Exploring perch provision options for commercial broiler chickens

Bailie, C. L., Baxter, M., & O'Connell, N. E. (2018). Exploring perch provision options for commercial broiler chickens. *Applied Animal Behaviour Science*, *200*, 114-122. https://doi.org/10.1016/j.applanim.2017.12.007

Published in:
Applied Animal Behaviour Science

Document Version:
Peer reviewed version

Queen's University Belfast - Research Portal:
Link to publication record in Queen's University Belfast Research Portal

Publisher rights
Copyright 2017 Elsevier.
This manuscript is distributed under a Creative Commons Attribution-NonCommercial-NoDerivs License (https://creativecommons.org/licenses/by-nc-nd/4.0/), which permits distribution and reproduction for non-commercial purposes, provided the author and source are cited.

General rights
Copyright for the publications made accessible via the Queen's University Belfast Research Portal is retained by the author(s) and / or other copyright owners and it is a condition of accessing these publications that users recognise and abide by the legal requirements associated with these rights.

Take down policy
The Research Portal is Queen's institutional repository that provides access to Queen's research output. Every effort has been made to ensure that content in the Research Portal does not infringe any person's rights, or applicable UK laws. If you discover content in the Research Portal that you believe breaches copyright or violates any law, please contact openaccess@qub.ac.uk.

Open Access
This research has been made openly available by Queen's academics and its Open Research team. We would love to hear how access to this research benefits you. – Share your feedback with us: http://go.qub.ac.uk/oa-feedback

Download date:19. Apr. 2024

Exploring perch provision options for commercial broiler chickens

Carley L. Bailie, Mary Baxter and Niamh E. O'Connell*

Institute for Global Food Security, School of Biological Sciences, Queens University Belfast, Belfast, BT9 7BL

***** Corresponding author

E-mail: Niamh.oconnell@qub.ac.uk

Abstract

Two related experiments involving broiler chickens are presented. Experiment 1 evaluated the use of six perch types: (1) an A-frame design (incorporating a platform and ramps), (2) a 'flat top' ramp, (3) a curved ramp, (4) a suspended bar, (5) a fixed bar and (6) a suspended platform. Two of each perch type was provided in one commercial house on each of two farms over two 6-week production cycles. Each perch was videoed for a 24 hour period in weeks 1-6 of cycle 1, and weeks 1-5 of cycle 2. Scan sampling was used to assign an occupancy score to different perch components (platform, bar and ramp, where appropriate), and an overall weighted occupancy score also calculated. Counts were made of perching and failed perching attempts following selected scans in cycle 1. There were significantly higher occupancy scores for platform than for bar or ramp components, and this was apparent across the production cycle. This resulted in a higher overall weighted occupancy score for suspended platforms. The percentage of failed perching attempts was significantly greater with fixed and suspended bar perches than with the curved ramp. Three treatments were assessed in Experiment 2: (1) provision of six suspended platform perches (P), (2) provision of six suspended platform perches and four peat-filled dust baths (PD), and (3) control treatment with no platform perches or dust baths. Treatments were applied in one of three houses on each of two farms, and replicated over three cycles. Two perches in each of the P and PD treatments were videoed for a 25 min period in weeks 3, 4 and 5, and number of birds using the perches recorded. The severity of angular leg deformities, hock burn and pododermatitis lesions, and walking ability were scored in weeks 3, 4 and 5, and prevalence of pododermatitis and hock burn recorded at slaughter. Litter moisture and production-related measures were also taken. On average, 26 birds (12.6 birds/m^2) occupied the perches, and this was not affected by provision of dust baths or age. Treatment did not significantly affect any of the measures taken. It is concluded that broilers prefer to perch on platforms rather than bars or ramps, and thus that platforms better cater for an important behavioural need. However, provision of platform perches, even in combination with dust baths, did not improve leg health, and future research should investigate greater levels of provision of these enrichments.

Key words: behavior, broiler chickens, dust baths, leg health, perches, welfare

1. Introduction

Perching is an anti-predation measure performed by fowl during resting (Newberry *et al*., 2001). It typically involves seeking an elevated structure that birds can grasp with their feet, and from which they can survey their environment (EFSA, 2015). Past research suggests that the underlying motivation to perch persists in fast growing commercial broiler chicken breeds (Ventura *et al.,* 2012; Bailie and O'Connell, 2015). Despite this, low levels of perching behaviour have traditionally been recorded in these birds (Su *et al*., 2000; Pettit-Riley and Estevez, 2001; Rodriguez-Aurrekoetxea *et al*., 2015). This suggests that common perch designs offered to broiler chickens are unsuitable. These designs typically require broilers to balance on a wooden or metal bar which they grasp with their claws. These types of behaviours may be difficult to perform for modern commercial broilers due to changes in their morphological conformation associated with genetic selection for rapid growth and increased breast muscle, which has caused their centre of gravity to shift forwards (Corr *et al*., 2003), potentially adversely affecting their ability to balance on a traditional perch. Leg health issues may also make it difficult to grasp a bar. Therefore it is possible that perches incorporating elevated platforms may be more suitable than elevated bars or poles.

The inability of fowl to carry out behaviours they are strongly motivated to perform, such as perching, may result in behavioural frustration (Duncan, 1970), and thus compromise welfare. As well as this, provision of perches has previously been shown to attenuate the age-related increase in fearfulness in broiler breeders (Brake *et al*., 1994). Facilitating an increase in perching behaviour, through the provision of suitable perches, may therefore improve welfare in commercial broilers by reducing levels of frustration and fear. Increased perching behaviour may also improve leg health by increasing exercise associated with stepping on to and off perches (Bizeray *et al*., 2002). Leg health issues associated with contact with litter, such as pododermatitis and hock burn, may also be reduced if birds spend more time perching (Su *et al*., 2000). Improved leg health may lead to reduced levels of mortality and culling, and may also promote growth performance by facilitating access to feed.

The objective of the first experiment in this paper was to determine the preference of commercial broiler chickens for different perch types. Six perch types were assessed which typically differed in design, in material of construction and in perching space available. It was hypothesized that perch designs incorporating access to platform perching space would be preferred to those not offering this. This study was also used to gain more general information about ease of use of different perch designs, and about the effects of age and time of day on occupancy of perches. The objective of the second experiment was to examine the overall effects on welfare- and performance-related parameters of providing commercial broiler chickens with access to a preferred perch type. It was hypothesised that increased usage associated with having access to a preferred perch type would result in improved leg health, and consequent improvements in production performance. This study also investigated if the use and effectiveness of preferred perches was influenced by access to another type of environmental enrichment in the house in the form of peat-filled dust-baths. Dust bathing, like perching, may be considered a highly motivated behaviour in domestic fowl (Olsson and Keeling, 2005). The provision of dust baths filled with peat, a preferred dust bathing substrate (Petherick and Duncan, 1989), has the potential to stimulate an increase in bird activity levels which may have additional benefits for leg health. These leg health benefits may, in turn, make it easier for broilers to access perches. Therefore it was hypothesised that use of perches, and overall effects of access to perches on welfare-related parameters, would be improved if access to dust baths was also provided.

2. Materials and methods

Both experiments in this paper were approved by the School of Biological Sciences (Queen's University Belfast) Research Ethics Committee (reference number QUB-BE-AREC-17-001).

2.1 Experiment 1

2.1.1 Treatments and experimental design

Perch design preference was assessed across two rearing cycles on each of two farms in Northern Ireland between June and November 2015. One house on each farm (Houses 1 and 2) was virtually divided into halves (front and back) and six perch designs were placed in each half house from the beginning of each rearing cycle. Perch type 1 ('A-frame', Supplementary photo 1) was comprised of a plastic mesh platform area measuring 240x60cm (located 66cm above litter), and three wooden bars with rounded edges each measuring 300x4cm (two bars each located 23cm above litter and one bar located 88cm above litter). Additional wooden bars with rounded edges were used to support the platform area and provided an additional 480cm^2 of surface area in total. The perch also contained two metal mesh ramps each measuring 54x122cm which could also be used for perching. Perch 2 ('flat top' ramp, Supplementary photo 2) was comprised of a plastic mesh platform area measuring 58x59cm (located 66cm above litter) and four wooden bars with rounded edges (two of which supported the platform). Available wooden bars provided an additional 992cm^2 of surface area in total and the two metal mesh ramps each measured 54x122cm. Perch 3 ('curved ramp', Supplementary photo 3) was comprised of a rectangle of wire mesh which was bent in order to provide a central summit measuring 5x98cm (located 32cm above litter), and two curved ramps each measuring 58.5x98cm. Perches 4 and 5 ('fixed bar', Supplementary photo 4, and 'suspended bar') were comprised of wooden bars with rounded edges measuring 300x4cm. The bar from perch 4 was located 15cm above the litter. The suspended bars were presented at ground level during Week 1 of the rearing cycle and were raised by 5cm at the beginning of each week until a maximum height of 20cm was reached at the beginning of Week 5 of the rearing cycle. Perch 6 (‘suspended platform’) was comprised of a plastic mesh platform measuring 240x60cm. It was raised as described for the suspended bar above. Slots measured 2x5cm in the plastic mesh and 3x3cm in the wire mesh.

Perch designs included in this study represented those already in use on farms, or new designs being considered for commercial implementation. Perch types 1, 2, 3 and 4 were free standing, whereas perches 5 and 6 were suspended. Suspended bars were fixed to roof supports in Houses 1 and 2. Suspended platforms were suspended from roof supports in House 1. However, in order to avoid damaging metal roof supports, platforms were suspended within a free standing metal cradle within House 2. The location of perches was balanced as much as possible across each half of the house in order to control for placement effects. This meant that, where possible given existing house equipment, perch types were placed in opposing quarters of a particular house (Figure 1), and this position remained constant across cycles.

2.1.2 Animals, husbandry and housing

A total of 69,500 Ross 308 broiler chickens obtained from 1 breeding company (Aviagen Ltd, UK) were used. Birds were placed in houses ‘as hatched’, resulting in mixed sex houses, and both houses were matched exactly for strain of birds. Both houses were stocked to a target stocking density of 30kg/m^2 during Cycles 1 and 2. Thinning did not take place in either house during Cycle 1, and an initial stocking density of 12birds/m^2 was used. However, during Cycle 2 approximately half of the birds from each house were removed for slaughter after day 30 of the production cycle, and the remaining birds were removed between days 32 and 42. Both Houses 1 and 2 were therefore stocked at a higher initial stocking density of 17birds/m^2.

Both houses were of a similar rectangular design and had windows placed down each of the long sides. House 1 was constructed of wood and House 2 of steel. Temperature, ventilation and feeding regimes, and feed sources and blends were identical between houses. Birds were fed on an *ad libitum* basis and received 3 different diets across the production cycle. All feeds were wheat/soya-based and were manufactured in a commercial feedmill (diet 1 was a starter crumb offered from days 0 to 10 days (21.5% crude protein (CP)); diet 2 was a grower pellet offered from 11 to 22 days (19.5% CP); diet 3 was a finisher pellet offered from 23 days to slaughter (18% CP)). All drinkers were of the nipple variety and included cups. The artificial lighting regime was identical across all houses and has been previously detailed in Bailie *et al.* (2013). The dark period was between 2300h and 0500h for both houses. Both lights and shutters were automatically controlled using timers. Shutters were set to automatically close at the onset of, and open at the end of, the dark period. Houses had centrally controlled indirect heating installed. Bedding comprised of wood shavings and was placed in the house prior to the birds arriving. Additional sawdust was then added to specific areas of the houses when deemed necessary by the farmer.

2.1.3 Measurements

2.1.3.1 Perch occupancy

CCTV cameras (Swann Communications Ltd, Milton Keynes, UK) were used to record perches in both halves of each house across a 24 hour period once a week during weeks 1-6 of Cycle 1 and weeks 1-5 of Cycle 2. Two cameras on tripods, set on opposite sides of the perches, were used to record the A-frame, ‘flat top’ ramp and curved ramp designs in order to ensure visibility of the entire perches, whereas one camera was used for other designs. The percentage occupancy of each perch was recorded using instantaneous scan sampling at 4 hour intervals across each 24 hour period (starting at 0000h). Footage was recorded on the same day of the rearing cycle for each house.

Perches 4, 5 and 6 were of a simple design, incorporating only one component part, and were therefore assigned an overall occupancy score of between 1 and 5 which related to the percentage of the upper surface area of the perch deemed to be occupied by birds (1 = 0%, 2 = 1-24%, 3 = 25-49%, 4 = 50-74%, 5 = 75-100%). Perches 1, 2 and 3 were more complex in their designs, and an occupancy score was assigned in the same manner to each of the component parts of these perches (e.g. platform, ramps and bars, as appropriate). Each bar or ramp on a given perch was assigned an occupancy score and then an average score calculated for all bars or ramps on that perch. Component occupancy scores were used to calculate a 'weighted' overall occupancy score for these more complex perch types. This involved calculating the surface area of each component part of the perch available for perching as a percentage of the total surface area for perching on that perch type. The occupancy scores for each component part were then weighted accordingly (e.g. reflective of the percentage of total perching space that that component represented) and combined.

2.1.3.2 Perching attempts and occupancy

Following scans of each perch type at 0800h, 1200h, 1600h and 2000h during weeks 2, 4 and 6 of Cycle 1 counts were made of the numbers of successful attempts at perching over a two minute period. Successful attempts were defined as sitting, standing or walking on a perch for a period of >2secs. Failed attempts were defined as when a bird attempted to access a perch but failed to make contact with their feet, or made contact with their feet or another body part for a period of <2secs before landing unevenly. Crossing over bars, or stepping onto and off the edge of the ramp while remaining in contact with the litter with a single foot, without pausing for at least 2 s, was not considered perching (Fiscus LeVan *et al*., 2000).

2.1.4 Statistical analysis

Due to equipment malfunction and operational issues ~0.07% of the video files for scan sampling were missing. However missing data were balanced across perch types. Data regarding overall occupancy of different individual perch components (bars, platforms and ramps) comprised unequal samples sizes and were non-normally distributed and were analysed using a Kruskal-Wallis test with ‘Component type’ as a treatment factor. Analysis was also performed to compare occupancy of different component parts of perches within perch type. This involved Kruskal-Wallis tests for perch types with three component parts (A-frame and ‘flat top’ ramp), and a Mann-Whitney U test for the perch type with two component parts (curved ramps), with ‘Component type’ as a treatment factor. The overall data set was also split by week, and occupancy of different perch components within each week analysed using Kruskal Wallis tests.

Multiple Kruskal–Wallis tests were used to assess the effects of ‘Perch type’, and also of ‘Week’ and ‘Time of day’ on overall weighted perch occupancy scores. This data file was then split by ‘Week’ and reanalysed using ‘Perch type’ as a treatment factor in order to compare the occupancy of different perch designs across weeks 1-6 of the rearing cycle. Numbers of failed perching attempts were expressed as a percentage of the total number of perching attempts recorded at each perch. These non-normally distributed data were then analysed using Kruskal-Wallis tests with ‘Perch type’ as a treatment factor in order to compare the numbers of perching attempts and the proportion of failed perching attempts between different perch designs. Significant differences between the ranked means of treatment groups were ascertained using pairwise comparisons where appropriate. Data were analysed using SPSS (v22) and results were adjusted for effects of multiple comparisons using a Bonferroni adjustment.

2.2 Experiment 2

2.2.1 Treatments and experimental design

Three treatments were assessed on two commercial broiler chicken farms in Northern Ireland between March and August 2016: (1) provision of platform perches (P) (Supplementary photo 5), (2) provision of both platform perches and peat dust baths (PD)

(Supplementary photo 6), and (3) control treatment with no platform perches or dust baths (C). In Treatments 1 and 2 six perches (with a platform measuring 230x90cm, and a wooden bar located above the platform) were placed in the house from day 7 of the rearing cycle. The perches were suspended within a large rectangular cradle and the platform remained at a fixed height of 20cm above the litter. The wooden bar above the platform was not used by the birds (Supplementary photo 5), hence the perches were referred to as 'platform perches'. Three perches were placed down each side of the house as indicated in Figure 2. In Treatment 2, four dust baths (each measuring 230x90cm, Supplementary photo 6) containing peat were placed in an irregular pattern in the centre of the house (Figure 2). The dust baths were filled with two 80L bags of peat initially, and were subsequently refilled by researchers twice weekly throughout the study. Farmers also examined the dustbaths on a daily basis and added additional peat once areas of the floor were visible and/or the peat was not considered friable enough for the birds to use. Three houses on each of the two farms were assigned to the study, and each treatment was assessed on each farm over three production cycles. This resulted in six replicates per treatment in total, and treatments were moved between houses in each farm between cycles.

2.2.2 Animals, husbandry and housing

A total of 405,000 Ross 308 broiler chickens obtained from one breeding company (Aviagen Ltd, UK) were used in this experiment. Birds were placed in houses 'as hatched', resulting in mixed sex houses. All houses were matched for strain of birds placed, and the date when chicks were placed was matched exactly for all 3 houses on each farm. Approximately half of the birds were removed for slaughter after day 30 of the production cycle, and the remaining birds were removed between days 32 and 42.

All houses were of an identical rectangular design and had the same number of windows. Houses on both farms were located side-by-side with an identical orientation. The total floor area/house available to the birds was 1325m^2 for Houses 1, 2 and 3 (Farm 1), 1398m^2 for

Houses 4 and 5 and 1395m^2 for House 6 (Farm 2). Stocking densities did not exceed 30 kg/m^2 at any stage of the production cycle. Temperature, ventilation and feeding regimes, and feed sources and blends were identical between houses. Birds were fed on an *ad libitum* basis and received the same 3 diets as specified in Experiment 1.

As in Experiment 1, the artificial lighting regime was identical to that detailed in Bailie *et al*. (2013). The dark period was between 2300h and 0500h hours for Farms 1 and 2. Houses were heated using centrally controlled indirect heating systems. Bedding comprised of straw pellets on Farm 1 and wood-shavings on Farm 2. Bedding was placed in houses prior to the birds arriving, and additional straw and shavings were added to specific areas of the houses when deemed necessary by the farmer. The farmers culled as normal throughout the study.

2.2.3 Measurements

2.2.3.1 Behavioural Observations

Behaviour was assessed during 1 day each week between weeks 3 and 5 of the rearing cycle. Video observations of 2 perches in each of the P and PD treatments on each farm were made between the hours of 10.00 and 13.00. Perches in the same location were selected for observation within all houses each week using a random number table. Simultaneous 30 minute recordings were made of one perch in each of the P and PD houses on the same farm for 30 min in the absence of the researcher using 2 camcorders fixed to wooden tripods. Cameras were then moved to the second perch in each house and these were filmed for 30 minutes.

2.2.3.2 Group scans of perch occupancy

The first 5 min of film was cut from all videos in order to ensure a settling period had been imposed after the exit of the researcher from the house. Instantaneous scan sampling for each 25 minute clip involved recording the total number of birds occupying platforms at 180 second intervals between 5 and 26 minutes.

2.2.3.3 Continuous observations of perching attempts

During the 3 minute period following scan sampling at 5, 11, 17, 20 and 23 minutes continuous observations were made of the number of successful and failed perching attempts on the platforms (as defined in Experiment 1).

2.2.3.4 Leg health, dermatitis measurements and bodyweight

The severity of angular leg deformities, hock burn and podo dermatitis lesions, and walking ability were scored in all treatments on the same day, once a week during weeks 3, 4 and 5 of the rearing cycle. This involved simultaneously corralling a number of birds into a wire pen placed in each of 4 areas of the house; preselected using a random number table. Pens were placed in identical areas across all houses each week in order to limit possible placement effects. Six birds (1296 birds in total across the experiment) were then removed from each pen individually. Birds were selected by holding a Perspex grid divided into thirty-six 5 cm^2 squares above the pen. Squares for selection were chosen using a random number table. The bird observed within the chosen square was examined for angular leg deformities using a 4 point scale where 0=no angulation of the hock (<10°) and 3= severe angulation (>45°) (Letterier and Nys, 1992). The foot pads of both feet and hocks were cleaned if required and both podo dermatitis and hock burn scored using the 5 point Welfare Quality® recommended scales where 1=no lesion and 5=very severe lesion (Forkman and Keeling, 2009). For each measure, the bird was assigned the highest score observable on either leg/foot. Walking ability was assessed using a 6 point scale where 0 = no impairment and 5 = complete lameness (Garner *et al*., 2002), and the percentage of lame birds (with a score ≥3) calculated. The prevalence of podo dermatitis and hock burn at slaughter was also recorded by slaughterhouse staff as in Bailie *et al. (*2013).

2.2.3.5 Productivity and mortality

The cumulative percentage of birds that had been culled or died by day 30 of the rearing cycle was calculated for each house. Water consumption per thousand birds at day 30 of the rearing cycle was also recorded for each house using company records. Average slaughter weights and the percentage of birds downgraded at slaughter were taken from farm records at thinning and clearing.

2.2.3.6 Litter moisture content

During weeks 3, 4 and 5 of the rearing cycle samples of litter were taken from 8 areas of the house. Sampling areas were selected using a random number table, with the requirement that four samples were taken from the edge and four from the centre of the house. Samples were stored in plastic bags and transported in a cool box to limit drying. Samples were thoroughly mixed to produce a 100g whole house sample and dried at 70°C for 24 hours. The dry matter percentage of the litter was then assessed (McLean *et al*., 2002).

2.2.4 Statistical Analysis

Due to equipment malfunction and operational issues approximately <0.45% of video scans were missing. A histogram of the residuals for each variable was plotted, and residuals tested for normality using the Shapiro–Wilk test and for homogeneity of variance using Levene's test. The means of normally distributed data were compared using ANOVA with 'cycle' and 'house' as blocking factors. Normally distributed behavioural and physical data, collected during weeks 3, 4 and 5 of the rearing cycle, were compared using ANOVA with 'enrichment * week' as a treatment factor. Normally distributed production data collected at day 30 of the rearing cycle and at thinning and slaughter were analysed using 'enrichment' as a treatment factor. For each measure, average values per treatment, week (if appropriate) and replicate were used as experimental units, and all main and interactive effects were determined in analysis. Root mean square error (RMSE) values are presented for ANOVA data and were calculated by taking the square root of error mean square values. Significant differences between the means of treatment groups were ascertained using

Tukey HSD post hoc tests. Data from a small number of measures remained non-normally distributed following transformation; therefore a Kruskal–Wallis test was used to compare ranked means of treatment groups. A Kruskal-Wallis test was also used to compare ranked means from dermatitis, gait and angular leg deformity score data. Results from this analysis were adjusted for multiple comparisons using a Bonferroni adjustment. As with Experiment 1, data were analysed using SPSS (v22).

3. Results

3.1 Experiment 1

3.1.1 Perch occupancy (component parts) (Table 1)

There was a significant difference in the percentage occupancy of different perch component parts (bar, platform or ramp). Results of pairwise comparisons showed that platforms were occupied significantly more than either ramps or bars ($p<0.001$), and ramps were significantly more occupied than bars ($p<0.001$). Platform components were also consistently occupied to a greater degree than either ramps or bars across weeks 1-6 of the rearing cycle.

This effect also appeared consistent across perch designs incorporating different component parts. Median occupancy scores of 4 were found for comparably-sized platform areas in both the A-frame and suspended platform perches; suggesting that these platforms were occupied to a similar degree.

3.1.2 Perch occupancy (overall weighted score) (Table 2)

There was a significant difference in the overall occupancy score assigned to different perch designs (Table 2). The suspended platform had a significantly greater overall occupancy score than all other perch types ($p<0.001$). In addition, the A-frame and 'flat top' ramp perches were more highly occupied than the curved ramp and fixed bar perches, which were more highly occupied than the suspended bar. These effects appeared consistent across time, with the suspended platform having the highest occupancy score across weeks 1 to 6 of the rearing cycle.

3.1.3 Perch occupancy (effect of week, time of day)

Both week ($H(5) = 60.4$, $n=1470$, $p<0.001$) and time of day ($H(5) = 21.0$, $n=1470$, $p=0.001$) had a significant effect on perch occupancy. Occupancy was significantly lower during week 1 than in weeks 2, 3, 4 and 5 ($p<0.001$), and in week 6 compared to weeks 2, 3, 4 and 5

($p<0.05$) (median score values: Week 1 = 2.0, Week 2 = 2.4, Week 3 = 2.4, Week 4 = 2.2, Week 5 = 2.3; Week 6 = 2.0). Occupancy was significantly lower at 0000h than at 0800h, 1200h and 2000h ($p<0.05$) (median score values: 0000h = 2.0, 0400h = 2.1, 0800h = 2.5. 1200h = 2.3, 1600h = 2.2, 2000h = 2.2).

3.1.4 Perching attempts (Table 3)

Results showed a significant difference between perch types in the total number of perching attempts made. More perching attempts were made at the A-frame, ‘flat top’ ramp, curved ramp and suspended platform perches than at the fixed bar perch (<0.05), or the suspended bar ($p=0.05$). There was also a significant difference in the proportion of perching attempts that failed for different perch designs, with significantly more failed perching attempts at the suspended and fixed bar perches than at the curved ramp perch ($p<0.05$).

3.2 Experiment 2

3.2.1 Behavioural Observations

3.2.1.1 Perch occupancy On average 26 birds (12.6 birds/m^2) were observed on the perches. There was no significant effect of the provision of dust baths or bird age on the degree to which platforms perches were occupied (Table 4).

3.2.1.2 Perching attempts There was no significant effect of the provision of dust baths on the number of perching attempts made, or on the percentage of failed perching attempts (Table 4). Bird age had no significant effect on the number of perching attempts made. The percentage of failed attempts was, however, significantly affected by bird age (Table 4). A significantly greater percentage of perching attempts failed during week 4 than week 5 ($p=0.007$) only.

3.2.1.3 Gait score There was no significant effect of the provision of platform perches and dust baths on the percentage of lame birds (Table 4), or on the mean gait score of birds

(Table 5). There was no significant effect of bird age on the percentage of lame birds, however there was a significant increase in mean gait score across weeks (Table 5).

3.2.2 Physical observations

The provision of platform perches and dust baths had no significant effect on the severity of angular leg deformities, hock burn lesions and podo dermatitis lesions. However significant age effects were shown (Table 5), with severity levels increasing with age. The overall mean incidence of hock burn and podo dermatitis recorded at slaughter was 6.4% and 25.6%, respectively, and was not significantly affected by treatment (Table 6).

3.2.3 Culls, mortality and productivity

Provision of platform perches and dust baths had no significant effects on water consumption per 1000 birds (median values (l): C = 264, P = 266, PD = 266; $H(2) = 0.04$, $p=0.98$), or on the proportion of birds who died and were culled, recorded at day 30 of the rearing cycle (Table 6). There was no significant treatment effect on the slaughter weight of birds (median values (kg): C 2.3, P 2.2, PD 2.3; $H(2) = 2.00$, ($n = 18$), $p=0.37$), or on the percentage of birds downgraded at slaughter (Table 6).

3.2.4 Litter moisture content

This was not significantly affected by treatment but tended to increase with age (Table 4).

4. Discussion

The first experiment in this paper was designed to provide guidance to a commercial company on the most appropriate perch type to use out of a number being considered. In addition to differing fundamentally in design, the perch types also differed in material of construction, and in overall perching space available. These designs were, however, representative of what would ultimately be provided to the chickens. Our assessment of percentage surface area occupancy accounted for relative differences in the size of component parts. In a similar vein, White and colleagues (1989) previously measured the percentage cage surface area occupancy of guinea pigs using a computerized video digitalizer and computer-controlled data acquisition and processing system. However, within the current study, the challenges of finding suitable places in which to fix cameras within commercial houses and of ensuring that the full surface areas of differently sized and shaped perch designs were visible during recording, resulted in CCTV cameras being placed at different angles to, and distances from, perches; making digital processing difficult. Therefore, the level of occupation was assessed manually using an occupancy scoring system in order to improve the accuracy of observations. To the authors' knowledge, this is one of the first studies to investigate preferences for perch design within commercial broiler chicken houses across a production cycle.

The study showed greater overall occupancy of platform components than of ramps and bars, and greater occupancy of ramps than bars, and these effects remained consistent across the rearing cycle. These findings are similar to those of Norring *et al.* (2016), and may reflect the morphology of modern commercial broilers which has been altered by selection for rapid growth, resulting in weaker legs and heavier breast tissue (Schmidt *et al*., 2009). These morphological changes, and the associated shift in the birds' center of gravity (Corr *et al*., 2003), may make it difficult for fast growing broilers to balance on a traditional perch in the form of a bar. A raised platform provides a wider area for birds accessing the perch to land on. The finer mesh allows birds of all ages to grip more easily than on a traditional perch where feet have to be wrapped around a wider bar. The platform also removes the need for broilers to balance when perching as the wider base supports the whole underside of the bird, including the heavy breast tissue later on in the rearing cycle, and therefore removes strain on the legs, potentially reducing the level of pain experienced by lame birds (Danbury *et al*., 2000). The preference for occupying platforms over ramps was likely related to the birds' tendency to prefer horizontal to angled perches (Fiscus Le Van *et al*., 2000).

This apparent preference for platform components explains why the suspended platform perch showed the highest overall occupancy score. This score was weighted according to the extent to which different components were incorporated in the perch design, and platform components contributed ~45%, ~20%, ~4% and 100% of the overall space available for perching at the A-frame, 'flat top' ramp, curved ramp and suspended platform, respectively (and 0% at both the step up perch and swinging bar). However it is worth pointing out that platforms presented as part of a larger, more complex perch structure appear to have been used to a similar degree as comparably sized platforms suspended on their own. For example, the platform components on the A-frame and suspended platform perches were of similar size and were similarly occupied.

The largest number of perching attempts occurred at the A-frame, 'flat top' ramp, curved ramp and suspended platform perches, which incorporated platform components, reflecting the preference for these components over ramps and bars. Additionally, the largest percentage of failed perching attempts occurred at the fixed and suspended bar perches, which incorporated only bar components. The increased proportion of failed attempts was likely due to the instability of these perch designs and the resultant difficulty that heavy, unbalanced birds may have had in accessing these perches and remaining upon them.

There was a significant effect of week and time of day on the average percentage occupancy scores recorded in Experiment 1. Results suggest that broiler chickens are motivated to perch from the first week of the rearing cycle. However, this is only possible when access to perches is enabled either by provision of access ramps, or by altering the height of the perch throughout the rearing cycle. Past research suggests that peak perching occurs between weeks 4 and 5 of the rearing cycle (Ventura *et al*., 2012; Zhao *et al.,* 2013; Bailie and O'Connell, 2015). However the results of this study suggest that age-related patterns of use may differ for different perch component types. Within the current study, the use of both ramps and bars peaked during weeks 2 and 3, while the use of platforms peaked during week 5 of the rearing cycle. These findings may have reflected the reduced ability of older birds to access bars and ramps, likely due to the relative instability of these components compared with platforms. Older, heavier birds may find it difficult to access and balance on bars due to the forward shift in their centre of gravity (Corr *et al.,* 2003) and the increased prevalence of lameness (Weeks *et al*., 2000), and associated skeletal abnormalities of the legs and feet (Kestin *et al*., 1992), which may make gripping bars mechanically difficult and painful (Danbury *et al.,* 2000). Similarly, they may also have difficulty walking or resting on a slope, which places an increased strain on feet and legs, compared with walking and resting on a flat, horizontal surface; such as that provided by platforms.

Experiment 2 investigated the effects of the provision of platform perches on welfare- and production-related measures in commercial broiler chickens. It also assessed if these effects were influenced by the presence of other environmental enrichment in the form of dust-baths. The average occupancy rate of platforms was 12.6 birds/m^2, which is similar to that described by Norring *et al*. (2016). Platform perches were occupied by birds in 99.7% of observations, which is a relatively high level of usage compared with past research suggesting that perching took place in less than 25% of observations of more traditionally shaped barrier type perches when provided to birds at a stocking density of 8 birds/m^2 (Ventura *et al*., 2012). The fact that perch occupancy was not affected by the presence of dust-baths may have reflected the fact that use was already high (and perhaps also the lack of effect of dust-baths on leg health). It was hypothesised that access to a preferred perch type would have a positive effect on leg health as use of these perches would be increased compared with the relatively low levels of perch usage recorded by past studies (eg. Martrenchar *et al*., 2000; Fiscus Le Van et al., 2000; Pettit-Riley and Estevez, 2001). However this was not the case in the current study as no treatment effect was shown on gait score, on the proportion of lame birds, or on physical leg health measures. The severity of both hock burn and pododermatitis lesions increased with bird age. As litter moisture content is one of the most salient factors in the development of dermatitis lesions in broiler chickens (Greene *et al*., 1985; Shepherd and Fairchild, 2010), this effect was likely related to the tendency towards increasing litter moisture content across weeks 3 to 5 of the rearing cycle.

It has been suggested that muscles and joints may be exercised in a more diverse variety of ways by crossing barriers and stepping onto perches than during walking and running alone (Bizeray *et al*., 2002). Previous studies have shown beneficial effects of access to perches on muscle conformation and development (Sandusky and Heath, 1988a,b), leg bone development and condition (Hester, 1994; Reiter and Bessei, 1996; Bizeray *et al.,* 2002; Ventura *et al*., 2010) and on bone breaking strength (Balog *et al*., 1997). The fact that overall benefits to leg health were not shown in the current experiment may have reflected the level of provision of perches, with only six provided per house. This may also have applied to the lack of effect of dust baths, with only four provided per house. Current industry guidelines for the provision of perches to broiler chickens are based of linear space allowances. For example, RSPCA (2013) standards require 2 m of perching space to be provided per 1000 birds. Determining the correct level of provision of areas of perching space (rather than lengths of perching bars) will require more research. In addition, understanding the correct placement of these perches is also likely to be important as, in reality, the use of platform rather than bar type perches may mean fewer perches are provided.

It is also possible that beneficial effects of perches on welfare-related parameters were not shown because access was restricted for very young birds. The results from Experiment 1 showed that birds chose to access platform perches from a young age, but these perches were provided at ground level initially, and increased in height across weeks. In Experiment 2 it was decided to evaluate these perches at a fixed height of 20 cm, in order to increase practicality of presentation within commercial houses, and this may have adversely affected the ability of younger birds to access these platforms until week 2. It has been previously suggested that increased mobility in chicks results in beneficial long term effects on leg health (Bizeray *et al.,* 2000). Enabling early perching opportunities may have additional benefits for long term leg health as the provision of perches allows more diverse physical activity (Bizeray *et al.,* 2002). The lack of early perching opportunities may therefore have resulted in the absence of beneficial effects on leg health within this study.

5. Conclusions

The results of this study agree with those of past research suggesting that motivation to perform perching behavior persists in fast growing commercial broilers. However, it is likely that the morphological changes and possibility of poorer leg health associated with genetic selection for rapid growth have contributed to an increased inability of birds to access, and balance on, traditional perches. Providing birds with a raised platform, in lieu of a traditional perch, may provide a more stable area for perching. Despite the fact that the provision of platforms had no significant effect on parameters such as leg health, it appears to better enable birds to fulfil an important behavioural need and this may convey welfare benefits. Further applied research is needed to ascertain the optimum level of provision and placement of perches to achieve positive outcomes on broiler leg health. It is suggested that the lack of effect of an additional enrichment in the form of dust-baths on leg health or on use of platform perches may have reflected the low level of provision of the dust-bathing material.

6. Acknowledgements

This research was supported by funding from Moy Park Ltd.

7. Declarations of interest: None

8. References

Bailie CL, Ball MEE and O'Connell NE 2013. Influence of the provision of natural light and straw bales on activity levels and leg health in commercial broiler chickens. Animal 7, 618-626.

Bailie CL and O'Connell NE 2015. The influence of providing perches and string on activity levels, fearfulness and leg health in commercial broiler chickens. Animal 9, 660-668.

Balog JM, Bayyari GR, Rath NC, Huff WE and Anthony NB 1997. Effect of intermittent activity on broiler production parameters. Poultry Science 76, 6-12.

Bizeray D, Leterrier C, Constantin P, Picard M, Faure JM 2000. Early locomotor behaviour in genetic stocks of chickens with different growth rates. Applied Animal Behaviour Science 68, 231–242.

Bizeray D, Estevez I, Leterrier C, and Faure JM 2002. Influence of increased environmental complexity on leg condition, performance, and level of fearfulness in broilers. Poultry Science 81, 767–773.

Brake J, Keeley TP and Jones RB 1994. Effect of age and presence of perches during rearing on tonic immobility fear reactions of broiler breeder pullets Poultry Science 73, 1470-1474.

Corr SA, Gentle MJ, McCorquodale CC and Bennett D 2003. The effect of morphology on walking ability in the modern broiler: a gait analysis study. Animal Welfare 12, 159-171.

Danbury TC, Weeks CA, Chambers JP, Waterman-Pearson AE and Kestin SC 2000. Preferential selection of the analgesic drug carprofen by lame broiler chickens. Veterinary Record 146, 307-311.

Duncan IJH 1970. Frustration in the fowl. B.M. Freeman, R.F. Gordon (Eds.), Aspects of Poultry Behaviour, British Poultry Science, Edinburgh, Scotland, UK, 15-31.

EFSA 2015. Panel on Animal Health and Animal Welfare (AHAW), Scientific Opinion on welfare aspects of the use of perches for laying hens EFSA Journal 13, 4131.

Fiscus LeVan NF, Estevez I and Stricklin WR 2000. Use of horizontal and angled perches by broiler chickens. Applied Animal Behaviour Science 65, 349–365.

Forkman and Keeling (Eds) 2009. Welfare Quality™: Assessment of animal welfare measures for layers and broiler. Available at http://www.welfarequality.net/everyone/43217/7/0/22 [Accessed 27th June 2017].

Garner J, Falcone C, Wakenell P, Martin M and Mench J 2002. Reliability and validity of a modified gait scoring system and its use in assessing tibial dyschondroplasia in broilers. British Poultry Science 43, 355-63.

Greene JA, McCracken R and Evans R 1985. A contact dermatitis of broilers - clinical and pathological findings. Avian Pathology 14, 23-38.

Hester PY 1994. The role of environment and management on leg abnormalities in meat-type fowl. Poultry Science 73, 904–915.

Kestin SC, Knowles TG, Tinch AE and Gregory NG 1992. Prevalence of leg weakness in broiler chickens and its relationship with genotype. Veterinary Record 131, 190– 194.

Martrenchar A, Huonnic D, Cotte JP, Boilletot E and Morisse JP 2000. Influence of stocking density, artificial dusk and group size on the perching behaviour of broilers. British Poultry Science 41, 125–130.

Letterier C and Nys Y 1992. Clinical and anatomical differences in varus and valgus deformities of chick limbs suggest different etiopathogenesis. Avian Pathology 21, 429-442.

McLean JA, Savory CJ and Sparks NHC 2002. Welfare of male and female broiler chickens in relation to stocking density, as indicated by performance, health and behaviour. Animal Welfare 11, 55-73.

Newberry RC, Estevez I and Keeling LJ 2001. Group size and perching behaviour in young domestic fowl. Applied Animal Behaviour Science 73, 117-129.

Norring M, Kaukonen E and Valros A 2016. The use of perches and platforms by broiler chickens. Applied Animal Behaviour Science 184, 91-96.

Olsson IAS and Keeling LJ 2005. Why in earth? Dustbathing behaviour in jungle and domestic fowl reviewed from a Tinbergian and Animal Welfare perspective. Applied Animal Behaviour Science 93, 259–282.

Petherick JC and Duncan IJH 1989. Behaviour of young domestic fowl directed towards different substrates. British Poultry Science 30, 229-38.

Pettit-Riley R and Estevez I 2001. Effects of density on perching behavior of broiler chickens. Applied Animal Behaviour Science 71, 127–140.

Reiter K and Bessei W 1996. Effect of the distance between feeder and drinker on behaviour and leg disorders of broilers Proceedings of the 30th International Congress of Applied Ethology, Guelph, Canada, 131–132.

Rodriguez-Aurrekoetxea A, Leone EH and Estevez I 2015. Effects of panels and perches on the behaviour of commercial slow-growing free-range meat chickens. Applied Animal Behaviour Science 165, 103-111.

RSPCA Welfare Standards for Chickens 2013. RSPCA Freedom Food Farm Assurance and Food Labelling Scheme. Available at https://www.berspcaassured.org.uk/media/1086/rspca-standards-chickens-nov2013.pdf [Accessed 27th June 2017].

Sandusky CL and Heath JL 1988a. Effect of age, sex, and barriers in experimental pens on muscle growth. Poultry Science 67, 1708–1716.

Sandusky CL and Heath JL 1988b. Growth characteristics of selected broiler muscles as affected by age and experimental pen design. Poult. Sci. 67, 1557–1567.

Schmidt C, Persia M, Feierstein E, Kingham B and Saylor W 2009. Comparison of a modern broiler line and a heritage line unselected since the 1950s. Poultry Science 88, 2610-9.

Shepherd EM and Fairchild BD 2010. Footpad dermatitis in poultry. Poultry Science 89, 2043-2053.

Su G, Sorensen P and Kestin SC 2000. A note on the effects of perches and litter substrate on leg weakness in broiler chickens. Poultry Science 79, 1259–1263.

Ventura B, Siewerdt F and Estevez I 2010. Effects of barrier perches and density on broiler leg health, fear, and performance. Poultry Science 89, 1574-83.

Ventura B A, Siewerdt F and Estevez I 2012. Access to barrier perches improves behavior repertoire in broilers. PLoS One **7(1)**, e29826.

Weeks CA, Danbury TD, Davies HC, Hunt P and Kestin SC 2000. The behaviour of broiler chickens and its modification by lameness. Applied Animal Behaviour Science 67, 111-125.

White WJ, Balk MW and Lang CM 1989. Use of cage space by guineapigs. Laboratory Animals. 23, 208-214.

Zhao JP, Jiao HC, Jiang YB and Lin H 2013. Cool perches improve the growth performance and welfare status of broiler chickens reared at different stocking densities and high temperatures. Poultry Science 92, 1962-1971.

Figure 1 Title

General placement of perch types (1-6) in one house on each of two farms in Experiment 1. Perch types are as follows: 1 = A-Frame, 2 = flat top ramp, 3 = curved ramp, 4 = fixed bar, 5 = suspended bar, 6 = suspended platform.

Figure 2 Title

Placement of platform perches and dustbaths in Experiment 2 (not to scale). Red and blue vertical lines represent feeder and drinker lines, respectively. Boxes on the outside of the house represent windows.

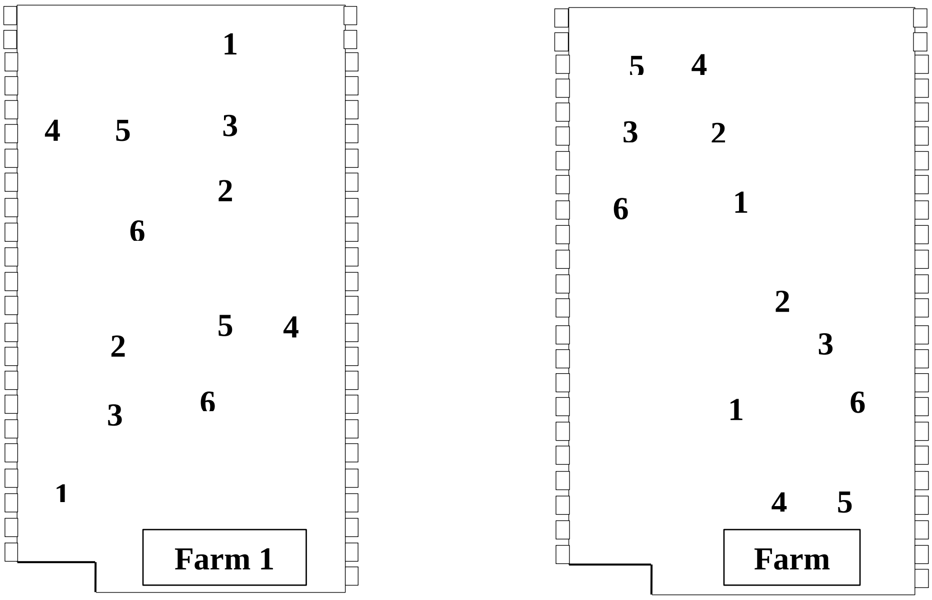

Figure 1.

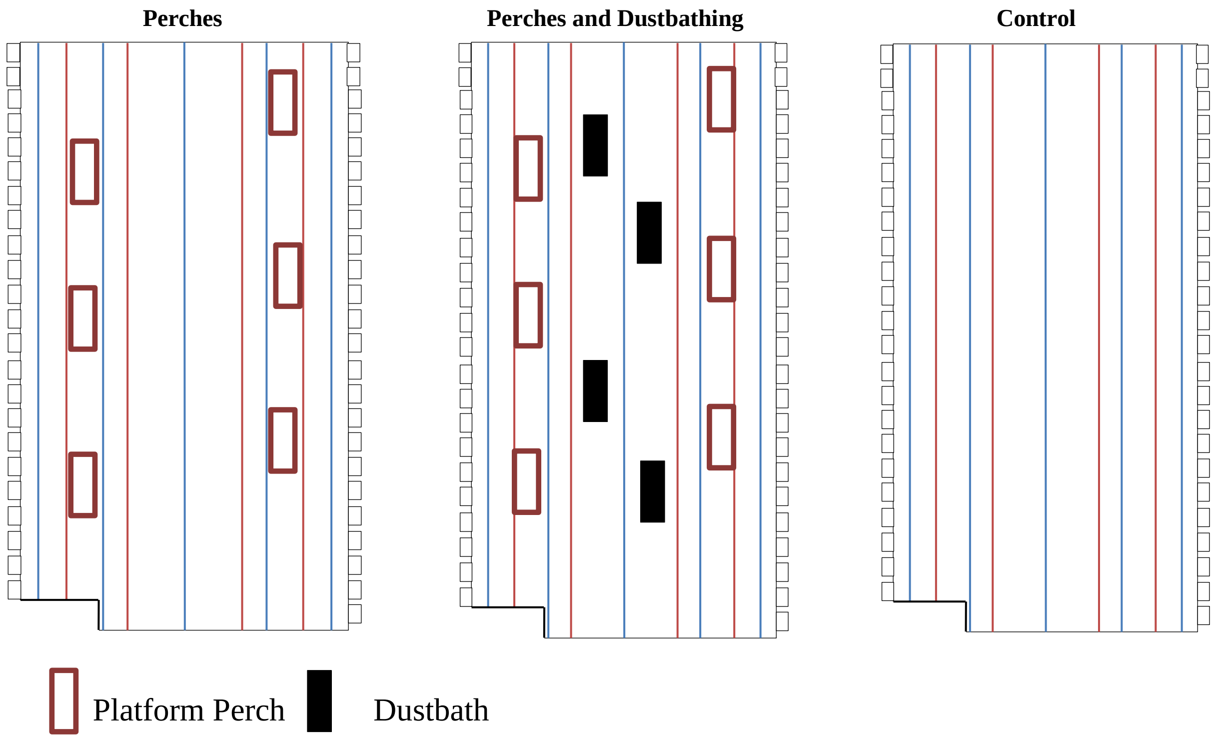
Perches
Perches and Dustbathing
Control
Platform Perch
Dustbath

Figure 2.

Table 1 *Main effects of perch component type on overall component occupancy and component occupancy recorded for complex perches (A-frame, 'flat top' ramp, curved ramp perches) and during weeks 1-6 of the rearing cycle in Experiment 1 (median score values presented)*

	Component type				
Occupancy	Bar	Platform	Ramp	H(2)	P
Overall	1.0[c]	4.0[a]	2.0[b]	1648.29	<0.001
A-frame	1.3[c]	4.0[a]	2.5[b]	464.67	<0.001
'Flat top' ramp	1.0[c]	5.0[a]	2.0[b]	595.35	<0.001
Curved ramp	N/A	5.0	1.5	U=2259.0	<0.001
Week 1	1.0[c]	3.0[a]	2.0[b]	332.32	<0.001
Week 2	1.3[c]	4.0[a]	2.3[b]	278.54	<0.001
Week 3	1.4[c]	4.0[a]	2.0[b]	346.97	<0.001
Week 4	1.3[c]	4.0[a]	2.0[b]	352.35	<0.001
Week 5	1.0[c]	5.0[a]	2.0[b]	302.55	<0.001
Week 6	1.0[c]	3.0[a]	2.0[b]	130.05	<0.001

Overall component occupancy (n = 2702), A-frame (n = 735), 'Flat top' ramp (n = 735), Curved ramp (n = 497), Week 1 (n = 528), Week 2 (n = 468), Week 3 (n = 528), Week 4 (n = 528), Week 5 (n = 452), Week 6 (n = 198). Whole data set analysed using Kruskal-Wallis test with 'Component type' as treatment factor for overall component occupancy. Data file split by 'Perch type' and analysed by Kruskal-Wallis test for A-frame and 'flat top' ramp, and by Mann-Whitney U test for curved ramp with 'Component type' as treatment factor. Data file split by 'Week' and analysed by Kruskal-Wallis test with 'Component type' as treatment factor. Statistical analysis was performed on ranked means but median score values presented for ease of interpretation.

Two of each of six perch types were provided in one house on each of two farms and observed at 4 hour intervals over one 24 hour period each week during weeks 1-6 of Cycle 1 and weeks 1-5 of Cycle 2. Occupancy scores were assigned to perch components as follows: 1=0%, 2 = 1-24%, 3 = 25 – 49%, 4 = 50-74%, 5 = 75-100%. A-frame, 'Flat-top' ramp and curved ramp perches had either two or three components, whereas fixed and suspended bar perches, and suspended platform perches had only one component. [a,b,c] means in the same row with a different superscript differ significantly.

Table 2 *Main effects of perch type on perch occupancy score across all weeks (overall) and during weeks 1-6 of the rearing cycle in Experiment 1 (median score values presented)*

	Perch type							
	A-frame	'Flat top' ramp	Curved ramp	Fixed bar	Suspended bar	Suspended platform	H(5)	p
Overall	2.8^{b}	2.5^{b}	1.6^{c}	2.0^{c}	1.0^{d}	4.0^{a}	785.31	<0.001
Week 1	2.2^{b}	2.5^{ab}	2.1^{b}	1.0^{c}	1.0^{c}	3.0^{a}	178.27	<0.001
Week 2	3.0^{a}	2.9^{a}	2.0^{b}	2.0^{b}	2.0^{b}	4.0^{a}	113.97	<0.001
Week 3	3.0^{ab}	2.6^{b}	1.6^{c}	2.0^{c}	2.0^{c}	4.0^{a}	163.60	<0.001
Week 4	3.0^{b}	2.5^{b}	1.6^{c}	2.0^{c}	1.5^{c}	4.0^{a}	173.19	<0.001
Week 5	2.9^{b}	2.5^{bc}	1.6^{de}	2.0^{cd}	1.0^{e}	4.0^{a}	168.12	<0.001
Week 6	2.5^{a}	2.5^{a}	1.1^{b}	1.0^{b}	1.0^{b}	3.5^{a}	85.27	<0.001

Overall perch occupancy (n = 1470), Week 1 (n = 288), Week 2 (n = 252), Week 3 (n = 288), Week 4 (n = 288), Week 5 (n = 246), Week 6 (n = 108). Whole data set analysed using Kruskal-Wallis test with 'Perch type' as treatment factor for overall occupancy scores. For weekly occupancy data file was split by 'Week' and analysed using Kruskal-Wallis test with 'Perch type' as treatment factor. Statistical analysis was performed on ranked means but median score values presented for ease of interpretation.

Two of each of the six perch types were provided in one house on each of two farms and observed at 4 hour intervals over one 24 hour period each week during weeks 1-6 of Cycle 1 and weeks 1-5 of Cycle 2. Occupancy scores were assigned to perch components (platform, bars and ramps, as appropriate) as follows: 1=0%, 2 = 1-24%, 3 = 25 – 49%, 4 = 50-74%, 5 = 75-100%. A-frame, 'Flat-top' ramp and curved ramp perches had either two or three components, whereas fixed and suspended bar perches, and suspended platform perches had only one component. Overall occupancy scores assigned to A-Frame, 'Flat top' ramp and curved ramp perches were weighted on the basis of the contribution of each perch component to the total surface area available for perching on that perch type. ^{a,b,c,d,e} means in the same row with a different superscript differ significantly.

Table 3 *Main effects of perch type on perching attempts recorded during weeks 2, 4 and 6 of cycle 1 in Experiment 1 (mean values presented)*

	Perch type							
	A-frame	'Flat top' ramp	Curved ramp	Fixed bar	Suspended bar	Suspended platform	H(5)	p
Number of perching attempts per 2mins	11.3[a]	14.6[a]	10.9[a]	3.1[b]	4.9[b]	16.1[a]	54.02	<0.001
Percentage of failed perching attempts	9.0[ab]	5.3[ab]	1.9[b]	19.1[a]	23.6[a]	7.0[ab]	17.14	0.004

Data analysed by Kruskal-Wallis test with 'Perch type' as a treatment factor (n = 240). Statistical analysis was performed on ranked means but average values are presented for ease of interpretation. Two of each of six perch types were observed in one house on each of two farms in weeks 2, 4 and 6 of a production cycle. Observations were conducted over 2 min periods at 0800h, 1200h, 1600h and 2000h in each observation week. [a,b] means in the same row with a different superscript differ significantly.

Table 4 *Main effects of perch treatment and bird age on the perching behaviour of birds, and on lameness and litter moisture content recorded on farm during Experiment 2 (mean values presented)*

	Enrichment (E)			Age (Wk)					
	C	P	PD	Wk3	Wk4	Wk5	R.M.S.E	p(E)	p(Wk)
Perch occupancy (no. birds)	N/A	24.2	28.0	26.6	25.3	26.3	7.29	0.13	0.90
Total no. perching attempts/3mins	N/A	8.1	8.8	12.8[a]	6.6[b]	6.0[b]	3.51	0.56	<0.001
% failed perching attempts	N/A	15.3	12.9	15.1[ab]	17.2[a]	9.8[b]	5.35	0.19	0.007
% lame birds	9.3	13.7	12.3	12.0	13.0	10.2	14.03	0.64	0.83
% litter moisture content	32.3	30.8	31.5	29.1	32.2	33.4	5.39	0.73	0.058

C= Control, P = perches, PD = perches and dust baths, E = enrichment, Wk = age, R.M.S.E. = root mean square error. Data analysed by ANOVA with ‘cycle’ and ‘house’ as blocking factors and ‘enrichment*week’ as treatment factor. Perching behaviors: ‘E’ df 1, 23; ‘Wk’ df 2, 23; % lame birds: ‘E’ df 2, 38, ‘Wk’ df 2, 38; litter moisture content: ‘E’ df 2, 38, ‘Wk’ df 2, 38). Enrichment treatments were applied in three separate houses on each of two farms and replicated over three production cycles on each farm (alternating between houses in each replicate). Assessments were conducted in weeks 3, 4 and 5. Perching behaviour was assessed in two perches in each of the P and PD treatments each week. Perch occupancy was evaluated from scans taken at 3 min intervals over a 21 min period each week, and perching attempts were evaluated during continuous 3 min observations after five of the scans. Gait score was recorded on a scale of 0 (no impairment) to 5 (complete lameness) in twenty-four birds in each house each week and the percentage of birds with a score of 3 or more calculated. Litter moisture was determined in samples collected in eight different areas of each house each week. [a,b] means in the same row with a different superscript differ significantly.

Table 5 *Main effects of treatment and bird age on score data regarding angular leg deformities, lameness and dermatitis recorded on farm in Experiment 2 (mean values presented)*

	Enrichment (E)			Age (Wk)						
	C	P	PD	Wk3	Wk4	Wk5	H(2) (E)	H(2) (Wk)	p(E)	p(Wk)
Severity of angular leg deformities	0.7	0.7	0.7	0.5^{a}	0.8^{b}	0.8^{b}	0.36	10.48	0.84	0.005
Mean gait score	1.5	1.6	1.5	0.8^{a}	1.7^{b}	2.2^{c}	0.21	44.66	0.90	<0.001
Severity of hock burn lesions	1.2	1.2	1.3	1.0^{a}	1.2^{b}	1.4^{b}	1.07	27.48	0.59	<0.001
Severity of podo dermatitis lesions	1.8	2.1	2.0	1.4^{a}	2.1^{b}	2.4^{b}	1.54	21.63	0.46	<0.001

C = control, P = perches, PD = perches and dust baths, E = enrichment (n = 54), Wk = age (n = 54). Data were analysed by separate Kruskal-Wallis tests with ‘Enrichment’ and ‘Week’ as treatment factors. Statistical analysis was performed on ranked means but average score values are presented for ease of interpretation. Angular leg deformity was recorded on a scale of 0 (no angulation) to 3 (severe angulation), and severity of hock burn and pododermatitis lesions were recorded on a scale of 1 (no lesion) to 5 (very severe lesion). Gait score was recorded on a scale of 0 (no impairment) to 5 (complete lameness). Enrichment treatments were applied in three separate houses on each of two farms and replicated over three production cycles on each farm (alternating between houses in each replicate). Twenty-four birds were evaluated in each house in each of weeks 3, 5 and 5 of the production cycle. ^{a,b,c} means in the same row with a different superscript differ significantly.

Table 6 *Main effects of treatment on the incidence of mortality and culls recorded at day 30 and the incidence of dermatitis and downgrades at slaughter in Experiment 2 (mean values presented)*

	Enrichment				
	C	P	PD	R.M.S.E	p
% mortality	2.4	2.5	2.4	0.89	0.98
% culls	0.6	0.7	0.7	0.29	0.86
% incidence hock burn at slaughter	7.1	3.6	8.4	8.39	0.62
% incidence of podo dermatitis at slaughter	24.5	27.1	25.2	3.32	0.94
% downgrades at slaughter	1.6	1.7	1.6	0.46	0.82

C = control, P = perches, PD = perches and dust baths, R.M.S.E. = root mean square error. Data analysed by ANOVA with 'Enrichment' as a treatment factor and 'Cycle' and 'House' as blocking factors (all data df 2,8). Enrichment treatments were applied in three separate houses on each of two farms and replicated over three production cycles on each farm (alternating between houses in each replicate). Mortality and cull data recorded at Day 30 of the rearing cycle. Hock burn, podo dermatitis and downgrades data recorded at thinning and final clearing of house.