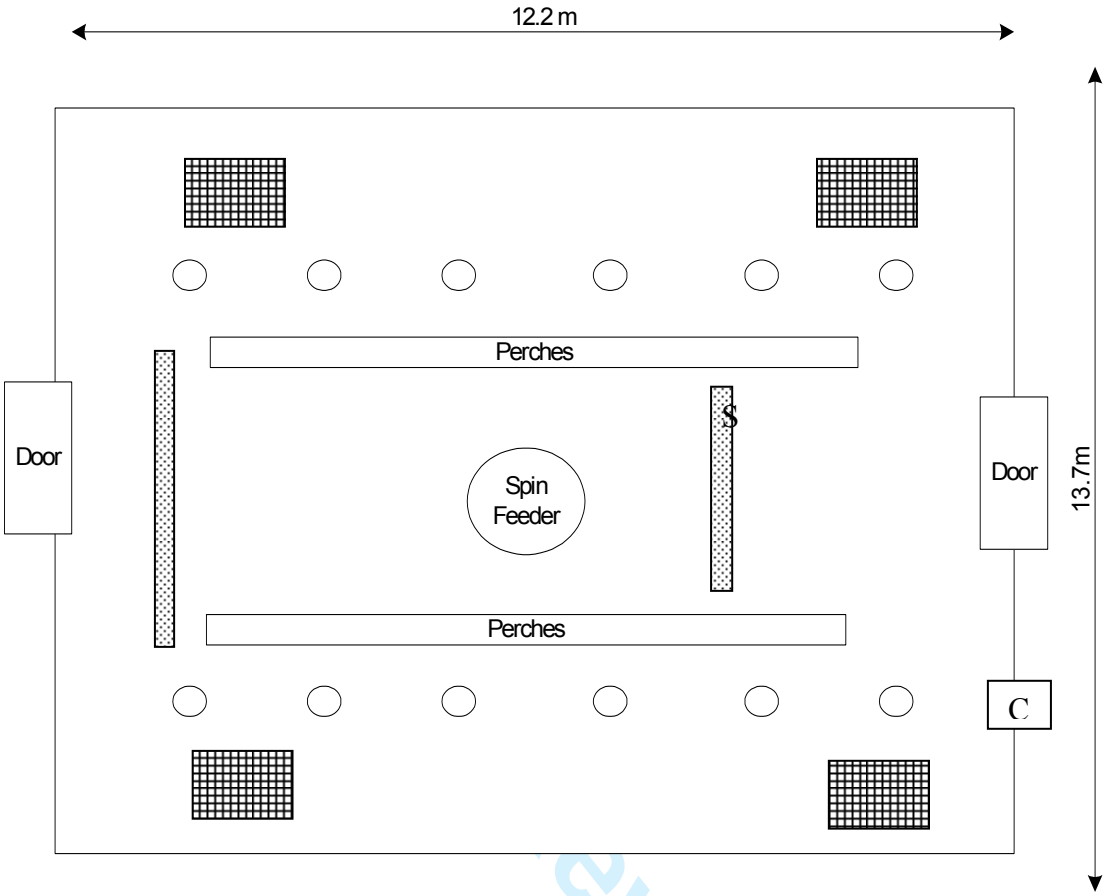
*** $P<0.001$

For Peer Review Only

## Legends for Figures

**Figure 1**

**Figure 1.** Schematic plan view of one of the three pens in each of the four rooms. C = camera; = polythene covered bale of wood shavings; = batons with bunches of polypropylene string

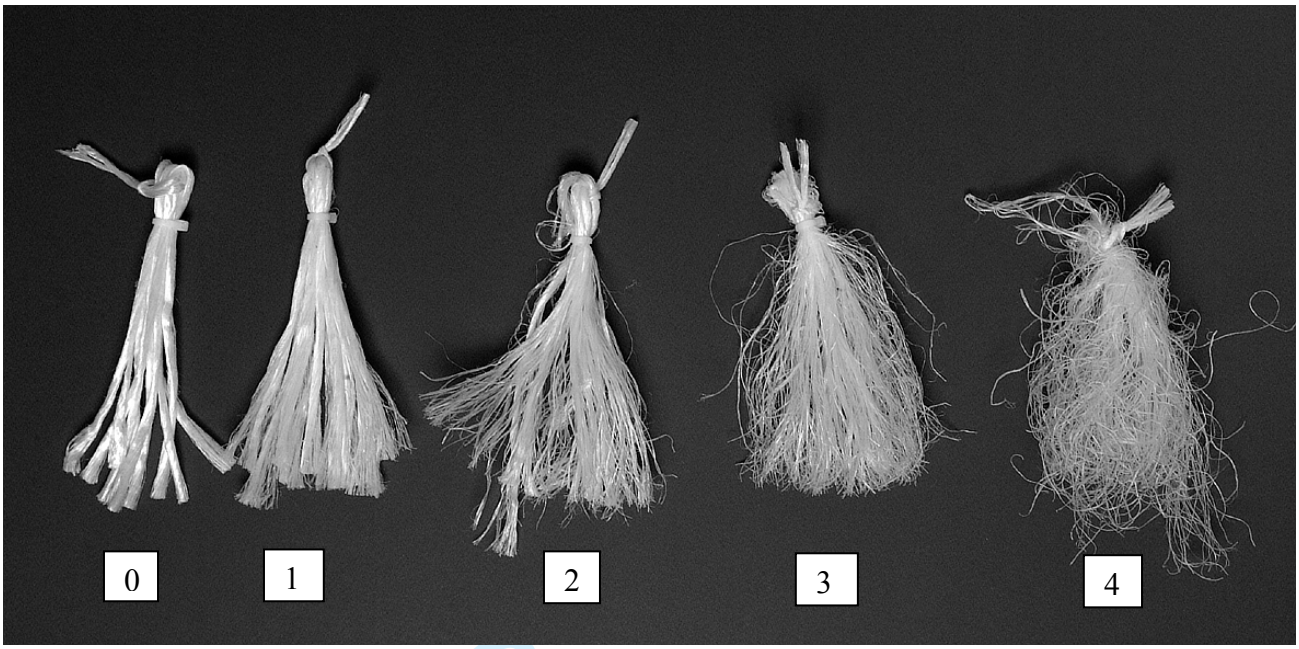



Review Only

**Figure 2**

Scores for condition of string bunches.

**Figure 2.** Scores for condition of string bunches.




For Review Only