Taylor & Francis
Taylor & Francis Group

British Poultry Science

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/cbps20

How are they really doing? Animal welfare on organic laying hen farms in terms of health and behaviour

L. Göransson, S. Abeyesinghe, J. Yngvesson & S. Gunnarsson

BRITISH POULTRY SCIENCE
2023, VOL. 64, NO. 5, 552–564
https://doi.org/10.1080/00071668.2023.2241829

How are they really doing? Animal welfare on organic laying hen farms in terms of health and behaviour

L. Göransson [a], S. Abeyesinghe [b], J. Yngvesson [a] and S. Gunnarsson [a]

[a]Department of Animal Environment and Health, Swedish University of Agricultural Sciences (SLU), Skara, Sweden; [b]Department of Pathobiology and Population Sciences, Royal Veterinary College (RVC), Hatfield, UK

ABSTRACT

1. The present study describes the current welfare situation on commercial organic laying hen farms in Sweden in terms of indoor environment, bird health and behaviour.
2. Organic laying hen farms ($n = 11$) in Sweden were visited for one day each. The farm visits were performed at the end of lay and involved farmer interviews, indoor environment assessments, behavioural observations and tests and clinical examinations in one flock per farm.
3. In 95% of all human avoidance distance test trials performed, the hens distanced themselves from the observer before the test was completed. Median number of birds per flock approaching during a novel object test ($n = 4$ trials per flock) was 2 (0-9). These results may indicate a high level of fear of humans and general fearfulness among the hens.
4. Plumage damage was especially prevalent and most severe on the breast and belly, tail and wings, with median prevalence of moderate-severe damage of 96% (84–100), 96% (72–100) and 98% (94–100), respectively. Median prevalence of keel bone deviations was 67% (32–84) with 3% fractures (0–8). Median prevalence of breast skin lesions was 57% (10–74). There was a significant positive association between breast skin lesions and keel bone deviations ($P = 0.02$) and foot pad hyperkeratosis ($P < 0.001$). Median prevalence of severe hyperkeratosis was 33% (8–96), with prevalence being significantly lower where litter depth was thicker ($P = 0.003$). More dust bathing events were observed in flocks where litter depth was thicker ($P = 0.007$).
5. The present study contributes with updated knowledge of laying hen welfare on organic farms in Sweden. The results confirm the findings of previous on-farm studies, demonstrating that important issues, including keel bone damage and severe feather pecking, remain in need of attention to ensure the welfare of laying hens in future commercial egg production.

ARTICLE HISTORY
Received 31 January 2023
Accepted 13 June 2023

KEYWORDS
Free-range; fearfulness; behaviour; poultry; dust bathing; plumage; feather pecking; keel bone damage

Introduction

High animal welfare standards are fundamental in organic animal farming. Animal welfare encompasses biological functioning (health), and the possibility to express natural behaviour subjective experience of the individual animal (Fraser et al. 1997). Initially, animal welfare discussions were focused on meeting the animals' basic needs. However, it is now widely accepted that merely minimising unpleasant experiences such as pain, fear or hunger does not secure good animal welfare. Therefore current animal welfare frameworks encompass the promotion of positive welfare, *i.e.*, pleasant experiences associated with positive emotions (Mellor et al. 2020).

The possibility to express natural behaviour in a natural environment is strongly emphasised in organic animal farming as important for ensuring good welfare. Thus, current European Union (EU) regulations on organic farming (EU 2018) require *e.g.*, lower stocking densities than in non-organic production, outdoor access and the provision of roughage for laying hens to better provide the opportunity to perform foraging and dust bathing, which are important behaviours for laying hen welfare (Weeks and Nicol 2006).

Good animal health must be ensured in organic production by disease prevention, through e.g. appropriate management practices, high-quality feed, exercise, appropriate stocking density, and choice of healthy breeds (EU 2018). However, laying hen hybrids used on organic farms are the same as those used in non-organic commercial egg production and, apart from outdoor access in organic systems, the indoor environment is similar across commercial loose-housing systems. Thus, some of the main laying hen welfare issues in loose-housing systems are the same in organic and non-organic production (Van de Weerd, Keatinge, and Roderick 2009). Common problems include severe feather pecking, *i.e.*, pecking and pulling at the feathers of a conspecific, which is painful (Gentle and Hunter 1991) and stressful for the recipient bird and other birds in the flock (Jones et al. 2004). To mitigate plumage damage from feather pecking, laying hens in many countries are beak-trimmed, but this painful procedure is prohibited in organic production (EU 2018). Keel bone damage, *i.e.*, deviations and fractures of the sternum, is another important welfare issue in laying hens. Deviations are thought to result from prolonged mechanical pressure during perching (Heerkens et al. 2016) and have been suggested to reduce welfare due to impaired movement (Tauson et al. 2006). Traumatic injuries (Stratmann et al. 2015), high laying performance (Jung et al. 2019), early onset of lay and the production of large eggs

CONTACT L. Göransson lina.goransson@slu.se Department of Animal Environment and Health, Swedish University of Agricultural Sciences (SLU), Box 234, Skara SE - 532 23, Sweden

Supplemental data for this article can be accessed online at https://doi.org/10.1080/00071668.2023.2241829

(Thøfner et al. 2021) may contribute to keel bone fractures, which are associated with pain, impaired mobility (Nasr et al. 2012) and a reduced use of pop-holes (Richards et al. 2012). Laying hen welfare can also be influenced by the quality of human-animal (Zulkifli 2013).

On-farm studies are imperative in order to gain knowledge about the welfare of animals in commercial production (Dawkins 2012). Large-scale epidemiological on-farm studies in organic egg production have been performed in Denmark (Hegelund, Sørensen, and Hermansen 2006), the Netherlands (Bestman and Wagenaar 2014) and across eight other European countries, including Sweden (Jung et al. 2020). However, the latter was performed almost 10 years ago (Bestman et al. 2017; Jung et al. 2019, 2020), and since then no epidemiological studies on organic laying hens have been undertaken in Sweden.

There are around 460 million laying hens in the EU (FAOSTAT 2022), of which around 6% are kept on organic farms (Augère-Granier 2019). Sweden has one of the highest proportions of organic laying hen farms in the EU (Augère-Granier 2019), comprising around 16% of national egg production. Sweden had 98 commercial organic laying hen farms in 2020 (Swedish Board of Agriculture 2022b), of which 69% were certified according to the standards of the private organic incorporated association KRAV® (Robert Dinwiddie, pers. comm., 11 August, 2022). KRAV standards comply with the organic EU regulations and in some cases go further, for instance, by including requirements on provision of specific sand baths indoors or on the veranda during periods without outdoor access (KRAV 2022).

The aims of the present study were to assess the current welfare situation on commercial organic laying hen farms in Sweden in terms of indoor environment, bird health and behaviour.

Materials and methods

Ethical statement

This work included behavioural observations and clinical scoring in commercial laying hens, without any invasive treatment, and thus ethical approval by an ethics committee for animal experiments was not required according to Swedish legislation (SJVFS 2019:9). The study did not include collection of any sensitive personal data, and hence no ethical review for research involving humans was required under Swedish law (SFS 2003:460).

Farms and flocks

Farms included in the study were recruited through a national organic poultry advisor in Sweden, who contacted organic egg producers in Sweden by telephone (in no particular order) during spring 2020. Farmers with at least one flock approaching the end of the laying period were invited to participate in the study, after being informed about the project. The first 10 consenting farmers were included in the study. These farmers were then contacted via telephone by the first author and provided with a more detailed description of the study aim and methods. They were also informed that they could withdraw their consent at any time during the study. All farms were located in the southern third of Sweden, and each was visited on one day during a period between May (early summer) and December (winter) 2020. Farm visits were scheduled towards the end of the laying period and arranged to ensure that all flocks were around the same age during data collection. All phone calls and visits were performed by the first author and one assistant. Upon arrival at the farm, one farmer did not consent to individual handling of the birds and therefore an additional farm was visited (bringing the total to 11 to create a complete data set from 10 farms).

Data collection

On arrival at a farm, the farmer or manager was interviewed according to a structured protocol (see Supplementary Material). This provided information on general farm structure, management and husbandry routines, housing, bird health and behaviour, productivity, outdoor access and free-ranging behaviour. On completion of the interviews, flock observations were made in one flock and their indoor environment.

Some flocks were housed in a single undivided indoor barn whilst others were divided by wire fencing, to create up to six separate sections with no more than 3,000 birds in each (EU 2020). In the latter case observations were performed as though the house was not divided and encompassed all sections. Since the hens were not separated in this way in the free-range area, they were considered as one flock unless separated by a solid wall with access to separate free-range areas.

The dimensions of the house and veranda (a roofed platform at ground level with three walls and one curtain, littered floor and natural ventilation, adjacent to the hen house and connecting this to the free-range area) and the number and/or dimensions of (as applicable) sections, nests, tiers, perches, windows, pop-holes, drinkers and feeders were recorded, along with any additional environmental enrichment. Farmers were asked to provide structural drawings of the hen house.

A dust sheet test was performed according to the Welfare Quality® (WQ) assessment protocol for poultry (Welfare Quality® 2009). For this, a piece of black paper was placed on a horizontal surface upon entry to the hen house and collected on the way out, after a minimum of 3 h. Upon exit, the dust level on the paper was assessed using a five-point scale from 'a' (none) to 'e' (paper colour not visible). The observer walked through the house and assessed the following at five different locations: Litter quality on a five-point scale from 0 (completely dry and flaky) to 4 (sticks to boots once compacted crust was broken; WQ); litter depth on a three-point scale from 0 (no or very thin layer of litter, through which floor could easily be discerned) to 2 (thick or very thick layer of litter, in which boot left noticeable indentation when walking); and thermal environment, assessed by estimating the proportion of groups of 100 birds panting or huddling at each of the five locations (WQ). Due to differences between the houses in terms of, e.g. size and aviary system, it was difficult to perform these assessments at standardised locations, so the actual location was recorded for each observation (e.g. lower tier, litter area or in front of pop-hole).

Behavioural observations were performed in parallel with the assessment of the indoor environment, at around 12.30–15.00 on five farms (visited in May–June) and around 10.00–11.30 on six farms (visited in September–December).

Use of litter was assessed at the five assessment locations by recording presence/absence of dust bathing; scratching or manipulation of litter; single bird dust bathing; and/or more than two birds dust bathing together (WQ). When walking through the hen house, a novel object test (NOT; $n = 4$ trials per flock) and a human-avoidance distance test (ADT; $n = 21$ trials per flock) were performed (WQ). For the NOT, a 50 cm long colourful stick was placed in the litter area, and the observer stepped back 2 m and counted the number of hens within approximately 30 cm of the novel object every 10 s in the next 2 min. For the ADT, the observer walked slowly parallel to the slatted floor at a distance of 1.5 m from the edge. When a hen was sitting on the edge of the slatted floor, the observer turned 90° and walked slowly towards that hen and estimated the distance (cm) at which the hen started to move away. If a hen distanced herself before the observer could stop, turn and face the bird, the test trial was considered unsuccessful.

Pop-hole behavioural observations were performed at two different pop-holes per farm. Birds in the pop-holes or directly adjacent to these (in the litter area) were included in the observations, which were performed at a distance (approximately 6 m) to minimise affecting bird behaviour but allow for accurate recording. During three consecutive minutes, the number of observations of birds performing different behaviours (Table 1) were recorded. Thereafter, a stationary person test (SPT) and group behavioural observations were performed in the litter area in the middle of the aviary. During the SPT, the observer sat down in the litter area and recorded the number of birds within arm's length after 5 min and the minimum distance to an approaching bird. This allowed for 5 min of habituation prior to group behavioural observations, which were performed continuously during five consecutive minutes on all birds within an imaginary semi-circle with radius 5 m in front of the observer. State behaviours, i.e. patterns with relatively long duration (Martin and Bateson 2007), were recorded as the estimated percentage of birds performing the behaviour (overall assessment of the majority behaviour for each bird across 5 min), except for observations of preening and dust bathing, which were counted (Table 1). The number of birds observed performing event behaviours, i.e. behaviour patterns of relatively short duration (Martin and Bateson 2007), including vocalisations, was counted.

Clinical examinations on 50 birds per farm, based on a partly modified WQ assessment protocol for laying hens (Table 2), were performed last during the indoor observations. The artificial lights were temporarily turned off to enable a gentler and less stressful collection of birds. The hens were collected from one, or at most two, adjacent sections to ensure that birds were released back to their home section after examination. The captured birds were kept in two groups, each within four connected compost grids placed in the litter area and covered by a black bed sheet. They were gently picked up one at a time and weighed and thereafter examined and scored. The same person performed all clinical examinations throughout the study.

Statistical analysis

Data collection involved a selection of measures from the Welfare Quality® assessment protocol for poultry, but no aggregation of scores or classification of farms was made (Welfare Quality® 2009). Data compilation was performed in Microsoft Excel 2016. First, data were thoroughly explored visually to look for any patterns and possible correlations. Patterns or correlations found were further investigated through statistical analyses performed in R (R Core Team 2020). Results were considered significant at $P < 0.05$. Results are presented as median and range (min-max), unless otherwise stated.

Pearson's Chi-squared Test for Count Data was used to analyse any association between litter depth and number of observations of at least one bird dust bathing per farm

Table 1. Ethogram for behavioural observations on organic laying hen farms (modified from Rodriguez-Aurrekoetxea, Leone, and Estevez 2015; Ventura et al. 2012).

Behaviour	Description
State behaviours	
Standing	Upright motionless position on extended legs with both feet, but no other body part touching the ground during ≥ 2 s
Sitting	Positioned with bent legs, hocks resting on the ground and abdomen in contact with the ground
Resting	Positioned with sternum in contact with the ground, head lowered and resting on ground or tucked in under own wing, with eyes open, semi- or fully closed
Walking	Locomotion starting when bird takes two or more steps forward in succession
Perching (if applicable)[1]	Bird standing, sitting or resting positioned on perch or other elevated structure
Foraging	Bird lowers its head and manipulates substrate on ground with beak and scratches with feet in search of food, while standing or slowly walking forward with head below rump level
Preening	Manipulation (cleaning, arranging or oiling) of own feathers with beak, while standing or sitting
Dust bathing	Bird sitting or lying down in substrate, pecking and scratching at litter material, tossing and distributing loose substrate onto its back and wings, ruffling and shaking its feathers with or without rubbing head against ground
Event behaviours	
Wing stretching	Slowly extending one wing
Leg stretching	Slowly extending one leg backwards or laterally
Feather ruffling	Bird raises feathers from her body during a rocking or shaking motion
Running	Rapid locomotion starting when bird takes two or more steps forward in rapid succession
Flying	Locomotion starting when bird extends and flaps wings and moves a distance through the air
Gentle feather pecking[2]	Bird uses beak to gently manipulate and lightly peck at feathers of recipient bird, which does not move away
Severe feather pecking[2]	Bird uses beak to forcefully manipulate feathers of recipient bird, which moves away from performer bird. Pecks are hard, fast and often singular and may result in detached feathers
Aggressive pecking[2]	Bird raises head and uses beak to forcefully stab at recipient bird, which moves away. Pecks usually directed towards the head, but may also be directed at the body
Walking along pop-hole[3]	Bird walking in pop-hole parallel to its opening, at least three steps in succession
Turning back in[3]	Bird walking or running through pop-hole from inside towards outside, but making a halt and change of direction to remain indoors
Turning back out[3]	Bird walking or running through pop-hole from outside towards inside, but making a halt and change of direction to remain outdoors

[1]Not pop-hole observations. [2]From Daigle (2017). [3]Pop-hole observations only.

Table 2. Scoring protocol for clinical examinations of birds on organic laying hen farms.

Measure	Score
Respiratory infection[1]	0 (no); 1 (yes)
Eye pathologies[1]	0 (no); 1 (yes)
Enlarged crop[1]	0 (no); 1 (yes)
Comb colour	0 (normal); 1 (pale); 2 (blue)
Comb dehydration	0 (no); 1 (yes)
Comb pecking wounds[1]	0 (intact comb); 1 (<3 wounds); 2 (≥3 wounds)
Plumage condition (body, *i.e.*, head, neck and underneck; back and rump; breast and belly)[2]	0 (intact feathers); 1 (some feathers scruffy, ≤3 missing feathers); 2 (more damaged feathers, >3 feather missing); 3 (bald patch <5 cm diameter or <50% of area); 4 (bald patch ≥5 cm diameter or ⩾50% of area) 5 (completely denuded area)
Plumage condition (flight feathers, *i.e.*, tail; coverts and primary feathers)[2]	0 (intact feathers); 1 (few feathers separated and none broken or missing); 2 (many feathers separated and/or a few broken or missing); 3 (all feathers separated and many broken or missing feathers); 4 (most feathers missing or broken); 5 (almost all feathers missing)
Plumage cleanliness[3]	0 (clean) – 3 (very dirty)
Skin lesions (head and neck; back and rump; tail; belly and cloaca)	0 (no lesions); 1 (<5 pecks or scratches); 2 (at least one lesion <1 cm, or ⩾5 pecks or scratches); 3 (at least one lesion <1 cm but <2 cm); 4 (at least one lesion ≥2 cm)
Keel bone deviation	0 (none or ≤0.5 cm); 1 (>0.5 but ≤1 cm); 2 (>1 cm)
Keel bone fracture	0 (no deformity); 1 (callus formation/sharp bends/fragmented sections)
Breast skin haematoma	0 (no); 1 (yes)
Breast skin lesion	0 (intact skin); 1 (focal thickening and reddening of skin overlying the keel bone, and/or with brown or black scabs)
Diarrhoea	0 (no); 1 (altered faecal state with increased liquid content)
Hyperkeratosis (metatarsal foot pads)[4]	0 (no thickening of skin) – 2 (excessive thickening of skin)
Foot pad dermatitis (bumble foot)[4]	0 (no lesions); 1 (discoloration, ulceration and/or necrosis, with no or minor swelling); 2 (abscess, dorsally visible swelling)
Missing toe(s)[4]	0 (intact toes); 1 (one toe and/or claw missing); 2 (≥2 toes and/or claws missing)
Toe wounds[4]	0 (intact toes, no lesions); 1 (<3 wounds); 2 (≥3 wounds)

[1]Welfare Quality® protocol for laying hens. [2]Modified from Bilcík and Keeling (1999). [3]Welfare Quality® protocol for broilers. [4]Both feet assessed: scoring based on most severe lesion found.

(categorised as ≤2 observations; 3–4 observations; ≥5 observations). The same test was used to analyse any association between the total number of birds per farm approaching during the NOT (categorised as ≤2 birds; 3–5 birds; ≥6 birds) and flock age at the first free-range access (weeks of age ≤25 or ≥40), provision of environmental enrichment (yes or no), successful ADT trials (i.e. the test could be completed in at least one trial), and minimum distance of a bird approaching during the SPT (distance <100 or ≥100 cm; see Supplementary Material). Pearson's Chi-squared test was used to analyse any association, on an individual level, between breast skin lesions and keel bone deviations/hyperkeratosis/foot pad dermatitis (bumble foot), and between skin lesions and plumage damage to the back, rump/breast and belly.

The relationship between body weight and keel bone deviation (score ≥1), and between body weight and breast skin lesions, was analysed using a generalised linear mixed-effects model (binomial distribution), including farm as a random factor. A significant interaction was found between body weight and hybrid (Bovans White, Bovans Brown, and Lohmann Selected Leghorn) for both keel bone deviation and breast skin lesions. This was problematic to interpret, as two of the hybrids were represented in only one flock each. These two flocks were excluded from these analyses, which were thus based solely on data from Bovans White flocks. Generalised linear mixed-effects models were used to analyse the relationship between litter depth and the number of dust bathing observations made during the continuous group behavioural observations (Poisson distribution), and between litter depth and the prevalence of hyperkeratosis (score ≥1) and severe hyperkeratosis (score 2) (binomial distribution), including farm as a random factor.

Results

Farms and flocks

All farms in the study were KRAV-certified (KRAV 2022). Three farmers had previous experience of conventional egg production before converting to organic. The median number of years in organic egg production was 17 (4–25). The median age of the observed flocks at the time of visit was 74 (73–78) weeks. Hybrids included Bovans White ($n = 9$), Bovans Brown ($n = 1$) and Lohmann Selected Leghorn (LSL) ($n = 1$). The median flock size at the time of visit was 5750 (1118–17,373), and farm size (i.e. total number of birds) was 18 000 (3000–120,000). Pullets were placed at 15–16 weeks of age. They were, in general, reared without outdoor access, but with access to a veranda in summertime during favourable weather conditions on one of the laying hen farms, which reared its own pullets. Hens were slaughtered at around 75–85 weeks of age on six farms and 85–95 weeks of age on four farms. On the remaining farm, birds were killed on-farm to avoid transport to an abattoir, at around 92–102 weeks of age. All flocks were kept in aviaries on two ($n = 3$ farms) or three ($n = 8$ farms) tiers and group nests. On eight farms, a veranda adjoined the pop-holes to the free-range area. On 10 farms the hens had access to pop-holes on one side of the house, and on one farm hens could access the outdoor area through pop-holes on both sides of the house. There was a height difference between the litter area and the pop-hole on all farms except one (on which birds accessed the windows functioning as pop-holes via ramps). The median height difference was 10 (1–40) cm.

Indoor environment

Wood shavings were used as litter material on all farms, but one farm mixed this with sand. Prior to placement of pullets only a thin layer of litter was provided, which thickened over time as dry manure and feathers were added to it. Litter depth was scored as thin (score 0) on three farms, average (score 1) on four farms and thick (score 2) on four farms. On three of the farms, some or all of the bedding was removed without replacement when it was considered too thick, to avoid floor eggs according to one farmer. On one farm, the old bedding was removed approximately every two monthsand replaced with new litter. Litter quality was dry and flaky (score 0) in all five locations on nine of the farms, although it was difficult to make a proper assessment on two due to a very thin layer of wood shavings. Moderately (score 2) and severely (score 3) deteriorated litter was observed in one of the five locations (otherwise score 0) on each of the two remaining farms.

On farms where pop-holes were open at the time of visit, the dust sheet test revealed no dust (score a), little dust (score b) or a thin covering of dust (score c) on one, five and one farm, respectively. For the four farms where pop-holes were closed, no dust (score a), little dust (score b), a thin covering (score c) and much dust (score d) was observed, respectively. No birds were seen panting or huddling in any of the flocks.

Roughage was provided as lucerne, silage, hay or straw bales and fodder carrots on the floor (indoors) and/or on the veranda. Six of the farmers provided roughage year-round, while five of the farmers did so only when the birds had no outdoor access. Pecking stones, limestone blocks and/or sea-shells were provided as additional environmental enrichment on six of the farms.

Behaviour

The median number of locations (out of five per farm) where observations were made for birds scratching or manipulating litter was 2 (0–5), single birds dust bathing was 2 (0–5), and two or more birds dust bathing together was 1 (0–3). *Signs* of dust bathing and/or *signs* of scratching and manipulation of litter were observed at all five locations on all farms except one, on which the litter had recently been removed. There was a tendency for an association between the number of locations with at least one bird dust bathing per farm and litter depth ($\chi^2 = 9.29$, df = 4; $P = 0.05$). Relatively more observations of dust bathing were made in flocks where litter depth was thicker (score 2).

The majority ($n = 219$) of the ADT trials performed in total ($n = 231$) on all farms were unsuccessful (i.e. the birds distanced themselves before the observer could stop, turn and face a sitting hen). The successful trials ($n = 12$) were performed on five farms, with six of these trials performed on one farm. The latter was the only farm with brown hens, as opposed to the white hybrids on the other 10 farms. The median distance between the observer and a hen was 90 (20–150) cm.

During the SPT, four birds in total were counted within arm's length. All these were in one flock (that in which half the successful ADT trials were also performed i.e. the only flock with brown hens). The median minimum distance between the observer and a hen was 100 (0–200) cm.

The median number of birds per farm approaching during the NOT ($n = 4$ trials per farm) was 2 (0–9). Of the 44 trials performed in total on all farms, at least one hen approached in 16 trials and on 10 farms, respectively. The median time for all birds to approach (trials when no birds were excluded), as well as for the first bird in each trial to approach, was 80 s (10–120 s). There were no significant associations between number of birds approaching per farm and flock age at first free-range access ($\chi^2 = 1.64$, df = 2; $P = 0.44$), provision of environmental enrichment observed during farm visits ($\chi^2 = 1.64$, df = 2; $P = 0.44$) or as reported by farmers ($\chi^2 = 0.24$, df = 2; $P = 0.89$), successful ADT ($\chi^2 = 0.91$, df = 2; $P = 0.63$), or minimum distance recorded between observer and hen during the SPT ($\chi^2 = 0.24$, df = 2; $P = 0.89$).

Behavioural observations at pop-holes were performed on eight farms. The categories for behaviour are shown in Table 1. The pop-holes on the three remaining farms were closed at the time of the visit due to unfavourable weather conditions and predator issues. Walking (through the pop-hole), standing and foraging were the most commonly observed behaviours (Table 3). Walking was primarily observed on six of the farms, and standing and foraging were mainly observed on four of these. Pop-hole activity was in general low on the two remaining farms.

Standing and foraging were the state behaviours most commonly observed during 5 min continuous group observations in the litter area (Figure 1). Comfort behaviours were observed in all flocks, although the number of observations varied, while aggressive behaviours and feather pecking were rarely or never observed (Figure 2).

Table 3. Median (per pop-hole and per farm) number of observations of behaviours recorded during group behavioural observations (3 min per pop-hole) at pop-holes ($n = 16$) on organic laying hen farms ($n = 8$). Median (min-max) pop-hole width: 128 (110–200) cm.

Behaviour[1]	Total number of pop-holes	Median (min-max) per pop-hole	Total number of farms	Median (min-max) per farm
Walking	16	12.5 (2–76)	8	25.5 (7–104)
Standing	15	8 (0–21)	8	18 (1–36)
Foraging	12	5 (0–21)	7	11.5 (0–35)
Walking (along)	6	0 (0–3)	5	1 (0–4)
Turning back in	3	0 (0–3)	2	0 (0–4)
Turning back out	3	0 (0–3)	2	0 (0–3)
Sitting	3	0 (0–1)	3	0 (0–1)
Preening	2	0 (0–1)	2	0 (0–1)
Running	1	0 (0–1)	1	0 (0–1)
Aggressive pecking	1	0 (0–1)	1	0 (0–1)

[1]The following behaviours were not observed on any of the farms: flying, resting, wing stretching, leg stretching, dust bathing, gentle feather pecking, or severe feather pecking.

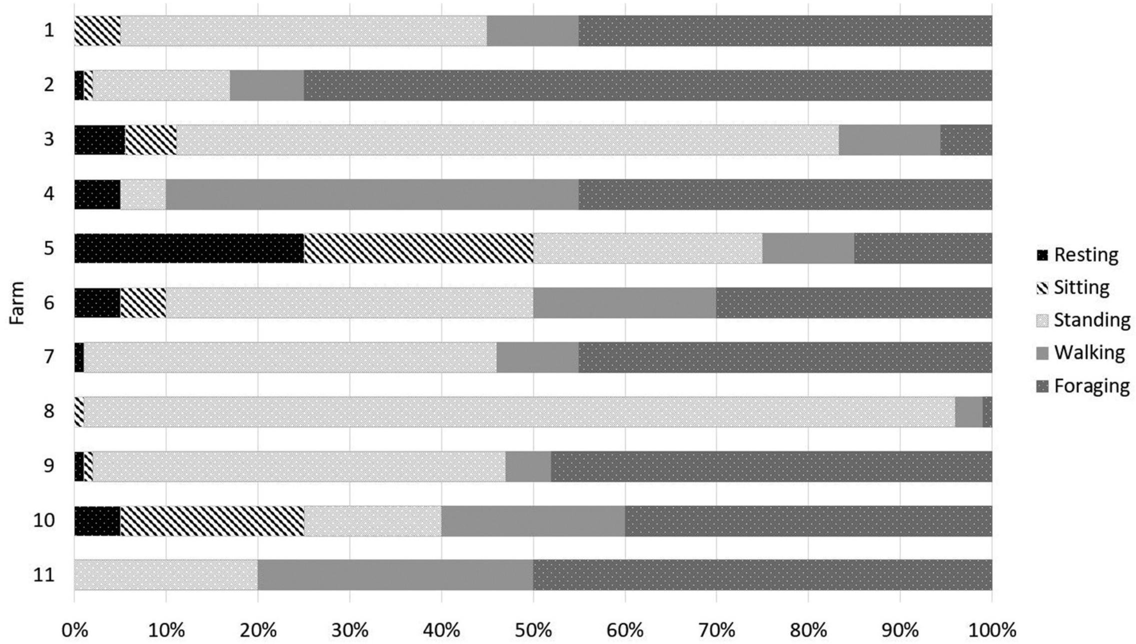

Figure 1. Estimated proportion (%) of birds observed performing different state behaviours (overall assessment of the majority behaviour for each bird during a five-minute period) during continuous group behavioural observations on organic laying hen farms (n = 11). Hens on farms 5, 8 and 9 had no outdoor access at the time of observations.

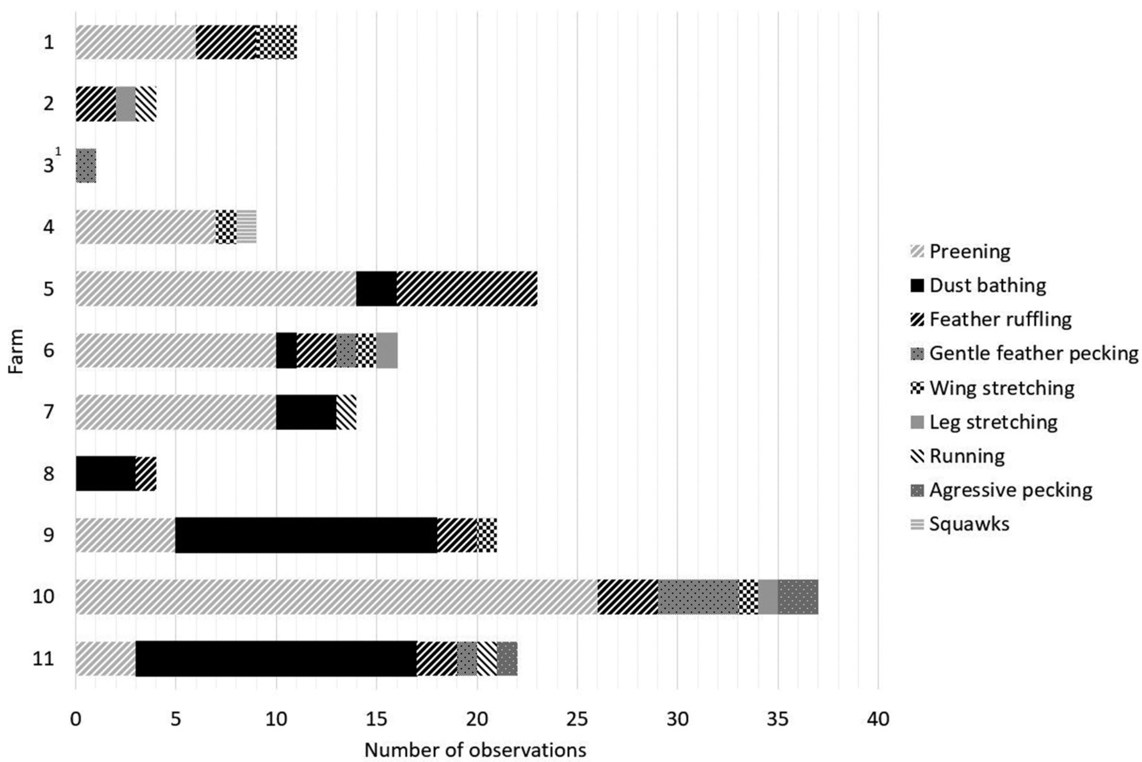

Figure 2. Number of observations (counts) of different event behaviours seen during continuous (five minutes per flock) group behavioural observations on organic laying hen farms (n = 11). Hens on farm 5, 8 and 9 had no outdoor access at the time for observations. [1]Large number of birds (estimated proportion 10%) preening not included. On one farm, the large number of birds preening made it impossible to count individual occurrences and the percentage of birds preening on this farm was estimated at 10%.

The number of dust bathing observations also varied between flocks, and there was a significant association between litter depth and the number of dust bathing events observed per farm (χ^2 7.32, d 1; P = 0.007). With increasing litter depth, the number of dust bathing events per group was greater, in correspondence with the greater number of locations in which dust bathing occurred demonstrated above (litter use).

Clinical examinations

The scoring protocol for clinical examinations is shown in Table 2.

Clinical examinations of 50 birds per flock were performed on all farms but one ($n = 10$). The average (mean ± SD) hen body weight was 1778 ± 162 g for the white hybrids, and 2041 ± 163 g for the brown hybrid.

Plumage damage was especially prevalent and most severe on the breast and belly, and tail, with median prevalence of plumage damage scores ≥3 per flock of 96 (84–100) % and 96% (72–100%), respectively. Most birds had moderate to severe plumage damage to the wings (score 2–4), for which the median prevalence per flock was 98% (94–100%). Plumage damage to the head and neck, and back and rump, was generally less severe and varied more between flocks (Table 4). The data from one flock were excluded due to (natural) moulting.

The median prevalence of dirty plumage (score ≥1) was 71% (0–100%). The majority of these hens (72%) had slightly dirty plumage (score 1; Table 5). Birds with moderate and very dirty plumage (score ≥2) were found predominantly on three of the farms. Skin lesions (score ≥1) were most severe and most common on the belly and cloaca, with a median prevalence of

Table 4. Prevalence (%) of plumage damage per flock ($n = 50$ birds per flock) on organic laying hen farms ($n = 9$): Median and range (min-max). Score 0–5 means no-severe damage.

	Score	Median	Min	Max
Head and neck	0	18.0	4.0	72.0
	1	25.6	12.0	56.0
	2	16.0	0.0	36.0
	3	14.0	0.0	42.0
	4	2.0	0.0	31.7
	5	0.0	0.0	0.0
Back and rump	0	12.2	2.0	76.2
	1	12.0	0.0	28.0
	2	12.0	0.0	42.0
	3	16.0	4.8	32.0
	4	20.0	0.0	62.0
	5	2.0	0.0	14.0
Tail	0	0.0	0.0	0.0
	1	0.0	0.0	4.0
	2	4.0	0.0	28.0
	3	10.0	0.0	56.0
	4	60.0	20.0	90.0
	5	10.0	0.0	46.0
Wings	0	0.0	0.0	0.0
	1	2.0	0.0	6.0
	2	50.0	8.0	60.0
	3	40.0	28.0	52.0
	4	10.0	4.0	56.0
	5	0.0	0.0	2.0
Breast and belly	0	0.0	0.0	4.0
	1	0.0	0.0	4.1
	2	0.0	0.0	14.0
	3	8.0	2.0	54.0
	4	60.0	36.0	86.0
	5	14.0	0.0	38.0

Table 5. Prevalence (%) of integument lesions per flock ($n = 50$ birds per flock) on organic laying hen farms ($n = 10$): Median and range (min-max). Score 0 = no lesions, and score 3 (plumage cleanliness), score 4 (skin lesions), score 2 (comb pecking wounds) = severe lesions. For breast skin lesions, score 0 = no lesions and score 1 = lesions.

		Score	Median	Min	Max
Plumage cleanliness		0	29.0	0.0	100.0
		1	48.0	0.0	96.0
		2	4.0	0.0	70.0
		3	0.0	0.0	10.0
Skin lesions	Head and neck[1]	0	100.0	96.0	100.0
		1	0.0	0.0	4.0
	Back and rump[2]	0	99.0	74.0	100.0
		1	1.0	0.0	20.0
		2	0.0	0.0	6.0
	Tail[2]	0	100.0	96.0	100.0
		1	0.0	0.0	4.0
		2	0.0	0.0	2.0
	Belly and cloaca	0	96.0	60.0	100.0
		1	4.0	0.0	26.0
		2	2.0	0.0	16.0
		3	0.0	0.0	2.0
		4	0.0	0.0	2.0
Comb pecking wounds		0	62.0	42.0	86.0
		1	36.0	12.0	58.0
		2	1.0	0.0	8.0
Breast skin lesions		0	43.4	26.0	90.0
		1	56.6	10.0	74.0

[1]No birds with score ⩾2. [2]No birds with score ⩾3.

4% (0–40%; Table 5). The affected birds were predominantly found in four of the flocks, in which the majority (97%) of the birds with lesions on the back and rump (score ≥1) were observed. There were significant positive associations between skin lesions and plumage damage on the back and rump (χ^2 = 64.82, df = 10; $P < 0.001$), and between skin lesions on the belly and cloaca and plumage damage on the breast and belly (χ^2 = 55.80, df = 20; $P < 0.001$). All birds with skin lesions (score ≥1) also had moderate to severe plumage damage (score ≥3) on the corresponding body part. Comb pecking wounds were observed in all flocks (Table 5). Breast skin lesions, which appeared as brown or black scabs and/or a focal thickening and reddening of the skin overlying the keel bone, were observed in 50.5% of the hens and in all flocks (Table 5). There was a significant association between body weight and such lesions (χ^2 = 13.30, df = 1; $P < 0.001$), with every 100 g increase in body weight resulting in a 36% increase in odds of breast skin lesions (statistical model including Bovans White hybrid only).

Keel bone deviations were observed in all flocks. The median prevalence of minor-moderate deviations (score 1) and severe deviations (score 2) per flock was 24% (16–39%) and 44% (12–66%), respectively. There was no significant association between body weight and keel bone deviation (χ^2 = 1.08, df = 1; $P = 0.30$). However, there was a significant positive association between keel bone deviation and breast skin lesions (χ^2 = 8.06, df = 2; $P = 0.02$). Fractures were observed in eight flocks. The median prevalence of fractures per flock was 3% (0–8%).

The majority of the birds (71.5%) observed showed hyperkeratosis (score ≥1). The median prevalence of birds with minor evidence of hyperkeratosis (score 1) and severe lesions (score 2) per flock was 35% (0–58%) and 33% (8–96%), respectively. There was a significant positive association between hyperkeratosis and breast skin lesions (χ^2 = 14.00, df = 2; $P < 0.001$). There was no significant association between litter depth and the prevalence of hyperkeratosis (score ≥1) (χ^2 = 0.87, df = 2; $P = 0.65$). However, there was a significant positive association between litter depth and prevalence of severe hyperkeratosis (χ^2 = 11.84, df = 2; $P = 0.003$), with the prevalence being lower in flocks where litter depth was scored as thick (score 2).

The median prevalence of birds per flock with foot pad dermatitis (bumble foot) scores 1 and 2 was 10 (0–22) % and 3 (0–10) %, respectively. There was a significant positive association between foot pad dermatitis (bumble foot) and breast skin lesions (χ^2 = 7.40, df = 2; $P = 0.03$).

Birds missing one toe and/or claw (score 1) were observed in seven flocks and the median prevalence per flock was 3% (0–18%). No birds were missing two or more toes and/or claws. Less than three toe wounds (score 1) in three birds and three or more toe wounds (score 2) in another three birds were observed across three of the flocks.

The median prevalence of birds per flock observed with diarrhoea was 11% (0–48%). No birds were observed with signs of respiratory infection. For all other parameters (eye pathologies, enlarged crop, breast skin haematoma, comb colour and comb dehydration), no more than one bird per farm was found during clinical inspections.

Discussion

This study investigated animal welfare in terms of bird health and behaviour on commercial organic laying hen farms in Sweden. On-farm studies are important in order to gain knowledge about the welfare of animals in a commercial production context (Dawkins 2012), not least because the heterogeneity between farms can never be studied under experimental conditions. Important aspects of poultry production that ultimately affect bird welfare at the farm level, such as genetics, housing and management, may change over time, and so the findings of the present study were compared with those in previous studies. An epidemiological study, including organic laying hens in Sweden, was performed almost 10 years ago as part of a larger European study (Bestman et al. 2017; Jung et al. 2019, 2020). There are in general a limited number of studies of this kind, comprising on-farm observations and a relatively broad range of welfare parameters, within Europe (Bestman and Wagenaar 2014).

The participating farms in the present study ($n = 11$) represented approximately 11% of the total number of organic laying hen farms in Sweden (Swedish Board of Agriculture 2022b), and about 17% of the organic farms that are also certified according to KRAV® standards (Dinwiddie, pers. comm., 11 August, 2022). The median size of these KRAV-certified farms corresponds very well with that of farms included in the present study, which may therefore be considered to comprise a representative sample for assessing the current welfare status on organic laying hen farms in Sweden. Moreover, around 88% of the total number of hens in Sweden (organic and non-organic) are found on farms located in the southern third of the country, where all farms included in the present study were located (Swedish Board of Agriculture 2022a).

A large proportion of the ADT trials performed were unsuccessful, i.e. the birds distanced themselves from the observer before the test could be completed. Such an avoidance reaction is considered specifically to reflect fearfulness of humans (Graml, Waiblinger, and Niebuhr 2008). During the 12 successful ADT trials, the median distance at which birds moved away was 90 cm, which was somewhat higher than the 50–60 cm flight distance (i.e. estimated distance at which a group of hens moved away when approached) observed previously in various brown and white hybrids in commercial free-range flocks (Hegelund and Sørensen 2007; Whay et al. 2007). The remaining 219 trials in the present study were unsuccessful and the birds moved away much earlier than this. The results of both the aforementioned studies and the present study indicate a relatively high fear of humans in the birds, which may reduce their welfare. In contrast, Graml et al. (2008) were able to approach hens within 35–40 cm when on a commercial free-range farm where the hens had received only minimal human contact during standard management routines. However, those flocks comprised only 500 birds, which may have enabled a greater habituation to human presence, compared with much larger flocks where individuals would be in close proximity with humans less frequently (Jones 1993). Graml et al. (2008) studied brown hens, which are usually considered less fearful and flighty compared to white hybrids (Odén, Keeling, and Algers 2002; Rentsch, Ellis, and Widowski 2023). Indeed, half of the successful ADT trials in the present study were performed in the only flock with brown hens (all other flocks had white hybrids), in which all hens counted within arm's length during the STP were also observed. The farmer of that flock spent more time with the hens (at least 2 or 3 hours per day, compared with relatively short routine daily inspections of the birds in the other flocks), which could have reduced fearfulness of humans in this flock (Graml, Waiblinger, and Niebuhr 2008).

The large proportion of NOT trials in which no hens approached, and the low number of hens approaching in total, may indicate a relatively high general fearfulness (Christensen et al. 2021). Comparable results were found in another study of organic laying hens (Hegelund and Sørensen 2007), and Donaldson and O'Connell (2012) reported a similar hesitation in birds (brown hybrids) to approach and peck at a novel object. In a study assessing reactions to a novel object using a Visual Analogue Scale, it was concluded that the hens (predominantly brown hybrids) tended to be interested, rather than avoiding the object (Whay et al. 2007). Most birds showed interest in (i.e. looked at and circled around) the novel object in the present study, yet clearly hesitated to approach it (i.e. a low number of hens per trial approached). Early experiences may influence general fearfulness in laying hens, as may exposure to a more complex environment, such as free-range (Grigor, Hughes, and Appleby 1995). Genetics is another important factor, and white hybrids (as were most common in the present study) have been shown to have a higher approach rate than brown hens during NOT (Rentsch, Ellis, and Widowski 2023). It has been suggested that more fearful birds may be less prone to use a free-range area, although the direction of this relationship is unconfirmed (Campbell et al. 2016). The seemingly high levels of fearfulness among the hens in the present study might reflect or result in low use of the outdoor area. Indeed, observations from the outdoor areas, which are reported elsewhere (Göransson et al. 2023), indicated limited range use by the hens in the present study.

During the group behavioural observations in the litter area, a large proportion of hens were observed standing still. Layers in loose-housing systems have previously been shown to spend a large part of their day standing idle (Gunnarsson et al. 1995), especially with increasing age (Channing, Hughes, and Walker 2001). However, considering inactive birds often looked directly at the observer in the present study, it was possible that the presence of this person influenced the birds' behaviour during data collection and that this behaviour should have been recorded as vigilance (Evans, Evans, and Marler 1993).

Foraging, which is imperative for hen welfare (Weeks and Nicol 2006), was commonly observed in most flocks, although the proportion varied widely. The hens sometimes clustered at a distance from the observer, and the aforementioned variation may have been due to differences in terms of stocking density within the particular area observed (Channing, Hughes, and Walker 2001), which has been negatively associated with locomotion and foraging (Thuy Diep, Larsen, and Rault 2018). The variation between flocks may have reflected the extent to which the outdoor area was used, since laying hens have been shown to prefer the outdoors over indoors for foraging (Campbell et al. 2017; Thuy Diep, Larsen, and Rault 2018). The same factors may have influenced the number of observations of hens preening, which was high in some of the flocks, as preening has been shown to increase with a higher number of flock mates, as well as being performed indoors rather than outdoors (Thuy Diep, Larsen, and Rault 2018). The number of hens observed dust bathing, a behaviour used as a positive welfare indicator (McGrath et al. 2017), was significantly higher on farms with a relatively thick litter cover. Dust bathing activity increases when litter quality is good, i.e. dry and friable (Odén, Keeling, and Algers 2002), but there is also an evident need for sufficient amounts of substrate for this behavioural sequence to be fully performed (Edgar et al. 2013). Moreover, laying hens prefer different substrates for dust bathing, e.g. peat over wood shavings (de Jong, Wolthuis-Fillerup, and van Reenen 2007). In the present study, the bedding on all farms consisted of wood shavings (mixed with sand on one farm) to which feather, dust and dry manure were added over time, and thus dust bathing substrates were similar across the study flocks. Although it is unknown whether the hens in the flocks on no, or only a very thin, layer of litter experienced dust bathing frustration (Vestergaard 1982), negative welfare consequences of completely removing the litter (e.g. to avoid floor eggs) at intervals cannot be excluded, especially during periods without outdoor access. Since dust bathing is often performed in a synchronised manner and during a certain time of the day (Campbell et al. 2016; Odén, Keeling, and Algers 2002), the time at which behavioural observations were performed in the different flocks may have influenced the likelihood of dust bathing, although no such clear effect was discerned in the present study.

Pop-holes were mainly used for moving between the indoor and outdoor environments, although birds were observed standing and foraging in, or adjacent to, pop-holes. Considering that the sampling method in the present study encompassed no more than a total of 6 min per farm, it must be acknowledged that outdoor weather conditions and time of day would have had an influence (Richards et al. 2011). However, previous studies have found that laying hens use the pop-hole area for behaviours other than just going in or out (Thuy Diep, Larsen, and Rault 2018), and often remain sitting in the pop-holes (Harlander-Matauschek et al. 2006; Richards et al. 2011). Laying hens show diurnal rhythm and synchronised behaviour within the flock and may use resources such as pop-holes simultaneously (Odén, Keeling, and Algers 2002). Crowding in the pop-holes might be expected to result in agonistic behaviour, but aggressive pecking or birds turning back in or out were rarely observed, in agreement with previous findings (Hughes et al. 1997). However, comb wounds and plumage damage to the head were seen in all flocks, which may indicate aggressive pecking (Bilcík and Keeling 1999), although not necessarily in the pop-holes.

Health

The prevalence and magnitude of plumage damage, considered to be a good indicator of severe feather pecking, suggested that severe feather pecking occurred in all flocks in the present study (Bilcík and Keeling 1999), as did plumage damage to multiple body parts commonly observed in individual hens (Lambton et al. 2010). Discrepancies in scoring method and assessment criteria, presentation of results and age of hens hinder direct comparison with findings from other on-farm studies of organic laying hens. However, previous studies have reported marked plumage damage (Bestman and Wagenaar 2014; Bestman et al. 2017; Grafl et al. 2017) with considerable variation between flocks and farms (Hegelund, Sørensen, and Hermansen 2006; Jung et al. 2020). Despite considerable research, feather pecking remains a main welfare issue in non-cage systems, whether organic or non-organic (Grafl et al. 2017; Riber and Hinrichsen 2017; Schwarzer et al. 2021). Insufficient dietary protein content, in particular the amino acids methionine and cysteine, is a risk factor specific to organic egg production and welfare due to the ban on use of synthetic amino acids (Rodenburg et al. 2013; van Krimpen et al. 2016). However, in the present study, it was not possible to record the diet and feed consumption of the individual flocks. On the contrary, free-ranging has been shown to have a protective effect against severe feather pecking (Bestman and Wagenaar 2014; Bestman et al. 2017; Lambton et al. 2010). Organic poultry in Sweden rarely have outdoor access during winter (Göransson et al. 2021, 2023), and observations from the outdoor areas indicated limited range use by the hens in the present study, which suggested that any protective effect of free-ranging may have been limited (Bestman and Wagenaar 2003). On five of the farms, roughage was provided only during periods without outdoor access, as opposed to year-round on the other six farms. During periods with outdoor access for the former group, individuals that never or rarely entered the free-range area despite the opportunity to do so (Richards et al. 2011), were thus not provided with additional enrichment and a source of fibre, which has been shown to protect against feather pecking (Steenfeldt, Kjaer, and Engberg 2007). The litter on the farms in the present study was in general dry and friable and thus suitable for foraging, although was sometimes removed without replacement during a production cycle on three of the farms, which could potentially predispose feather pecking (Rodenburg et al. 2013).

The average prevalence of keel bone deviations (score ≥1) per flock was 65%, which was similar to the 66% previously reported for Swedish organic laying hens in aviary systems (Jung et al. 2019), a figure that raises concern for bird welfare. However, the latter figure included both deviations (>0.5 cm) and fractures (Jung et al. 2019). The average prevalence of keel bone deviations in the present study was higher than the 44.5% found across all flocks from the different European countries included in the previous study (Jung et al. 2019). Those flocks were younger (52–73 weeks of age) than in the present study (73–78 weeks of age), and the prevalence of deviations has indeed been shown to increase with age (Heerkens et al. 2016). The mean prevalence of keel bone fractures per flock found in the present study (3.4%) was considerably lower than the average 11.6–87.5% previously found in organic and free-range laying hens (Riber and Hinrichsen 2016; Richards et al. 2012; Thøfner et al. 2021). This difference may be explained by the limitations associated with using external palpation for the detection of fractures (Thøfner et al. 2021). Moreover, considering the high prevalence of keel bone deviations found in this study, the relatively low prevalence of fractures was likely an underestimation, especially since more severe deviations may be correlated to fractures (Thøfner et al. 2021).

Breast skin lesions were observed in half of all hens examined and in all flocks. Such lesions have rarely been described previously in laying hens. However, Steenfeldt and Nielsen (2015) found breast blisters, although these lesions were not described in detail, and redness in up to 25% of loose-housed hens in an experimental study, and Gunnarsson et al. (1995) reported low prevalence of breast skin lesions in the form of folliculitis and bursitis in loose-housed hens. Breast blisters may refer to enlarged sternal bursas, which can result from prolonged friction or pressure, especially in individuals with poor feather cover (Miner and Smart 1975), as found in the present study. The pathogenesis of skin lesions observed in the present study is unknown, as are the ensuing welfare implications, warranting further research. Gunnarsson et al. (1995) did not find any association between breast skin lesions and keel bone deviations, in contrast to the results of the present study, in which there was also a significant association between breast skin lesions and hyperkeratosis and foot pad dermatitis. This could suggest a common risk factor and should be further explored.

Hyperkeratosis, i.e. thickening of the skin of the foot pads, was observed in all flocks. The prevalence of excessive hyperkeratosis (score 2) was lower in flocks housed on a thick layer of litter (score 2), perhaps because this prevented contact with the cement floor while ground scratching. These hens may have been motivated to spend more time in the litter area and less time on the slatted floor or perches, which have been suggested to cause hyperkeratosis through prolonged excessive mechanical pressure exerted on the foot pads (Weitzenbürger et al. 2006). Whether severe hyperkeratosis in laying hens causes discomfort during e.g. perching should be considered in future studies. The average prevalence of hyperkeratosis (71.5%) found in this study was higher than previously reported (33.5%) in free-range flocks (Heerkens et al. 2016). Outdoor access has been associated with a lower prevalence of hyperkeratosis (Heerkens et al. 2016), as well as a positive (Rodriguez-Aurrekoetxea and Estevez 2016) or negative (Grafl et al. 2017) effect on foot pad dermatitis in laying hens. However, free-range use and local terrain and ground conditions, which may change with season and weather conditions, are likely to determine how outdoor access influences foot health in poultry (Heerkens et al. 2016). As reported by farmers in present and previous studies (Göransson, Yngvesson, and Gunnarsson 2020), wet and muddy ground conditions outdoors may cause poor (moist) litter quality indoors, which may be associated with foot pad dermatitis in laying hens (Wang, Ekstrand, and Svedberg 1998). Litter quality was, in general, found to be dry and friable and less likely to be a predisposing factor for such lesions observed in the present study. The average prevalence of foot pad dermatitis per flock (11.0%) was within the quite wide range (4.8-52.2%) previously reported as pad lesions in organic laying hens (Bestman and Wagenaar 2014; Grafl et al. 2017; Jung et al. 2020; Riber and Hinrichsen 2016). However, the use of different definitions and scoring methods for macroscopic assessment of foot pads in laying hens complicates any comparison. The average prevalence of bumble foot (3%) was nevertheless similar to previous findings for free-range laying hens (Bestman and Wagenaar 2014; Heerkens et al. 2016; Riber and Hinrichsen 2016).

Limitations of the study

The 11 farms included in this study comprised a reasonable sample to represent current organic egg production in Sweden, but the low number prevented further data analysis. Farm visits were limited to one day on each farm and behavioural observations to a certain time of day. The latter varied somewhat between farms for logistical reasons and might have influenced observations of e.g. behaviours, such as dust bathing, which are often performed during a certain time of the day. Repeated observations, within flocks and in more than one flock per farm, were not possible but would have enabled observations in a broader context, e.g. across flocks and different weather conditions. The sampling method used for behavioural observations was intended to give an overview of hen activity, but again, the limited number of flocks and farms did not allow for any further analysis of the large variation between flocks. Since participation was completely voluntary, the sample of farms might have been somewhat biased, e.g. the flocks included might have been healthier. The farm visits were planned so that the flocks were around the same age at the time of data collection, which therefore occurred during spring, summer and throughout autumn. This seasonal difference and associated weather variation could have had an effect on e.g. foot health and on behavioural observations, as some flocks did not have outdoor access at the time of visit.

Conclusions

The present study contributes with updated knowledge of laying hen welfare, in terms of health and behaviour, in a commercial context on organic farms in Sweden. The results indicated a high level of general fearfulness, but also pronounced fearfulness of humans, suggesting that large flocks and a limited amount of time spent among the hens on a daily basis may impede positive human-animal interactions. Dust bathing might have been temporarily hindered on some farms due to removal of the litter at intervals and this management routine may have had welfare implications, especially during periods without outdoor (and dust bathing substrate) access. The hens were frequently observed foraging and standing in the pop-holes, which did not appear to generate aggressive behaviour, despite rather high bird density in the area. The prevalence and magnitude of plumage damage demonstrated that severe feather pecking remains a welfare issue also in organic production, despite provision of outdoor access and roughage. The keel bone damage observed confirmed that such problems continue to be a major welfare issue in commercial egg production. Breast skin lesions, rarely described previously in laying hens, were common and found in all flocks, and further research is needed to identify the pathogenesis and welfare implications. The results from the present study show that common welfare issues in laying hens remain unresolved in practice. For future commercial egg production to be socially sustainable, novel solutions may be needed.

Acknowledgments

The authors would like to acknowledge Anne Larsen and Gunilla Jacobsson for their assistance with on-farm data collection, Jesper Rydén and Viktor Almqvist for their help with the statistical analysis, Åsa Odelros for much appreciated help and expertise, and the farmers who participated in the study.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This work was supported by the Coordination of European Transnational Research in Organic Food and Farming Systems [727495]; Svenska Forskningsrådet Formas [2017-01850].

ORCID

L. Göransson http://orcid.org/0000-0001-9664-6487
S. Abeyesinghe http://orcid.org/0000-0002-9977-7949
J. Yngvesson http://orcid.org/0000-0003-3123-2229
S. Gunnarsson http://orcid.org/0000-0002-9126-1905

References

Augère-granier, M. L. 2019. "The EU Poultry Meat and Egg Sector. Main Features, Challenges and Prospects." European Parliamentary Research Service (EPRS). https://www.europarl.europa.eu/thinktank/en/document/EPRS_IDA(2019)644195.

Bestman, M., C. Verwer, C. Brenninkmeyer, A. Willett, L. K. Hinrichsen, F. Smajlhodzic, J. L. T. Heerkens, S. Gunnarsson, and V. Ferrante. 2017. "Feather-Pecking and Injurious Pecking in Organic Laying Hens in 107 Flocks from Eight European Countries." *Animal Welfare* 26 (3): 355–363. https://doi.org/10.7120/09627286.26.3.355.

Bestman, M., and J. P. Wagenaar. 2014. "Health and Welfare in Dutch Organic Laying Hens." *Animals (Basel)* 4 (2): 374–390. https://doi.org/10.3390/ani4020374.

Bestman, M. W. P., and J. P. Wagenaar. 2003. "Farm Level Factors Associated with Feather Pecking in Organic Laying Hens." *Livestock Production Science* 80 (1): 133–140. https://doi.org/10.1016/S0301-6226(02)00314-7.

Bilcík, B., and L. J. Keeling. 1999. "Changes in Feather Condition in Relation to Feather Pecking and Aggressive Behaviour in Laying Hens." *British Poultry Science* 40 (4): 444–451. https://doi.org/10.1080/00071669987188 .

Campbell, D. L. M., G. N. Hinch, J. A. Downing, and C. Lee. 2016. "Fear and Coping Styles of Outdoor-Preferring, Moderate-Outdoor and Indoor-Preferring Free-Range Laying Hens." *Applied Animal Behaviour Science* 185:73–77. https://doi.org/10.1016/j.applanim.2016.09.004.

Campbell, D. L. M., G. N. Hinch, J. A. Downing, and C. Lee. 2017. "Outdoor Stocking Density in Free-Range Laying Hens: Effects on Behaviour and Welfare." *Animal* 11 (6): 1036–1045. https://doi.org/10.1017/S1751731116002342.

Campbell, D. L. M., M. M. Makagon, J. C. Swanson, and J. M. Siegford. 2016. "Litter Use by Laying Hens in a Commercial Aviary: Dust Bathing and Piling." *Poultry Science* 95 (1): 164–175. https://doi.org/10.3382/ps/pev183.

Channing, C. E., B. O. Hughes, and A. W. Walker. 2001. "Spatial Distribution and Behaviour of Laying Hens Housed in an Alternative System." *Applied Animal Behaviour Science* 72 (4): 335–345. https://doi.org/10.1016/S0168-1591(00)00206-9 .

Christensen, J. W., L. P. Ahrendt, J. Malmkvist, and C. Nicol. 2021. "Exploratory Behaviour Towards Novel Objects is Associated with Enhanced Learning in Young Horses." *Scientific Reports* 11 (1): 1428. https://doi.org/10.1038/s41598-020-80833-w.

Daigle, C. L. 2017. "Controlling Feather Pecking and Cannibalism in Egg Laying Flocks." Chap. 11 in *Egg Innovations and Strategies for Improvements*, 111–121. San Diego, Nottingham, UK: Academic Press. https://doi.org/10.1016/B978-0-12-800879-9.00011-1.

Dawkins, M. S. 2012. "Commercial Scale Research and Assessment of Poultry Welfare." *British Poultry Science* 53 (1): 1–6. https://doi.org/10.1080/00071668.2011.628640.

de Jong, I. C., M. Wolthuis-fillerup, and C. G. van Reenen. 2007. "Strength of Preference for Dustbathing and Foraging Substrates in Laying Hens." *Applied Animal Behaviour Science* 104 (1–2): 24–36. https://doi.org/10.1016/j.applanim.2006.04.027.

Donaldson, C. J., and N. E. o'connell. 2012. "The Influence of Access to Aerial Perches on Fearfulness, Social Behaviour and Production Parameters in Free-Range Laying Hens." *Applied Animal Behaviour Science* 142 (1): 51–60. https://doi.org/10.1016/j.applanim.2012.08.003.

Edgar, J. L., S. M. Mullan, J. C. Pritchard, U. J. McFarlane, and D. C. Main. 2013. "Towards a 'Good Life' for Farm Animals: Development of a Resource Tier Framework to Achieve Positive Welfare for Laying Hens." *Animals (Basel)* 3 (3): 584–605. https://doi.org/10.3390/ani3030584.

EU (Commission Implementing Regulation). 2020. "2020 /464 of 26 March 2020 Laying Down Certain Rules for the Application of

Regulation (EU) 2018/848 of the European Parliament and of the Council as Regards the Documents Needed for the Retroactive Recognition of Periods for the Purpose of Conversion, the Production of Organic Products and Information to Be Provided by Member States." OJ L 98, 2–25, March 31.

EU (Regulation). 2018. "2018 /848 of the European Parliament and of the Council of 30 May 2018 on organic production and labelling of organic products and repealing Council Regulation (EC) No 834/ 2007." OJ L 150, 1–92, June 14.

Evans, C. S., L. Evans, and P. Marler. 1993. "On the Meaning of Alarm Calls: Functional Reference in an Avian Vocal System." *Animal Behaviour* 46 (1): 23–38. https://doi.org/10.1006/anbe.1993.1158.

FAOSTAT. 2022. "FAOSTAT Data." Accessed September 28, 2022. https://www.fao.org/faostat/en/#data.

Fraser, D., D. M. Weary, E. A. Pajor, and B. N. Milligan. 1997. "A Scientific Conception of Animal Welfare That Reflects Ethical Concerns." *Animal Welfare* 6 (3): 187–205. https://doi.org/10.1017/S0962728600019795.

Gentle, M. J., and L. N. Hunter. 1991. "Physiological and Behavioural Responses Associated with Feather Removal in *Gallusgallus* Var *domesticus*." *Research in Veterinary Science* 50 (1): 95–101. https://doi.org/10.1016/0034-5288(91)90060-2.

Göransson, L., S. Abeyesinghe, S. Gunnarsson, and J. Yngvesson. 2023. "Easier Said Than Done! Organic Farmers Consider Free-Ranging Important for Laying Hen Welfare but Outdoor Areas Need More Shelter – Important Gaps Between Research and Practice." *British Poultry Science in Press* 1–8. https://doi.org/10.1080/00071668.2023.2220650.

Göransson, L., S. Gunnarsson, A. Wallenbeck, and J. Yngvesson. 2021. "Behaviour in Slower-Growing Broilers and Free-Range Access on Organic Farms in Sweden." *Animals* 11 (10): 2967. https://doi.org/10.3390/ani11102967.

Göransson, L., J. Yngvesson, and S. Gunnarsson. 2020. "Bird Health, Housing and Management Routines on Swedish Organic Broiler Chicken Farms." *Animals* 10 (11): 2098. https://doi.org/10.3390/ani10112098.

Grafl, B., S. Polster, T. Sulejmanovic, B. Pürrer, B. Guggenberger, and M. Hess. 2017. "Assessment of Health and Welfare of Austrian Laying Hens at Slaughter Demonstrates Influence of Husbandry System and Season." *British Poultry Science* 58 (3): 209–215. https://doi.org/10.1080/00071668.2017.1280723.

Graml, C., S. Waiblinger, and K. Niebuhr. 2008. "Validation of Tests for On-Farm Assessment of the Hen–Human Relationship in Non-Cage Systems." *Applied Animal Behaviour Science* 111 (3): 301–310. https://doi.org/10.1016/j.applanim.2007.06.002.

Grigor, P. N., B. O. Hughes, and M. C. Appleby. 1995. "Effects of Regular Handling and Exposure to an Outside Area on Subsequent Fearfulness and Dispersal in Domestic Hens." *Applied Animal Behaviour Science* 44 (1): 47–55. https://doi.org/10.1016/0168-1591(95)00576-E.

Gunnarsson, S., K. Oden, B. Algers, J. Svedberg, and L. Keeling. 1995. *Poultry Health and Behaviour in a Tiered System for Loose Housed Layers*. Skara, Sweden: Department of Animal Hygiene, Swedish University of Agricultural Sciences (SLU).

Harlander-matauschek, A., K. Felsenstein, K. Niebuhr, and J. Troxler. 2006. "Influence of Pop Hole Dimensions on the Number of Laying Hens Outside on the Range." *British Poultry Science* 47 (2): 131–134. https://doi.org/10.1080/00071660600610591.

Heerkens, J. L., E. Delezie, B. Ampe, T. B. Rodenburg, and F. A. Tuyttens. 2016. "Ramps and Hybrid Effects on Keel Bone and Foot Pad Disorders in Modified Aviaries for Laying Hens." *Poultry Science* 95 (11): 2479–2488. https://doi.org/10.3382/ps/pew157.

Heerkens, J. L., E. Delezie, T. B. Rodenburg, I. Kempen, J. Zoons, B. Ampe, and F. A. Tuyttens. 2016. "Risk Factors Associated with Keel Bone and Foot Pad Disorders in Laying Hens Housed in Aviary Systems." *Poultry Science* 95 (3): 482–488. https://doi.org/10.3382/ps/pev339.

Hegelund, L., and J. Sørensen. 2007. "Measuring Fearfulness of Hens in Commercial Organic Egg Production." *Animal Welfare* 16 (2): 169–171. https://doi.org/10.1017/S0962728600031250.

Hegelund, L., J. T. Sørensen, and J. E. Hermansen. 2006. "Welfare and Productivity of Laying Hens in Commercial Organic Egg Production Systems in Denmark." *NJAS - Wageningen Journal of Life Sciences* 54 (2): 147–155. https://doi.org/10.1016/S1573-5214(06)80018-7 .

Hughes, B. O., N. L. Carmichael, A. W. Walker, and P. N. Grigor. 1997. "Low Incidence of Aggression in Large Flocks of Laying Hens." *Applied Animal Behaviour Science* 54 (2): 215–234. https://doi.org/10.1016/S0168-1591(96)01177-X.

Jones, B., H. Blokhuis, I. Jong, L. Keeling, T. M. McAdie, and R. Preisinger. 2004. "Feather Pecking in Poultry: The Application of Science in a Search for Practical Solutions." *Animal Welfare* 13 (S1): 215–219. https://doi.org/10.1017/S0962728600014627.

Jones, R. B. 1993. "Reduction of the Domestic Chick's Fear of Human Beings by Regular Handling and Related Treatments." *Animal Behaviour* 46 (5): 991–998. https://doi.org/10.1006/anbe.1993.1280.

Jung, L., C. Brenninkmeyer, K. Niebuhr, M. Bestman, F. A. M. Tuyttens, S. Gunnarsson, J. T. Sørensen, P. Ferrari, and U. Knierim. 2020. "Husbandry Conditions and Welfare Outcomes in Organic Egg Production in Eight European Countries." *Animals* 10 (11): 2102. https://doi.org/10.3390/ani10112102.

Jung, L., K. Niebuhr, L. K. Hinrichsen, S. Gunnarsson, C. Brenninkmeyer, M. Bestman, J. Heerkens, P. Ferrari, and U. Knierim. 2019. "Possible Risk Factors for Keel Bone Damage in Organic Laying Hens." *Animal* 13 (10): 2356–2364. https://doi.org/10.1017/S175173111900003X.

KRAV. 2022. "Standards for KRAV-Certified Production 2022." Accessed September 28, 2022. https://www.krav.se/en/standards/download-krav-standards/.

Lambton, S. L., T. G. Knowles, C. Yorke, and C. J. Nicol. 2010. "The Risk Factors Affecting the Development of Gentle and Severe Feather Pecking in Loose Housed Laying Hens." *Applied Animal Behaviour Science* 123 (1): 32–42. https://doi.org/10.1016/j.applanim.2009.12.010.

Martin, P., and P. Bateson. 2007. *Measuring Behaviour: An Introductory Guide*. 3rd ed. Cambridge, UK: Cambridge University Press. https://doi.org/10.1017/CBO9780511810893.

McGrath, N., R. Dunlop, C. Dwyer, O. Burman, and C. J. C. Phillips. 2017. "Hens Vary Their Vocal Repertoire and Structure When Anticipating Different Types of Reward." *Animal Behaviour* 130:79–96. https://doi.org/10.1016/j.anbehav.2017.05.025.

Mellor, D. J., N. J. Beausoleil, K. E. Littlewood, A. N. McLean, P. D. McGreevy, B. Jones, and C. Wilkins. 2020. "The 2020 Five Domains Model: Including Human–Animal Interactions in Assessments of Animal Welfare." *Animals* 10 (10): 1870. https://doi.org/10.3390/ani10101870.

Miner, M. L., and R. A. Smart. 1975. "Causes of Enlarged Sternal Bursas (Breast Blisters)." *Avian Diseases* 19 (2): 246–256. https://doi.org/10.2307/1588978.

Nasr, M., J. Murrell, L. J. Wilkins, and C. Nicol. 2012. "The Effect of Keel Fractures on Egg-Production Parameters, Mobility and Behavior in Individual Laying Hens." *Animal Welfare* 21 (1): 127–135. https://doi.org/10.7120/096272812799129376.

Odén, K., L. J. Keeling, and B. Algers. 2002. "Behaviour of Laying Hens in Two Types of Aviary Systems on 25 Commercial Farms in Sweden." *British Poultry Science* 43 (2): 169–181. https://doi.org/10.1080/00071660120121364.

R Core Team. 2020. "R: A Language and Environment for Statistical Computing." Vienna, Austria: R Foundation for Statistical Computing. https://www.R-project.org/.

Rentsch, A. K., J. L. Ellis, and T. M. Widowski. 2023. "Fearfulness in Commercial Laying Hens: A Meta-Analysis Comparing Brown and White Egg Layers." *Poultry Science* 102 (6): 102664. https://doi.org/10.1016/j.psj.2023.102664.

Riber, A. B., and L. K. Hinrichsen. 2016. "Keel-Bone Damage and Foot Injuries in Commercial Laying Hens in Denmark." *Animal Welfare* 25 (2): 179–184. https://doi.org/10.7120/09627286.25.2.179 .

Riber, A. B., and L. K. Hinrichsen. 2017. "Welfare Consequences of Omitting Beak Trimming in Barn Layers." *Frontiers in Veterinary Science* 4 (222). https://doi.org/10.3389/fvets.2017.00222.

Richards, G. J., L. J. Wilkins, T. G. Knowles, F. Booth, M. J. Toscano, C. J. Nicol, and S. N. Brown. 2011. "Continuous Monitoring of Pop Hole Usage by Commercially Housed Free-Range Hens Throughout the Production Cycle." *Veterinary Record* 169 (13): 338. https://doi.org/10.1136/vr.d4603.

Richards, G. J., L. J. Wilkins, T. G. Knowles, F. Booth, M. J. Toscano, C. J. Nicol, and S. N. Brown. 2012. "Pop Hole Use by Hens with Different Keel Fracture Status Monitored Throughout the Laying Period." *Veterinary Record* 170 (19): 494–494. https://doi.org/10.1136/vr.100489.

Rodenburg, T. B., M. M. van Krimpen, I. C. de Jong, E. N. de Haas, M. S. Kops, B. J. Riedstra, R. E. Nordquist, J. P. Wagenaar, M. Bestman, and C. J. Nicol. 2013. "The Prevention and Control of Feather Pecking in Laying Hens: Identifying the Underlying Principles." *World's Poultry Science Journal* 69 (2): 361–374. https://doi.org/10.1017/S0043933913000354.

Rodriguez-aurrekoetxea, A., and I. Estevez. 2016. "Use of Space and Its Impact on the Welfare of Laying Hens in a Commercial Free-Range System." *Poultry Science* 95 (11): 2503–2513. https://doi.org/10.3382/ps/pew238.

Rodriguez-aurrekoetxea, A., E. H. Leone, and I. Estevez. 2015. "Effects of Panels and Perches on the Behaviour of Commercial Slow-Growing Free-Range Meat Chickens." *Applied Animal Behaviour Science* 165:103–111. https://doi.org/10.1016/j.applanim.2015.02.004.

Schwarzer, A., C. Plattner, S. Bergmann, E. Rauch, M. Erhard, S. Reese, and H. Louton. 2021. "Feather Pecking in Non-Beak-Trimmed and Beak-Trimmed Laying Hens on Commercial Farms with Aviaries." *Animals* 11 (11): 3085. https://doi.org/10.3390/ani11113085.

SFS 2003:460 "Lag om etikprövning av forskning som avser människor [The Swedish Act Concerning the Ethical Review of Research Involving Humans]." Stockholm, Sweden: Ministry of Education and Research.

SJVFS 2019:9 (Case no L 150). "Statens jordbruksverks föreskrifter och allmänna råd om försöksdjur [The Swedish Board of Agriculture's Regulations on Research Animals]." Jönköping, Sweden: The Swedish Board of Agriculture.

Steenfeldt, S., J. B. Kjaer, and R. M. Engberg. 2007. "Effect of Feeding Silages or Carrots as Supplements to Laying Hens on Production Performance, Nutrient Digestibility, Gut Structure, Gut Microflora and Feather Pecking Behaviour." *British Poultry Science* 48 (4): 454–468. https://doi.org/10.1080/00071660701473857.

Steenfeldt, S., and B. L. Nielsen. 2015. "Welfare of Organic Laying Hens Kept at Different Indoor Stocking Densities in a Multi-Tier Aviary System. II: Live Weight, Health Measures and Perching." *Animal* 9 (9): 1518–1528. https://doi.org/10.1017/S1751731115000725.

Stratmann, A., E. K. F. Fröhlich, A. Harlander-matauschek, L. Schrader, M. J. Toscano, H. Würbel, and S. G. Gebhardt-henrich. 2015. "Soft Perches in an Aviary System Reduce Incidence of Keel Bone Damage in Laying Hens." *PLOS ONE* 10 (3): e0122568. https://doi.org/10.1371/journal.pone.0122568.

Swedish Board of Agriculture. 2022a. "Jordbruksverkets statistikdatabas: Antal djur och jordbruksföretag med djur efter län. År 1981-2021 [Statistical Database: Number of Animals and Agricultural Enterprises with Animals According to County. Year 1981-2021]." Accessed September 28, 2022. https://statistik.sjv.se/PXWeb/pxweb/sv/Jordbruksverkets%20statistikdatabas.

Swedish Board of Agriculture. 2022b. "Jordbruksverkets Statistikdatabas: Antal Omställda Ekologiska Djur, Andel Ekologiskt Hållna Djur och Antal Företag efter Län, Variabel, Djurslag och År. År 2009-2021 [Statistical Database: Number of Organic Animals, Proportion Organic Animals and Number of Enterprises According to County, Variable, Animal Species and Year. Year 2009-2021]." Accessed September 28, 2022. https://statistik.sjv.se/PXWeb/pxweb/sv/Jordbruksverkets%20statistikdatabas/.

Tauson, R., K. Elwinger, K.-E. Holm, and H. Wall. 2006. "Analyses of a Database for Health Parameters in Different Housing Systems." LayWel WP3-Health Deliverables D.3.2-D.3.3. https://www.laywel.eu/web/pdf/deliverables%2031-33%20health-3.pdf.

Thøfner, I. C. N., J. Dahl, J. P. Christensen, and E. Tomaszewska. 2021. "Keel Bone Fractures in Danish Laying Hens: Prevalence and Risk Factors." *PLoS One* 16 (8): e0256105. https://doi.org/10.1371/journal.pone.0256105.

Thuy Diep, A., H. Larsen, and J. L. Rault. 2018. "Behavioural Repertoire of Free-Range Laying Hens Indoors and Outdoors, and in Relation to Distance from the Shed." *Australian Veterinary Journal* 96 (4): 127–131. https://doi.org/10.1111/avj.12684.

van de Weerd, H., R. Keatinge, and S. Roderick. 2009. "A Review of Key Health-Related Welfare Issues in Organic Poultry Production." *World's Poultry Science Journal* 65:649–684. https://doi.org/10.1017/S0043933909000464 .

van Krimpen, M. M., F. Leenstra, V. Maurer, and M. Bestman. 2016. "How to Fulfill EU Requirements to Feed Organic Laying Hens 100% Organic Ingredients." *Journal of Applied Poultry Research* 25 (1): 129–138. https://doi.org/10.3382/japr/pfv048.

Ventura, B. A., F. Siewerdt, I. Estevez, and C. Mettke-hofmann. 2012. "Access to Barrier Perches Improves Behavior Repertoire in Broilers." *PloS One* 7 (1): e29826–e29826. https://doi.org/10.1371/journal.pone.0029826.

Vestergaard, K. 1982. "Dust-Bathing in the Domestic Fowl — Diurnal Rhythm and Dust Deprivation." *Applied Animal Ethology* 8 (5): 487–495. https://doi.org/10.1016/0304-3762(82)90061-X .

Wang, G., C. Ekstrand, and J. Svedberg. 1998. "Wet Litter and Perches as Risk Factors for the Development of Foot Pad Dermatitis in Floor-Housed Hens." *British Poultry Science* 39 (2): 191–197. https://doi.org/10.1080/00071669889114.

Weeks, C. A., and C. J. Nicol. 2006. "Behavioural Needs, Priorities and Preferences of Laying Hens." *World's Poultry Science Journal* 62 (2): 296–307. https://doi.org/10.1079/WPS200598.

Weitzenbürger, D., A. Vits, H. Hamann, M. Hewicker-trautwein, and O. Distl. 2006. "Macroscopic and Histopathological Alterations of Foot Pads of Laying Hens Kept in Small Group Housing Systems and Furnished Cages." *British Poultry Science* 47 (5): 533–543. https://doi.org/10.1080/00071660600963099.

Welfare Quality®. 2009. *Welfare Quality® Assessment Protocol for Poultry (Broilers, Laying Hens)*. Lelystad, The Netherlands: Welfare Quality® Consortium.

Whay, H. R., D. C. Main, L. E. Green, G. Heaven, H. Howell, M. Morgan, A. Pearson, and A. J. Webster. 2007. "Assessment of the Behaviour and Welfare of Laying Hens on Free-Range Units." *Veterinary Record* 161 (4): 119–128. https://doi.org/10.1136/vr.161.4.119.

Zulkifli, I. 2013. "Review of Human-Animal Interactions and Their Impact on Animal Productivity and Welfare." *Journal of Animal Science and Biotechnology* 4 (1): 25. https://doi.org/10.1186/2049-1891-4-25.