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Animal welfare initiatives improve feather cover of cage-free laying hens in the UK

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Abstract

This paper describes a case example where initiatives from private assurance schemes, scientists, charities, government and egg companies have improved the welfare of UK cage-free laying hens. The RSPCA and Soil Association farm assurance schemes introduced formal welfare outcome assessment into their annual audits of laying-hen farms in 2011. Feather loss was assessed on 50 birds from each flock on a three-point scale for two body regions: Head and Neck (HN) and Back and Vent (BV). In support of the observations, assessors were trained in feedback techniques designed to encourage change in farmer behaviour to improve welfare. In addition, during Year 2 farmers were asked about changes they had made, and intended to make on their farms. During 2011–2013 there were also wider industry initiatives to improve feather cover. Data were analysed from 830 and 743 farms in Year 1 and Year 2, respectively. From Year 1 to Year 2 there was a significant reduction in the prevalence of feather loss from 31.8% (9.6% severe) to 20.8% (6% severe) for the HN region, and from 33.1% (12.6% severe) to 22.7% (8.3% severe) for BV. Fifty-nine percent of 662 farmers reported they had made changes on their farms during Year 1 to improve bird welfare. For such a substantial industry change, attributing causation to specific initiatives is difficult; however, this is the first study to demonstrate the value to animal welfare of certification schemes monitoring the effectiveness of their own and other industry-led interventions to guide future policy.

Keywords: *animal welfare, farm assurance, feather loss, hen, industry, policy*

Introduction

In 2004, the UK Government outlined their strategy for safeguarding animal health and welfare in which they signalled a reduction in governmental responsibility for this area towards a policy whereby they would "encourage and persuade industry, stakeholders and individuals to change practices and aspire to adopt higher standards of animal health and welfare" (Defra 2004). They stated that the UK Government would only intervene in animal health and welfare "where the market on its own cannot deliver some or all of the objectives" (Defra 2004). Maciel and Bock (2012) discuss this 'political modernisation' as a general change in modern societies and in the context of animal welfare suggest that within Europe private standards owned by charities, assurance companies or retailers have replaced what they consider to be stricter legislative requirements. However, they highlight that with increasing power to non-state actors there is a danger that these organisations are operating without the safeguards that exist within a democratic process to serve the common good (Maciel & Bock 2012).

Feather loss in hens has been shown to be common in both cage and cage-free systems for farming laying hens (eg Huber-Eicher & Sebo 2001; Tactacan *et al* 2009; Sherwin *et al* 2010). Methods of assessment and reporting of feather loss vary between observational studies but a mean of 15.5% of hens on free-range farms showed feather loss in one study in the UK (Sherwin *et al* 2010), whereas in another, 70% of UK free-range hen farmers reported seeing bald patches on hens in their last flock (Green *et al* 2000). Although feather loss may be caused by mechanical damage by objects within the environment, such as feeding tracks, it commonly arises as a result of injurious pecking by other birds (Huber-Eicher & Sebo 2001). Gentle feather-pecking may result in plumage damage but hens performing more severe feather-pecking can pull out other birds' feathers (Rodenburg *et al* 2013), which is both painful (Gentle & Hunter 1990) and can lead to denuded areas that can impact on the birds' ability to maintain thermal comfort. Feather-pecking is considered to be exploratory or foraging, rather than aggressive in origin, although reviews of the literature have identified a variety of causal factors, including genetic influences, rearing conditions, inadequate environmental exploratory and dustbathing opportunities and low dietary fibre during the laying period (Nicol *et al* 2013; Rodenburg *et al* 2013). As well as being a welfare problem, feather-pecking reduces productivity

(Huber-Eicher & Sebo 2001) and when feather cover is poor, increases feed consumption (Herremans *et al* 1989; Glatz 2001) resulting in economic loss for the farmer.

A knowledge and understanding of the causes and risk factors associated with feather-pecking is required to improve hen welfare on-farm (Nicol *et al* 2013). Lambton *et al* (2013) evaluated the effectiveness of bespoke management packages aimed at reducing feather-pecking in free-range flocks. They identified 46 management strategies that were expected to reduce feather-pecking and supported the implementation of these on farms through facilitated discussions with the farmers. The 53 intervention flocks employed more of the management strategies than the 47 control flocks and as a result had significantly less plumage damage, a finding mirroring a similar knowledge transfer intervention study of lameness in dairy cattle (Main *et al* 2012a). Irrespective of whether flocks were intervention or control flocks, the more management strategies employed by the farmer the greater the benefit (Lambton *et al* 2013).

There is currently significant interest in improving feather cover in hens beyond scientific projects. The 46 management strategies described in Lambton *et al* (2013) are now available as booklets for farmers and can be found at www.featherwel.org. The wider UK egg industry has supported these efforts to reduce feather loss in hens (Anon 2014) and many individual egg-producing companies have developed their own systems for monitoring feather loss (AD Joret, personal communication 2011). The UK Government has produced guidance to free-range hen farmers on strategies to reduce feather-pecking in free-range flocks (Defra 2005). One common management strategy employed by farmers to reduce feather loss is beak-trimming (Lambton *et al* 2010) with the majority of free-range hens and some organic hens beak-trimmed in the UK. Although prohibited in principle under EU law (Council Directive 99/74/EC 1999), individual member states may authorise beak-trimming to prevent poor welfare associated with feather-pecking (in the UK this is an amendment to The Mutilations [Permitted Procedures] [England] Regulations 2007). The UK Government is funding trials into managing intact flocks and intends to implement a ban on beak-trimming in 2016, unless these and other studies demonstrate substantial welfare problems associated with non-beak-trimmed flocks (Clarke 2014) and have set up an advisory Beak Trimming Action Group of industry, welfare charity and scientific representatives. The British Egg Industry Council, National Farmers Union and the British Free-Range Egg Producers Association are, at the time of writing, lobbying against the ban (Gent 2014).

In the UK, cage-free egg-production systems account for 49% of all eggs produced (Defra 2014). Almost all of these farms are farm assured under the RSPCA's Freedom Food Scheme (RSPCA 2014) and a small proportion are certified to the Soil Association organic standards. The RSPCA, Soil Association and University of Bristol are partners in the AssureWel project (www.assurewel.org) which aims to improve farm animal welfare through the introduction of welfare outcome assessments within farm assurance schemes. The Soil Association and RSPCA have, therefore, developed welfare outcome measures for inclusion within their respective Farm Assurance Scheme's annual audit for laying-hen farms. The process for selecting measures, determining an appropriate sample size, training assessors in both animal observations and motivational farmer feedback and developing farmer support material is discussed in detail elsewhere (Main *et al* 2012b). Here, we present the results of farm assurance assessor observations of feather loss in hens on Freedom Food and Soil Association members' farms over two years in the context of AssureWel and other industry activities aimed at reducing feather loss. To our knowledge this is the first report of a large-scale implementation of formal welfare outcome assessments within farm assurance schemes. In addition, we present the management changes that farmers said they had made, and intended to make, to improve bird welfare when questioned by assessors during the second year of outcome observations.

Materials and methods

Observations of feather loss in laying hens were included in all Soil Association (SA) inspections from May 2011 and all Freedom Food (FF) audits from August 2011 as part of a larger set of outcome measures (see Figure 1). To allow a small amount of time for embedding of the processes, the Year 1 feather-loss data used for analyses were collected from assessments that took place between 1st September 2011 and 31st August 2012, correspondingly, Year 2 feather-loss data were derived from inspections between 1st September 2012 and 31st August 2013. According to the Met Office the weather in the UK during Year 1 and 2 was close to long-term averages apart from an 'exceptionally' warm autumn 2011 (Sept to Nov), wet summer 2012 (Jun to Aug) and a notably dry summer 2013 (Jun to Aug) (Met Office 2015). Information on the scheme (SA or FF), management system (free-range, barn, organic [some FF flocks also belonged to alternative organic schemes, and a few also belonged to the SA scheme]), flock size, age and breed of the birds assessed, whether the flock was beak-trimmed, and the mortality of the previous year's flock as recorded by the farmer, as well as other husbandry and outcome information not presented here, was also collected during the inspections.

Methodology for assessment of feather loss

Forty SA assessors, 12 FF assessors and five RSPCA Farm Livestock Officers were trained to assess feather loss during a one-day, farm-based training programme prior to implementation (for further details and standardisation results, see Main *et al* 2012b) and completed an online training programme and attended further on-farm training during Year 2 (see Figure 1). Formative feedback on standardisation tests were provided to the assessors.

Feather loss was assessed on 50 hens randomly sampled (every fifth bird seen from ten different areas of the house and associated range) containing the eldest flock on the farm, or for all hens on farms with flocks of 50 or fewer

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Figure 1

Timeline of AssureWel and other industry activities aiming at improving feather cover in free-range laying hens. SA = Soil Association; FF = Freedom Food; BTAG = Beak Trimming Action Group; Bold = farmer-directed activites; Underlined = general industry-directed activities; Double underline = government-directed activities.

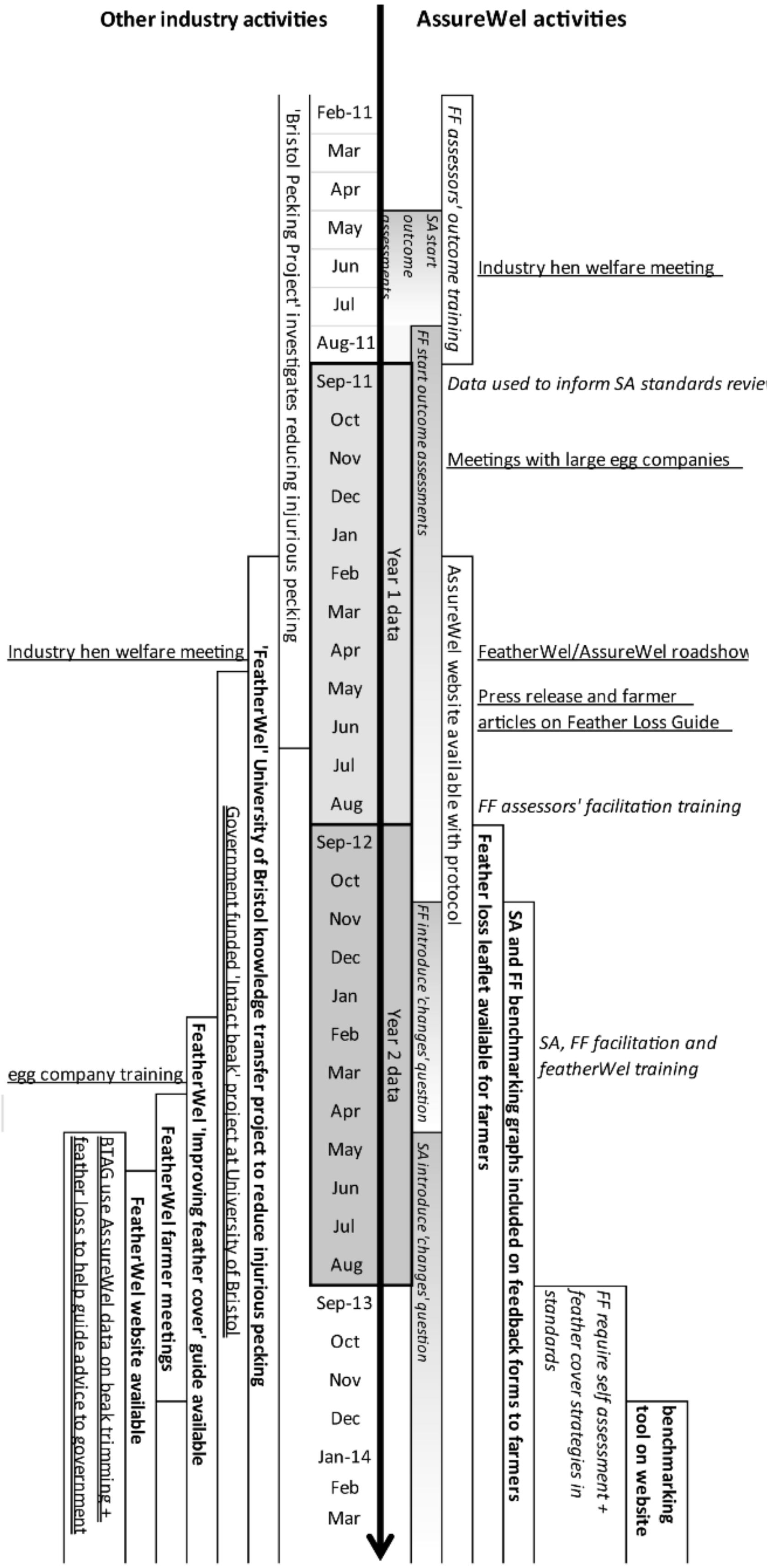

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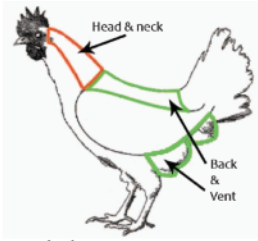
Figure 2

Feather loss

Sample size: 50 birds

Method of assessment: Assess and score 5 birds in each of 10 different areas of the house and/or range. Visually assess the head/neck area and back/vent area of the bird (without handling birds).



Scoring: Score separately for **head/neck** area and **back/vent** area.

0 = **No/Minimal feather loss**
No bare skin visible, no or slight wear, only single feathers missing

1 = **Slight feather loss**
Moderate wear, damaged feathers or 2 or more adjacent feathers missing up to bare skin visible < 5cm maximum dimension

2= **Moderate/Severe feather loss**
Bare skin visible ≥ 5cm maximum dimension

Feather-loss protocol for assessors.

Table 1 Examples of the type and likelihood to improve welfare categorisation of reported changes made or planned by farmers in answer to an open question.

Change type category	Categorised likelihood of improving bird welfare					
	High		Medium		Low/none/unknown	
	Example	Reason	Example	Reason	Example	Reason
Range (29 changes)	Improved natural cover	Will quickly provide more favourable ranging conditions	Trees planted	Will take time to improve ranging conditions	New fence	Too little information to determine impact on welfare
House (non-enrichment) (21 changes)	Measures to improve litter condition	Should improve bird welfare	Added perches in the house	Likely to be beneficial but risk of increasing harm	New slats	No evidence they will improve welfare
House enrichment (22 changes)	Straw bales	Should provide sustaining interest	Tennis balls	Some interest in pecking but not very sustaining	Hanging CDs	Likely to lose interest quickly
Health (17 changes)	Measures to reduce mortality	Should reduce poor welfare around death	Vaccination/ worming programme	Benefit will depend on disease challenge	Homeopathy	No evidence of effectiveness
Bird-rearing (4 changes)	Rearing own pullets on site	Easier to match rearing with laying conditions	Visit pullets at rearer	Matched conditions should improve welfare	n/a	n/a
Feed and water (8 changes)	Changing to *ad libitum* feeding	More autonomy and likely to improve feed intake	Feed intake monitored	May allow intervention when a problem occurs	Multi-vitamins added	No evidence of effectiveness
General management (9 changes)	n/a	n/a	Training of stockmen	Better stockmanship should improve welfare	Staff changes	Short-term change likely to reduce welfare, long-term effect unknown

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birds. One of three levels of feather loss could be recorded for each bird from Score 0 (no/minimal), through Score 1 (slight) to Score 2 (moderate/severe) for two body regions: 1) Head and Neck (HN); 2) Back and Vent (BV), as shown in Figure 2. Prior to February 2012 the Back and Vent region did not include the vent area.

Changes made on farms

During Year 2, from November 1st 2012 for FF inspections and May 1st 2013 for SA inspections, assessors asked farmers the following two open questions concerning management changes, usually after the farmer had been informed of the results of the feather-loss assessment:

• What changes to improve welfare have you made in the last 12 months?

• What changes to improve welfare do you intend to make in the next 12 months?

The answers were recorded by assessors as free text and later recoded both by type and by an estimation of efficacy to improve welfare on a three-point scale, allocated to each change by consensus of three animal welfare scientists with experience of laying-hen welfare improvement strategies (see Table 1 for examples of changes and their categorisations).

Initiatives to improve feather loss

Observation of feather loss by assessors was part of a range of activities undertaken through the AssureWel project and by the wider industry to improve feather cover in hens. The core activities are presented in Figure 1. Within Assurewel, assessors were also trained in motivational feedback when delivering results, using techniques previously shown to be effective in a dairy cow lameness intervention programme (Main *et al* 2012a). Supportive material, such as feedback forms, eventually including benchmarking graphs for all ages of flock, and guides on reducing feather loss became available during years one and two. Guidance to assessors of a threshold of when they should consider providing such materials was aided by benchmarking and set at the worst scoring 25% of farms for feather loss. Assessors were also encouraged to record separately whether any of the scheme's relevant resource standards had been breached on these farms. Industry initiatives included training of field staff of large companies in observation and improvement of feather cover and conferences on this topic. Research into management strategies to reduce feather loss was ongoing during this time, actively engaging both large and small producers, publishing findings (Lambton *et al* 2013) and providing farmer-focused advice on websites, on paper, and in person. In addition, the UK Government had formed the 'Beak Trimming Action Group' to discuss the potential impact on hen welfare of a ban on beak-trimming, and funded a trial of flocks with intact beaks on commercial farms (Defra 2012).

Statistical analysis

The data were analysed using the statistical package Ri386 3.02. A small, but unknown, number of farms were certified by both FF and SA schemes and their separate assessments each year were recorded under the scheme conducting the assessment that time. When farms had more than one assessment within the same scheme in a year only the first assessment was included in the analysis. The data for feather loss were found to consist of a large proportion of farms with zero prevalence (at least 30%) and the rest of the farms having a range of prevalences. Due to the on-farm sampling process, one would expect to see a certain number of farms with 0% prevalences, both true zeros, where there were no affected animals on the farm, and other zeros, where the sampled animals were not affected but other animals on the farm might have been. Initially, log-normal, binomial, negative binomial and Poisson distributions were fitted but all had substantial over-dispersion, indicating that there were more zero-prevalence farms than would be expected to arise from the on-farm sampling strategy alone. To model this type of data with a larger than expected number of zeros, zero-inflated models (using Poisson and negative binomial distributions) were fitted to capture the importance of both the many 0% farms, as well as the range of prevalences observed on the remaining farms.

To identify whether there was a significant difference between Year 1 and Year 2 prevalences for feather loss, two analyses were carried out: i) the input and outcome data of Year 1 farms that also contributed to the Year 2 dataset were compared using Chi-squared and Mann-Whitney tests; and ii) zero-inflated models were fitted to the data from those farms assessed in both years. To analyse the relationship between management changes made on farms and feather-loss scores, general linear models were fitted to data from farms that had reported changes made on the farm in Year 1 during their Year 2 assessment between November 2012 and August 2013. For these farms, the change in age of flock between Year 1 and Year 2 was included in all models and the change in feather-loss prevalence between Year 1 and Year 2 was the outcome of interest.

Results

Useable feather-loss data were returned from 830 farms in Year 1 and 743 farms in Year 2, representing 89 and 80%, respectively, of the number of farm assurance audits carried out under the Freedom Food (FF) or Soil Association (SA) farm assurance schemes. The characteristics of the farms are presented in Table 2. Mean mortality of the previous year's flock for farms assessed in Year 1 was 7.2% and for those assessed in Year 2 was 9.1%. All beak-trimmed birds (79% of flocks in both Year 1 and Year 2) were trimmed under ten days of age.

For the Head and Neck (HN) region the prevalence of any feather loss (either score 1 or 2) for all birds assessed in Year 1 was 31.8%, and 9.6% of birds were recorded as score 2. In Year 2, the prevalence of any HN feather loss was 20.8%, with 6.0% score 2. For the Back and Vent (BV) region the Year 1 prevalences for any feather loss and score 2 were 33.1 and 12.6%, respectively, compared with 22.7 and 8.3% for any feather loss and score 2, respectively, in Year 2 (see Figure 3).

To determine the effect of year, as well as flock age, size, beak-trimming status and hen breed on feather loss, zero-inflated models were applied only to data from 329 farms

Table 2 Farm characteristics.

		Year 1	Year 2	Farms assessed in both year 1 and Year 2
Number of farm assessments	Total	830	743	658 (329 farms)
	Freedom Food	752 (91%)	667 (90%)	594 (297 farms)
	Soil Association	78 (9%)	76 (10%)	64 (32 farms)
Maximum number of individual birds assessed	Total	41,129	36,726	32,820
	Freedom Food	37,673 (92%)	33,329 (91%)	29,821
	Soil Association	3,458 (8%)	3,419 (9%)	3,010
Management system	Free-range	657 (80%)	610 (82%)	552
	Organic	141 (17%)	112 (15%)	93
	Barn	26 (3%)	19 (3%)	13
Beak status	Beak-trimmed flock	625 (79%)	578 (79%)	527
	Not beak-trimmed flock	169 (21%)	157 (21%)	131
Flock age	Range	16–312 weeks	16–294 weeks	16–286 weeks
	Median	41 weeks	42 weeks	43 weeks
	Mean	45 weeks	45 weeks	45 weeks
	Number of flocks aged > 75 weeks	29	34	23
Flock size (Year 1; n = 823, Year 2; n = 741 farms)	Range	6–16,016 birds	8–16,750 birds	13–16,030 birds
	Median	6,000 birds	6,200 birds	6,500 birds
	Mean	7,668 birds	7,837 birds	7,869 birds
	Number of flocks with < 100 birds	39	36	23
Breed (Year 1; n = 812, Year 2; n = 738 farms)	Lohmann brown	314 (39%)	256 (35%)	238 (36%)
	Hyline	195 (24%)	145 (20%)	138 (21%)
	British blacktail	74 (9%)	82 (11%)	76 (12%)
	Isa warren	61 (8%)	59 (8%)	60 (9%)
	Shaver brown	70 (9%)	40 (5%)	42 (6%)
	Other commercial breeds	55 (7%)	76 (10%)	60 (9%)
	Traditional breeds	43 (5%)	80 (11%)	44 (7%)

assessed during both Year 1 and Year 2. The results are shown in Tables 3 and 4. There were no significant differences in flock size, flock age, breed, scheme membership and any feather-loss scores between Year 1 farms that were also assessed in Year 2 and those that were not. Zero-inflated models separately model both the likelihood of a farm being recorded with any affected birds and the likelihood of a farm being recorded with any of the positive prevalences. For either part of the four models fitted to data relating to HN and BV for scores 1 or 2, or just score 2, the significant factors were found to be Year (Year 2 lower than Year 1), Scheme (SA lower than FF) and flock age (increasing feather loss with increasing flock age). In addition, larger flocks were found to be significantly more likely to have higher prevalences of HN feather loss when it occurred and beak-trimmed flocks were significantly more likely to be recorded as a flock with 0% BV prevalence. Compared to the most common breed in the dataset, Lohmann Brown, British Blacktail flocks had significantly higher prevalences of BV feather loss when it occurred,

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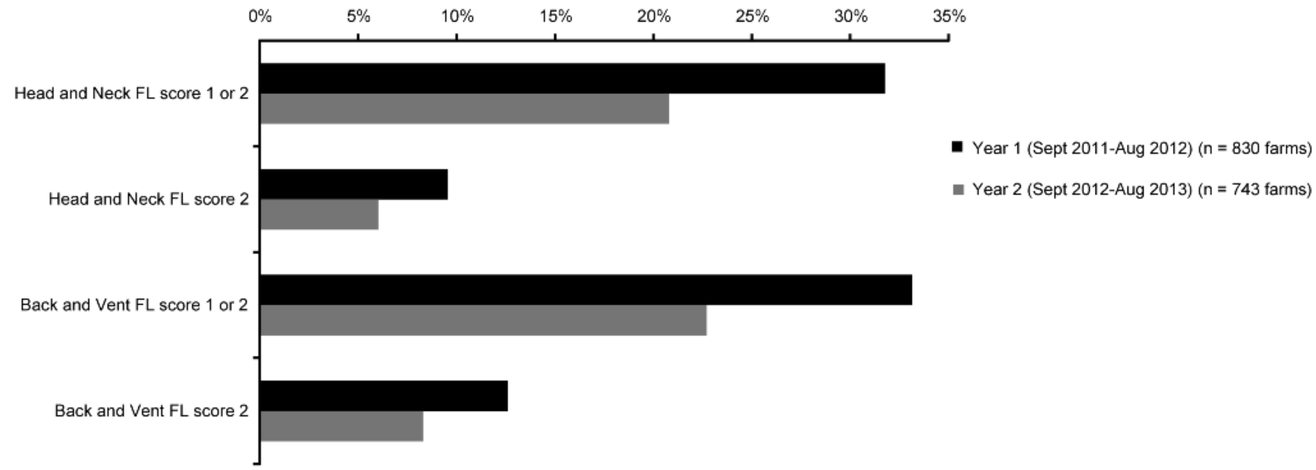
Figure 3



The prevalence of feather loss (FL) of the Head and Neck and the Back and Vent body regions of laying hens on Soil Association and Freedom Food members' farms between September 2011 and August 2013.

Table 3 Significant factors affecting Back and Vent feather-loss scores on farms assessed in both Year 1 and Year 2 (n = 329).

	Reference level	Back and Vent feather-loss score 1 or 2				Back and Vent feather-loss score 2			
		Estimate	Odds ratio	SEM	*P*-value	Estimate	Odds ratio	SEM	*P*-value
Count model coefficients									
Intercept		–0.653		0.095	< 0.001	–1.336		0.155	< 0.001
Year (year 2)	Year 1	–0.304		0.100	0.002				
Scheme (SA)	FF	–1.050		0.202	< 0.001	–1.302		0.332	< 0.001
Flock age (weeks)		0.007		0.003	0.017				
Breed									
British blacktail	Lohmann brown	0.402		0.187	0.032	0.710		0.349	0.042
ISA warren	Lohmann brown	–0.030		0.186	0.874	–0.196		0.314	0.533
Hyline	Lohmann brown	–0.385		0.134	0.004	–0.516		0.249	0.038
Shaver brown	Lohmann brown	–0.010		0.218	0.962	–0.336		0.396	0.397
Other commercial breeds	Lohmann brown	–0.331		0.198	0.095	–0.406		0.335	0.225
Traditional breeds	Lohmann brown	–0.095		0.215	0.658	–0.060		0.350	0.864
Log (theta)		0.073		0.091	0.422	–0.756		0.140	< 0.001
Zero-inflated model coefficients									
Intercept		–3.531		0.572	< 0.001	–2.229		0.660	0.001
Year (year 2)	Year 1	1.032	2.806	0.299	0.001	1.551	4.714	0.405	< 0.001
Scheme (SA)	FF	1.844	6.321	0.789	0.019				
Flock age (weeks)		–0.163	0.850	0.018	< 0.001	–0.142	0.868	0.020	< 0.001
Beak-trimming (trimmed)	Non-trimmed	1.109	3.030	0.461	0.016	1.622	5.065	0.504	0.001

Table 4 Significant factors affecting Head and Neck feather-loss scores on farms assessed in both Year 1 and Year 2 (n = 329).

	Reference level	Head and Neck feather-loss score 1 or 2				Head and Neck feather-loss score 2			
		Estimate	Odds ratio	SEM	*P*-value	Estimate	Odds ratio	SEM	*P*-value
Count model coefficients									
Intercept		–0.757		0.063	< 0.001	–1.872		0.089	< 0.001
Year (year 2)	Year 1	–0.206		0.093	0.026				
Scheme (SA)	FF	–0.935		0.176	< 0.001	–1.220		0.256	< 0.001
Flock size (number of birds)		2.54×10^{-5}		8.51×10^{-6}	0.003	4.42×10^{-5}		1.62×10^{-5}	0.006
Log (theta)		0.204		0.097	0.034	–0.687		0.122	< 0.001
Zero-inflated model coefficients									
Intercept		–3.641		0.624	< 0.001	–2.015		0.552	< 0.001
Year (year 2)	Year 1	1.136	3.113	0.327	0.001	1.609	5.000	0.438	< 0.001
Scheme (SA)	FF	3.533	34.240	0.908	< 0.001				
Flock age (weeks)		–0.214	0.807	0.031	< 0.001	–0.200	0.819	0.032	< 0.001

Table 5 Reported changes made or planned by farmers in response to open questions.

	Number of farmers (%) (n = 662)													
	Number of farmers (%)	Number of changes			Type of change							The highest estimated likelihood of any change mentioned by the farmer improving welfare		
		1	2	3 to 5	Range	Non-enrichment	Enrichment	Health	Bird rearing	Feed and water	General management	High	Medium	Low
Changes made	390 (59%)	230 (35%)	100 (15%)	60 (9%)	165 (25%)	106 (16%)	106 (16%)	102 (15%)	13 (2%)	23 (3%)	18 (3%)	165 (25%)	190 (29%)	34 (5%)
Changes planned	241 (36%)	189 (29%)	40 (6%)	2 (1%)	98 (15%)	29 (4%)	70 (11%)	31 (5%)	9 (1%)	6 (1%)	18 (3%)	22 (3%)	145 (22%)	68 (10%)

whereas Hyline flocks had a significantly lower degree of BV feather loss when it occurred.

Between November 1st 2012 (FF members' farms) or May 1st 2013 (SA members' farms) and the end of Year 2 (31st August 2013) data were collected from 662 welfare outcome assessments. Although some recording sheets contained no information about changes made or planned on farms, 390 farmers (59%) said they had made changes on their farm in the past year and 241 (36%) planned to make changes in the upcoming year (Table 5). The most common type of change made and planned was to the range, by 106 (29%) and 98 (15%) of farmers, respectively. A quarter of all farmers (165) reported they had made a change categorised as having a high likelihood of improving welfare, whereas only 3% (22) were planning a high likelihood of improvement change. Accounting for change in the age of the flock, none of a range of variables relating to number, type or risk category were found to be significant predictors of change in BV feather-loss prevalences from Year 1 to Year 2. Only changes reported to be made in the 'house enrichment' category were significantly predictive of a reduction in any HN feather loss (score 1 and 2) from Year 1 to Year 2 (P = 0.02, estimate = –13.7, CI = –24.8, –2.6; n = 207 farms).

Discussion

The significant reduction in feather loss from 33% (Back and Vent) and 32% (Head and Neck) of birds observed in Year 1 to 23% (BV) and 21% (HN) in Year 2 represents approximately 1.8 million extra fully feathered birds if extrapolated to the estimated 18 million cage-free hens in the UK (BEIC 2015). Despite the observations being made on a small sample of 50 birds, previous analysis suggested that when randomly sampled data from each farm were combined with data from other farms the confidence interval for the overall prevalence estimates of all

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farms in both Freedom Food and Soil Association schemes is approximately 0.9% (Main *et al* 2012b). The inclusion of formal welfare outcome recording within these schemes has allowed the most comprehensive national monitoring of cage-free hen welfare across the UK. In addition, it has provided data to the Government advisory group, the Beak Trimming Action Group, to aid their consideration of hen welfare aspects that may result from a ban on beak-trimming.

This case example demonstrates that in a modern society where the focus is less on government and more on governance by private organisations, motivated non-governmental actors can bring about improvements desired by society. In this case, a range of activities aimed at improving feather cover were carried out by charities, scientists and private companies in a relatively unco-ordinated way, albeit with a common goal. It could be argued that the common goal of reducing injurious pecking was brought into sharper focus for the non-governmental organisations by the government action of proposing a potential imminent legislative change to ban beak-trimming in laying hens. Industries that have a more co-ordinated approach, for example, through clear strategies (eg for pig welfare, see BPEX 2011) may be better placed to implement monitoring and improvement programmes. In discussing the increasing role of private standards in animal welfare governance over government involvement, Maciel and Bock (2012) highlight that there may be negative consequences as a result of a lack of democratic input acting as a safeguard to the process. However, it could also be the case that the increasing role of private standards could lead to greater animal welfare improvements than achieved through legislation and governmental control, due to the inevitable compromises that are made in order to reach consensus on legal minimum standards. Here, we make no comment on the right level of governance, but hope to inform a debate on the roles of wider society and the necessity of evolving legislation to influence the democratisation of private assurance scheme standards with this scientifically appraised evidence.

The reasons for the improvement in feather cover are not clear from this analysis. Whilst 59% of farmers reported making changes to improve bird welfare on their farms during Year 1, the only changes that were associated with a reduction in feather loss were those relating to enrichment in the house for the HN body region. Pecking objects in the house, such as hay-filled nets, rope or pecking blocks are recommended as a management strategy to reduce feather-pecking by allowing an alternative outlet for foraging behaviour (FeatherWel 2013). The lack of additional associations found in other studies, such as with improvements in the range (Green *et al* 2000; Bestman & Wagenaar 2003; Mahboub *et al* 2004; Shimmura *et al* 2008; Bright *et al* 2011; Breitsameter *et al* 2014), or number of management strategies employed (Lambton *et al* 2013) may be due to limitations of the analysis, where relatively few farms were observed in both Years 1 and 2, limitations of the change type categorisations, which included a wide range of changes, and/or effectiveness categorisation may not have been valid. It may also be that farmers did not report the changes that were actually effective on their farms.

Although changes outside of the farmers' control, such as bird genetics or weather, may have had some impact, it is likely that on-farm changes were more largely responsible for the improvements in feather cover as any improvement in this area related to genetic progress would be expected to occur over a longer period of time. Again, from this analysis, it is not possible to determine the effectiveness of individual drivers for farmers to make changes but rather to recognise the variety of influences, both within the farm assurance process, and from wider industry that have contributed to the improvements.

The farm assurance welfare outcome assessment was expected to heighten awareness of feather loss as a welfare problem which, in itself, may have had some effect in improving feather loss as was seen by improvements in 'control' dairy herds that only received monitoring in a study to assess lameness (Main *et al* 2012a). The way in which assessors fed back the results, eventually with benchmarking, was designed in such a way as to promote behaviour change in the farmer. These were based on social marketing techniques and the experiences of similar welfare improvement projects (Main *et al* 2012a). However, more sophisticated approaches employed in other settings, such as healthcare, using messaging tailored to an individual's information-processing style, such as a need for cognition (Cacioppo *et al* 1996, Williams-Piehota *et al* 2003) or sense of their level of control of a situation (Williams-Piehota *et al* 2004), may be likely to better promote farmer behaviour change. The independence of the assessors is regulated but was not compromised by providing feather-loss management literature, signposting other sources of advice or giving examples of other farmers who have made changes when they have poor scores. It could be imagined that a threshold for feather loss for inclusion within the scheme (ie there should not be more than *x*% of birds in a flock with feather loss) would act as a stronger driver for change, but it is acknowledged that the small sample of birds would not give sufficient confidence to achieve this (Main *et al* 2012b).

The overall focus of the whole of the egg industry on improving feather cover was clear throughout Year 1 and Year 2, as frequent articles in the industry press disseminated promising results on managing feather cover (Lambton *et al* 2013). The impending decision on whether to go ahead with the intended beak-trimming ban in 2016 also appeared to focus attention on feather-pecking and its impacts on bird welfare and flock mortality. In this study, bird mortality, as recorded by the farmer for the previous flock, was found to be at a similar level to the 8% described in two other studies of UK free-range flocks (Whay *et al* 2007; Lambton *et al* 2013). The implementation of monitoring programmes by large companies could be expected to have had a significant impact, however it is not known how the programmes identified farms at risk or encouraged change.

The additional information collected during the assessment was able to provide further detail about feather loss. In line with other studies, which have shown that feather loss increases as the flock ages (Huber-Eicher & Sebo 2001; Drake *et al* 2010; Lambton *et al* 2010), the age of the flock at assessment was a significant predictor of feather loss. The farm assurance audit is approximately annual and laying flocks of any age may be assessed, although the requirement to assess the oldest flock on the farm may have resulted in an overestimate of the true overall prevalence. Farms in the Soil Association scheme had lower feather-loss scores than those in the Freedom Food scheme, however this study was not designed to investigate the causes of such a difference and both schemes are welfare-orientated and have standards above legislative requirements. Significant differences in feather loss between breeds were only found to affect the BV region. Anecdotally, some breeds have been thought to engage in more feather-pecking and this is in line with the findings here. Changing breed of the bird can be achieved quickly, for the subsequent flock, and with little difference in cost outlay, although other productivity factors may be relevant in this decision-making. Our findings would suggest that, other things being equal, careful selection of breeds would be beneficial to reduce feather loss. Finally, the effect of beak-trimming on feather loss was a mixed picture. For the BV region, beak-trimmed flocks were three times more likely to have 0% of the birds with feather loss than non-trimmed flocks whereas beak-trimming had no effect on HN feather loss. Beak-trimming has previously been shown to be associated with reduced pecking and plumage damage (Hartini *et al* 2002; Staack *et al* 2007; Lambton *et al* 2010). However, Whay *et al* (2007) found no association between beak-trimming and feather-pecking or loss. Amongst other possible explanations it may be that the aetiology of feather loss differs between body regions, for example, beak-trimming is not likely to be protective for the HN area if mechanical damage rather than feather-pecking is a more significant cause.

Animal welfare implications and conclusion

The introduction of observations of feather loss within the RSPCA Freedom Food and Soil Association farm assurance schemes has enhanced monitoring of the welfare of cage-free hens in the UK. The significant reduction from Year 1 to Year 2 in the prevalence of feather loss from 31.8 (9.6% severe) to 20.8% (6% severe) for the HN region, and from 33.1 (12.6% severe) to 22.7% (8.3% severe) for BV region is dramatic. Fifty-nine percent of farmers reported they had made changes on their farms to improve bird welfare. The motivation to make these changes is unclear but both the initiatives of the farm assurance schemes and wider industry bodies are likely to have been important. This case example has shown that initiatives by a range of actors are able to deliver farm animal welfare improvements.

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