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Canopy cover is correlated with reduced injurious feather pecking in commercial flocks of free-range laying hens

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Abstract

*Injurious feather pecking in non-cage systems is a serious economic and welfare concern for the egg-producing industry. Here, we describe the first results from an ongoing collaborative project to improve range environment and welfare of laying hens (*Gallus gallus domesticus*) within the McDonald's Restaurants Ltd, UK supply base. The objective of this study was to investigate, in a commercial situation, the correlation between: i) proportion of range cover and ii) proportion of canopy cover, with plumage damage of end-of-lay hens. The assessment of plumage damage due to injurious feather pecking is a key animal-based welfare indicator for laying hens in non-cage systems. In 2007 and 2008, all laying-hen producers within the McDonald's Restaurants Ltd egg-supply base, were required to plant (if not present already), 5% of the total range area with blocks of trees either side, and between 20–25 m from the laying hen house. Plumage damage at end of lay was positively correlated with mortality and flocks depleted in summer had less plumage damage at end of lay than flocks depleted in autumn or winter, possibly because of weather conditions at the time of placement. There was no correlation between the proportion (5–90%) of range cover and plumage damage at the end of lay, however, plumage damage was negatively correlated with percent of canopy cover within tree-planted areas. Providing a minimum of 5% tree cover, planted close to the house but with good canopy coverage, may be a feasible and practical method enabling producers to reduce plumage damage due to injurious feather pecking in their laying-hen flocks. Tree cover provision may also provide environmental benefits, such as soil stabilisation, reduced nutrient leaching and carbon sequestration.*

Keywords: *animal welfare, canopy cover, free range, injurious feather pecking, laying hens, range cover*

Introduction

In response to public calls for more animal-friendly housing, traditional battery cages for laying hens (*Gallus gallus domesticus*) will be banned in the European Union from 2012. Injurious feather pecking (IFP) can be particularly problematic in non-cage systems (Huber-Eicher & Sebö 2001; Gentle & Hunter 1990; Gunnarsson *et al* 1999) because it is more difficult to control in large flocks (Appleby *et al* 1992). IFP is an abnormal behaviour that consists of pulling, plucking, and damaging feathers of conspecifics (Savory 1995). IFP can result in poor quality plumage, feather loss and damage to the skin (Savory 1995). Birds experience pain when feathers are removed (Gentle & Hunter 1990), damaged birds have poor thermoregulation and consequently greater energy demands than unaffected birds (Leeson & Morrison 1978; Tauson & Svensson 1980; Tullett *et al* 1980; Peguri & Coon 1993) and are more susceptible to cannibalism (Allen & Perry 1975; Keeling 1995; Cloutier *et al* 2000). IFP is therefore a serious economic and welfare concern for the egg-producing industry (Jones *et al* 2004; Rodenburg *et al* 2004).

The development of IFP reflects a multifactorial process encompassing genetic, environmental and management factors (eg Gunnarsson *et al* 1999; Huber-Eicher & Sebö 2001; Hocking *et al* 2004). However, insufficient opportunity to perform foraging behaviour is widely considered important in the development of IFP which is addressed as redirected foraging behaviour (Blokhuis 1989; Blokhuis & van der Haar 1989; Huber-Eicher & Wechsler 1997, 1998). The assessment of plumage damage using feather scoring is used as an alternative method to direct behavioural observations of IFP (Bilčík & Keeling 1999). Plumage damage is considered a key animal-based welfare indicator for laying hens in non-cage systems (Weeks & Nicol 2006).

In commercial free-range systems, the provision of an outdoor range leads to increased space allowances, a

Table 1 Variable information and range of values collected for end of lay flocks. Numbers in brackets are number of flocks for each variable.

Variable	Values (n)
Company	Lakes (29)
	Noble (133)
Farm type	Contracted (155)
	Not contracted (7)
Hybrid	Dekalb Amberlink (2)
	Columbian Black Tail (1)
	Bovans Goldline (15)
	Hyaline Brown (47)
	ISA Brown (10)
	Lohmann Brown (64)
	Oakham Blue (1)
	Shaver (22)
Season at end of lay	Summer (44)
	Autumn (37)
	Winter (30)
	Spring (51)
Beak trim	Yes (161)
	No (1)
Age at end of lay (weeks)	67–79
Date at end of lay	21/4/2008–30/6/2009
Egg per bird production (averaged to 72 weeks)	197–342
Percent of range planted	5–90
Percent canopy cover within planted area	5–100
Percent mortality (as recorded on-farm)	0.22–53.2
Number of birds placed	2,000–24,550
Number of birds to slaughter	1,596–22,621

higher number and increased diversity of stimuli, and opportunity to move between environments with different substrate, climatic and light conditions. Free-range systems therefore have the *potential* to improve the welfare of laying hens, in particular, by providing more opportunity for species-specific behaviours, such as foraging (Chow & Hogan 2005). In reality, only a fraction of the hens use the outdoor range in most commercial free-range systems and, those that do, remain close to the house (Elbe *et al* 2005; Fürmetz *et al* 2005; Hegelund *et al* 2006; Reiter *et al* 2006); the potential welfare benefits of the range are therefore unlikely to be realised.

Domestic chickens are descended from the red junglefowl of south-east Asia and are found in areas where there is plenty of undergrowth, and overhead cover, which provides shade, shelter and protection from aerial predators (Johnson 1963; Johnsgard 1986). Horton (2006) found that with tree cover present, a higher proportion of hens in commercial free-range flocks ranged, and ranged further, compared to hens without range tree cover; in ranges with tree cover, the maximum numbers of hens outside were 50 m from the house compared with 10 m in ranges without cover. Hegelund *et al* (2005) and Zeltner and Hirt (2008) demonstrated that artificial and tree/bush cover on the range can attract more hens away from the area immediately outside the house compared to ranges without cover, and that the variety and quality of cover was more important than the absolute amount of cover. Furthermore, there is a well-established link between range use and IFP in commercial laying-hen flocks; the higher the percentage of flocks using the outdoor range, the lower the prevalence of feather pecking (Green *et al* 2000; Bestman & Wagenaar 2003; Nicol *et al* 2003; Lambton *et al* 2010). In an experimental study by Mahboub *et al* (2004), a negative correlation was found between percent of time spent outside and plumage damage.

If providing cover on the range improves the number and distribution of hens using the range, and range use is negatively correlated with IFP, it might also be expected that range cover will be correlated with IFP. To our knowledge, however, the relationship between proportion of range cover or canopy cover and IFP has yet to be examined. Here, we describe the first results from an ongoing collaborative project between a major UK high street restaurant chain and two UK egg-producing companies, McDonald's Restaurants Ltd, UK (McDonald's), The Lakes Free Range Egg Co Ltd (Lakes) and Noble Foods Ltd (Noble). The aim of the project is to implement animal welfare research on a commercial scale and improve the welfare of laying hens within the McDonald's supply chain. During 2007 and early 2008, all 286 laying hen producers (approximately one-third are Lakes and two-thirds are Noble), were required by McDonald's to plant, if not present already, 5% of the total range area in trees (decided upon after consultation of existing farm assurance free-range standards, cost and practical considerations). There was a large variation in tree cover because of the proportion of the range on which producers decided to plant trees, the timing of planting prior to flock placements and the presence of existing tree stands. The objective of this study was to investigate, in a commercial situation, the correlation between: i) proportion of range cover and ii) proportion of canopy cover, with plumage damage of end-of-lay hens.

Materials and methods

Beginning April 2008, all 286 McDonald's egg producers were asked to: i) record the percentage of range actually planted in trees; ii) record the average percent of canopy cover within the planted area; and iii) assign an average plumage damage score for each flock at the end of lay. Flock information, productivity and mortality data were collected from farm records (Table 1).

Table 2 Description of scoring system used to evaluate canopy cover within tree-planted areas.

Percent	Canopy cover description
0	No trees or newly planted trees
10	Trees up to 2 m in height with spacing of no more than 5 m. Branches must cover more than 0.5 m^2 around the base of the tree
25	Trees are between 2 and 3 m in height with spacing of no more than 5 m. Branches must cover more than 1 m^2 around the base of the tree
50	Trees are at least 3 m in height with spacing of no more than 5 m. Branches must cover more than 2 m^2 around the base of the tree
75	Trees are at least 4 m in height with spacing of no more than 5 m. Branches must cover more than 3 m^2 around the base of the tree
100	Mature trees which have overlapping branches

Table 3 Description of scoring system used to evaluate plumage damage of end-of-lay flocks (adapted from Bright *et al* 2006).

Score	Description of plumage damage
1	Well feathered body parts with no/very little damage
2	Slight damage to any area of the body with feathers ruffled, body completely/almost completely covered
3	Severe damage to feathers, localised naked area (> 5 cm^2)
4	Severe damage to feathers with more than two naked areas > 5 cm^2 and/or broken/separated flight feathers; or naked area < 5 cm^2 and any damage to three other areas
5	Severe damage to feathers with broken/damaged skin anywhere; or any three naked areas > 5cm^2; or flight feathers completely removed

Tree-planting requirements

A method for assessing canopy cover (Table 2) was developed in conjunction with the account managers for McDonald's from the egg-producing companies and sent to all producers (with accompanying photographic examples) prior to data collection.

Trees were to provide a minimum of 500 m^2 cover per 1,000 hens when fully grown, corresponding to 5% of the total range area (stocking density: 1,000 hens per ha according to Freedom Food© 2008 laying hen standards). The species of tree was not specified, however, no more than 50% of the trees were to be of *Pinus* genus, (ie fast growing but providing little canopy cover). Producers were instructed to plant the trees in a belt surrounding the house, with the outer branches being 20 to 25 m from the house (Bestman *et al* 2002). This was done to be close enough to encourage birds away from the house, but not so close as to impede machinery movement or problems due to tree root growth.

Plumage damage score

The plumage damage scoring system (Table 3) was adapted for commercial use from Bright *et al* (2006) in conjunction with the account managers for McDonald's from the egg-producing companies and sent to all producers (with accompanying photographic examples) prior to data collection. The majority of plumage-scoring systems are used in research situations (on experimental or commercial flocks) and require sampling of individual birds by research scientists (eg Bilčík & Keeling 1999). In a commercial situation, it is not practical for producers to randomly sample individual birds to determine plumage damage scores (D Brass and A Joret, personal observation 2008). Therefore, in this study, a single, average plumage damage score was given by the producer for the entire flock.

The McDonald's account managers and technical managers from the two egg-producing companies were responsible for explaining to participating egg producers the canopy cover and plumage damage assessment. McDonald's were also provided with a *complete* list of egg-producer suppliers by Lakes and Noble. As part of McDonald's quality assurance programme, ~10 flocks from the The Lakes supply and ~30 flocks from the Noble supply are selected for a visit by the McDonald's technical team each year. During these visits, the technical team ensured that tree planting was in line with requirements and that producers understood the canopy cover and plumage damage assessment. McDonald's were provided with producer code, name and location only, so it was not possible for them to select producers based on hybrid or production data.

Plumage damage score comparison

To examine whether producer plumage damage scores were in line with plumage damage scores determined from random individual sampling, we carried out a comparison of producer plumage damage scores with those from a random sample of birds of the same flock. Lakes and Noble sent

Table 4 *F*-test ratios and associated *P*-value for GLM on the effects of amount of range cover and amount of canopy cover on plumage condition at the end of lay.

Effect	*F*-test ratios	*P*-value
Percent mortality	$F_{1,105} = 41.76$	< 0.01
Percent canopy cover within planted area	$F_{1,105} = 5.74$	0.02
Season at end of lay	$F_{3,105} = 5.71$	< 0.01
Hybrid	$F_{7,105} = 5.64$	< 0.01
Flock size	$F_{1,105} = 2.33$	0.18
Company	$F_{1,105} = 0.56$	0.47
Farm type	$F_{1,105} = 0.41$	0.73
Percent of range planted	$F_{1,105} = 0.38$	0.75
Production	$F_{1,105} = 0.26$	0.10
Season × percent canopy cover within planted area	$F_{3,105} = 0.03$	0.97

McDonald's a total list of flocks which were to be depleted and processed through the Gainsborough gas stunning abattoir (Lincolnshire, UK) between March and December 2009. McDonald's selected 41 flocks (using producer code and depletion date only) for plumage damage score comparison. A video camera was set up at the Gainsborough abattoir to record sample flocks, post- stun and shackling and pre-throat cut. From each flock video, ten 20 s timeframes were randomly selected (using a random number generator) and all individual birds within the 20 s timeframe were scored for plumage damage (Table 3). The processing line at Gainsborough normally runs at 2.5 birds s^{-1}, thus, in a 20 s timeframe, approximately 50 birds were scored and a total of approximately 500 birds from each flock (see Bright *et al* [2006] for sample size justification).

Statistical analysis

Range cover and plumage damage score

Between April 2008 and the end of July 2009, production data, range cover, canopy cover and plumage damage scores were collected from a total of 224 flocks, for producers where more than one flock was placed in the first year of data collection, a single flock was randomly selected (the majority of producers placed only one flock; thus, selecting a single flock avoided confounding producer and flock effects [Grafen & Hails 2002]). Flocks without accurate production records were also excluded, leaving a complete set of information (Table 1) for 126 flocks.

The statistical software used was Minitab for Windows, Release 15 (MINITAB® Inc). General Linear Model (GLM) procedures were used to test the relationship between: i) the proportion of range cover and ii) the proportion of canopy cover, and plumage damage of laying hens at the end of lay. Normality and homogeneity of variance were checked by visual examination of residual plots from fitted models. *F*-ratios and associated *P*-values were calculated using sequential sums of squares because the model was not orthogonal (Grafen & Hails 2002) and the sequence of variables in the model was rearranged to test the robustness of results. Tukey-Kramer pair-wise comparisons were performed to elucidate statistically significant ($P < 0.05$) GLM results. Pair-wise comparisons were considered significantly different at $P < 0.01$.

The final GLM was fit:

- Plumage damage score = Percent range planted + Percent canopy cover within planted area + Company + Farm type + Hybrid + Season at end of lay + Flock size + Percent mortality + Production + Season at end of lay × Percent canopy cover within planted area;
- Categorical variables: Company + Farm type + Hybrid + Season at end of lay + Season at end of lay × Percent canopy cover within planted area;
- Continuous variables: Percent range planted + Percent canopy cover within planted area + Flock size + Percent mortality + Production;
- $R^2 = 51\%$.

Plumage damage score comparison

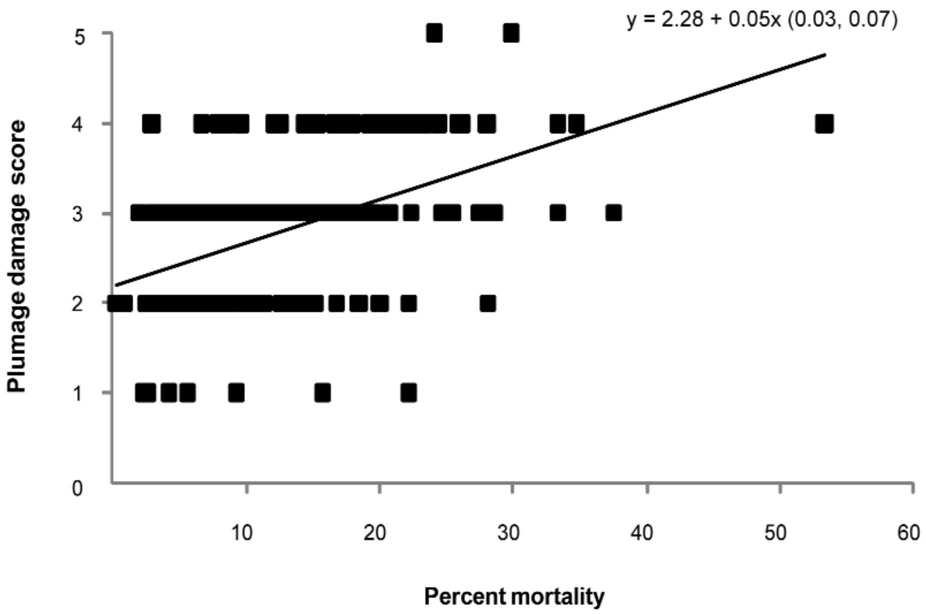
In Minitab for Windows, Release 15 (MINITAB® Inc), a Pearson's correlation was used to compare the average plumage damage score for a flock (n = 41), as given by the producer at the end of lay and as determined from a random sample of birds from video footage collected at Gainsborough abattoir. Confidence intervals were calculated using the formulae for 'Pearson's correlation confidence intervals' in Sokal and Rohlf (1995).

Results

There were significant ($P < 0.05$) correlations between plumage damage score, mortality and canopy cover within planted areas (Table 4), and effects of hybrid and season at end of lay on plumage damage score (Table 4). There were no significant effects of flock size, company, farm type, percent of range planted or production, on plumage damage score (Table 4). There was no significant interaction between season and total range cover.

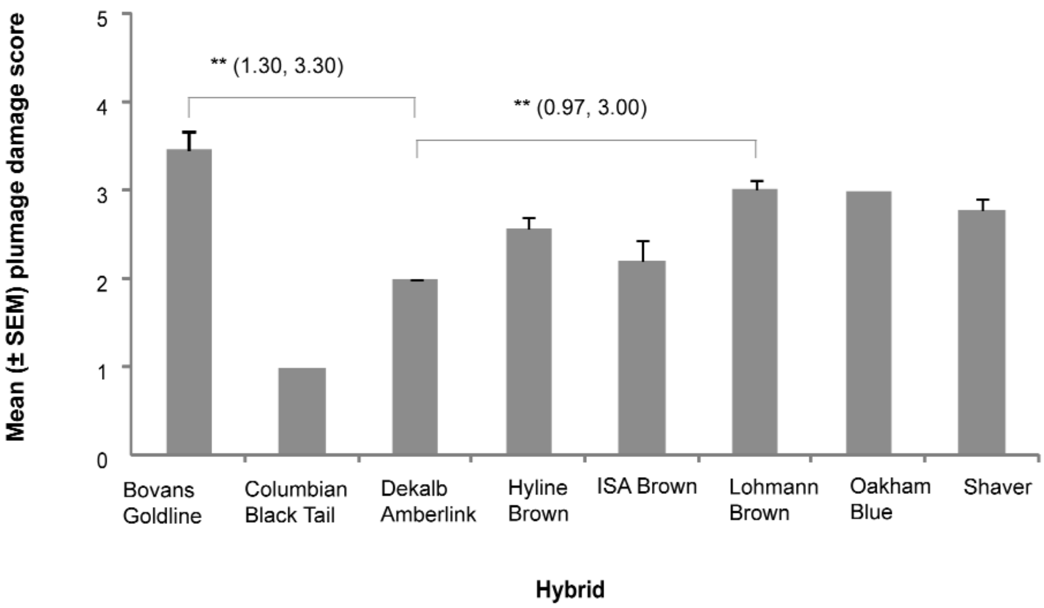
Plumage damage score was positively correlated with mortality (Figure 1); flocks with higher mortality were more likely to have worse plumage damage at the end of lay. Dekalb Amberlink flocks had less plumage damage at the end of lay than Bovans Goldline or Lohmann Brown flocks, although only two Dekalb Amberlink flocks were included (Figure 2). Flocks which were depleted in summer had less plumage damage than flocks depleted in autumn or winter (Figure 3). Plumage damage score was negatively correlated with canopy cover within planted area (Figure 4); flocks with less canopy cover within planted areas were more likely to have worse plumage damage at the end of lay.

Figure 1



The relationship between plumage damage score at end of lay and percent mortality. Numbers in brackets are 95% CI for regression equation.

Figure 2



Mean (± SEM) plumage damage score by hybrid. ** $P < 0.01$ difference between hybrids after Tukey-Kramer pair-wise comparisons. Numbers in brackets are 95% CI for comparisons.

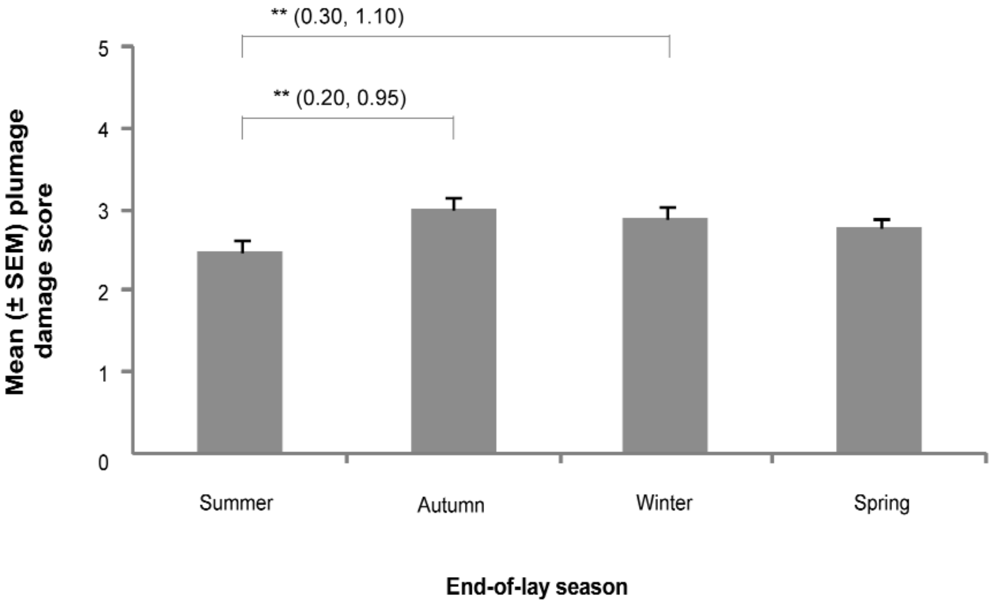
Plumage damage score comparison

The plumage damage scores given by the producer at the end of lay and the average plumage damage score as determined from the Gainsborough abattoir videos of the same flock were moderately/strongly positively correlated ($r = 0.69$; 95% CI = 0.50, 0.82; Figure 5, Table 5).

Discussion

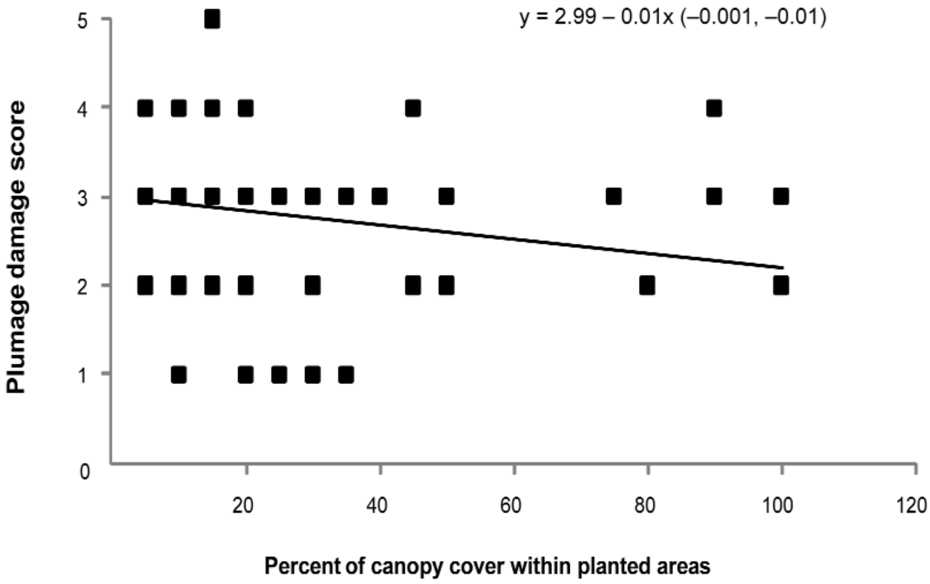
Existing UK Farm Assurance schemes recognise the need to make proper provision for animal welfare. However, most farm assurance protocols are based almost entirely on audit of the provision of resources to the animals and records of management procedures. What they have

Figure 3



Mean (± SEM) plumage damage score by end-of-lay season. ** $P < 0.01$ difference between seasons after Tukey-Kramer pair-wise comparisons. Numbers in brackets are 95% CI for comparisons.

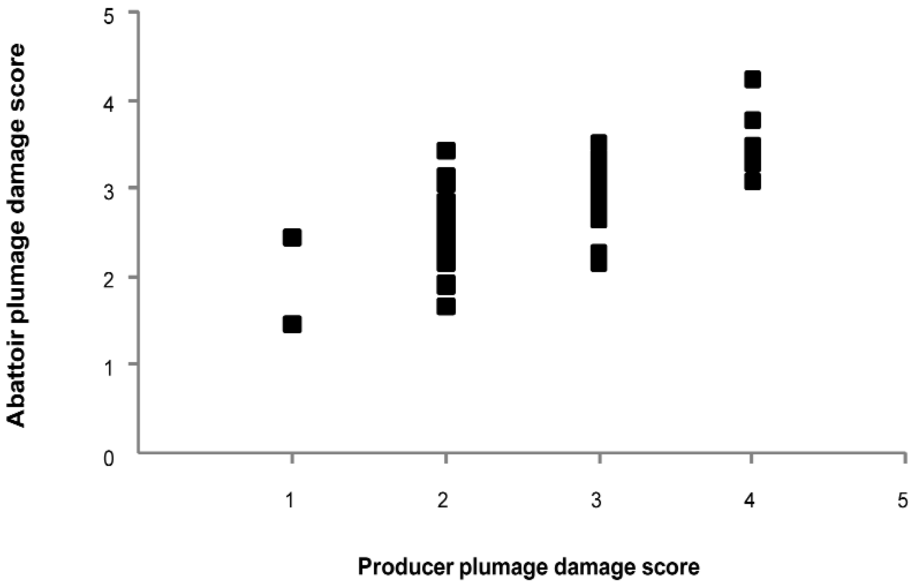
Figure 4



Relationship between plumage damage score at end of lay and percent of canopy cover within planted areas. Numbers in brackets are 95% CI for regression equation.

lacked is a significant element of animal-based welfare assessment (behavioural or clinical observations that are taken directly from the animal), which provide a more direct assessment of animal welfare (Whay *et al* 2003; Webster 2009). Plumage condition is considered a key animal-based welfare indicator for laying hens in non-cage systems (Weeks & Nicol 2006). In this study, we examined the relationship between proportion and quality of range cover for commercial free-range laying hens and plumage condition at the end of lay. The study itself was part of a larger collaborative project aimed at implementing animal welfare research on a commercial scale and improving the welfare of laying hens within the McDonald's supply chain.

Figure 5



Relationship between plumage damage scores at the end of lay as given by producers, and average plumage damage scores as determined from Gainsborough abattoir videos.

Mortality

That mortality was correlated with plumage damage (Table 4, Figure 1) is a similar finding to other commercial studies on the welfare of laying hens. Nicol and Sherwin (2009) surveyed producers from a variety of laying-hen production systems; the second highest reason given for mortality (after disease) was injurious pecking (including aggressive pecking, cannibalism and feather pecking). Injurious feather pecking (IFP) develops into vent pecking (Pötzsch *et al* 2001) and raises the risk of cannibalism (Keeling 1995; Cloutier *et al* 2000). Vent pecking and cannibalism are both correlated with mortality (Hughes & Duncan 1972; Pötzsch *et al* 2001). Furthermore, IFP is associated with disease (Green *et al* 2000; Pötzsch *et al* 2001; Nicol *et al* 2003).

Hybrid

Laying-hen hybrids differ in their behavioural, physiological and neurobiological characteristics (Rauw *et al* 1998) and it is highly likely that they will also differ in their propensity to feather peck. Both experimental and commercial studies have found variation between laying-hen hybrids and IFP (eg Savory & Mann 1997; Hocking *et al* 2004). In this data set, there was large variation in the hybrid group sizes (Table 1), which is reflected in the large confidence intervals for Tukey Kramer pair-wise comparisons (Figure 2); further research would be needed to confirm whether there is any difference in plumage damage between Dekalb Amberlink and other commercial laying hen hybrids.

Table 5 Producer plumage damage score and difference from mean (± SEM) abattoir plumage damage score.

Producer plumage damage score (n)	Difference from average abattoir plumage damage score (± SEM)
1 (2)	–0.93 (± 0.47)
2 (19)	–0.51 (± 0.10)
3 (12)	0.13 (± 0.12)
4 (8)	0.49 (± 0.13)

Season

A higher percentage of laying-hen flocks range in autumn than in other months (Nicol *et al* 2003) and on days without precipitation and strong wind (Hegelund *et al* 2005). Similarly, in commercial broilers, birds range more in summer and autumn than winter or spring (Dawkins *et al* 2003). We found a significant ($P < 0.001$) association between season and plumage condition at the end of lay; flocks depleted in summer had less plumage damage than flocks depleted in autumn or winter (Table 4, Figure 3). Commercial free-range laying hens spend ~52 weeks on a laying farm with access to the outdoor range (A Joret, personal observation 2008), therefore, the season of placement is equivalent to the season of depletion. We may have found an effect of season on plumage condition at the end of lay because birds first have access to the outdoor range when the weather is clement and are more inclined to leave the house; ranging behaviour being the most important factor influencing the development of IFP in commercial non-cage flocks (Green *et al* 2000; Bestman & Wagenaar 2003; Nicol *et al* 2003; Lambton *et al* 2010). Other factors related to season and age of the birds on placement, such as day length (Kjaer 2000), temperature (Nicol & Sherwin 2009; Lambton *et al* 2010), disease/parasite lifecycles (Nicol & Sherwin 2009) and litter quality (A Joret, personal observation 2008) may also have contributed to a reduction in IFP in this study.

Range cover

Recent commercial studies have identified ranging behaviour as a key factor in the development of IFP within laying-hen flocks; a higher proportion of the flock ranging reduces the risks of IFP (Green *et al* 2000; Bestman & Wagenaar 2003; Nicol *et al* 2003; Mahboub *et al* 2004; Lambton *et al* 2010). On laying-hen ranges with tree cover (minimum 20% cover), a higher proportion of the flock were observed ranging, and ranging further than on ranges without trees (Horton 2006). Bestman *et al* (2002) found a direct correlation between percent of the range covered in trees and number of hens ranging, however Zeltner and Hirt (2008) did not find any correlation between area of range covered with structures (artificial and natural) and use of the hen run but did find a preference for ranges with a greater variety of structures and for those that provided shelter and shade (Zeltner & Hirt 2008).

In this study, flocks which had less canopy cover within planted areas had significantly ($P < 0.05$) worse plumage damage at the end of lay than flocks which had more canopy cover within planted areas (Table 4, Figure 4). There was no correlation between the amount of range planted and plumage damage at the end of lay (Table 4). These results support the findings from Zeltner and Hirt (2008) and suggest that it is the degree of shade and shelter which is important to the hens rather than the absolute area, provided the distance between the house and the nearest cover is relatively close (Bestman *et al* 2002). It is well established that laying hens perform different behaviours in different locations (Vestergaard 1982; Appleby *et al* 1992; Newberry & Shackleton 1997; Carmichael *et al* 1999; Channing *et al* 2001) and light environments (Boshouwers & Nicaise 1993; Praytino *et al* 1997; Davis *et al* 1999; Prescott & Wathes 2002). Canopy cover on the range enables birds to rest/preen in shaded and sheltered areas, while still allowing for foraging and dust bathing behaviours in the open under higher illumination (Bright 2007).

Environment

In most commercial, free-range flocks, only a small proportion of hens use the range and, those that do, tend to stay close to the house (eg Fürmetz *et al* 2005; Hegelund *et al* 2006; Reiter *et al* 2006). A high density of hens in the range area close to the house may have adverse impacts on the range environment. In a study of organic egg production in Denmark, Elbe *et al* (2005) found that only 9.8% of hens used the range, 69% of the ranging birds staying within 0–17 m of the house. The excretion rates per hen amounted to 12.4 g h^{-1}, accounting for a 5% share of the total excrement of the flock: the nitrogen in the soil reached a very high level in the area close to the house. While not specifically tested in this study, providing tree cover and encouraging hens to range away from the houses, may spread nutrient load and parasitic contamination in a larger area around the range and provide a degree of soil carbon sequestration.

Plumage damage score comparison

Producers were able to accurately assess flock plumage damage at the end of lay (Figure 5, Table 5). Producers tended to score flocks as having less plumage damage than the corresponding video sample when plumage damage was slight (ie score 1 or 2; Table 5) and over-estimate plumage damage when it was more severe (score 4; Table 5), although the differences between producer and random sample scores of the same flock were small (Table 5). In the UK, laying-hen producers are asked to provide an end-of-lay plumage condition score for every flock, which is used to determine stocking density for thermal comfort during transport to the abattoir. Plumage scoring systems are commonly used in research situations (eg Bilčík & Keeling 1999), however, they are difficult to implement in a commercial situation because they require measurements from individual and randomly selected birds. Provided they are checked for consistency, plumage damage scores from producers, may be useful indicators of flock plumage damage and therefore as an *on-farm*, animal-based welfare measure.

Furthermore, the method developed in this study of plumage damage scoring large numbers of hens by video recording while shackled during processing, demonstrated the potential for automated recording/imaging system of plumage damage scoring at the abattoir. Automated plumage damage scoring at the *abattoir* may also be used as an animal-based welfare measure against which to audit retail supply chains and Farm Assurance schemes. The sector of the supply chain concerned (eg producer, processor, retailer, consumer) and stage of the animal's life (eg chick, pullet, layer) may determine whether the animal-based welfare measure is collected on-farm or at the abattoir, however, both are crucial for the appropriate assessment of welfare (Welfare Quality® 2009).

Animal welfare implications

A relatively small area of trees, planted close to the house but with good canopy coverage may be able to reduce plumage damage due to IFP in commercial laying hens, a major welfare problem for the egg-producing industry. Treating animals well is part of farmers' professional ethic and pride (Bock 2009) and many farmers report feeling distressed or guilty when their hens have poor feather cover (KA Drake, personal observation 2009). Tree cover provision on laying-hen ranges is a feasible and *practical* method on a commercial scale to encourage hens outdoors to utilise the range area as well as providing environmental benefits (eg soil stabilisation, reduce nutrient leaching, carbon sequestration).

Future studies from this ongoing collaborative project will investigate whether: i) the relationship between proportion and quality of range cover and flock plumage condition changes as tree stands mature and ii) tree planting improves plumage condition of flocks on the *same* farm over time. Finally, the relationship between season and plumage condition is, to our knowledge, a new finding and merits further investigation, as seasonality may have practical implications for timing of laying-flock placements.

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