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RECOMMENDATIONS FOR THE ON-FARM WELFARE OF LAYING HENS

SUBMISSION TO THE OIE BY THE INTERNATIONAL COALITION FOR ANIMAL WELFARE[1]

January 2017

Introduction

The International Coalition for Animal Welfare (ICFAW) welcomes the decision by the OIE to produce a chapter of the *Terrestrial Animal Health Code* concerning the on-farm welfare of laying hens.

ICFAW's submission focuses on the health and welfare problems that are associated with industrial production. Globally, at least 55% of hens are produced industrially[2] and this proportion is likely to increase as the Food and Agriculture Organization (FAO) reports that industrial animal production systems have been growing rapidly.[3] Such systems do not proactively support—or even enable—management of the animals in a way that respects their individual needs, and hinder the performance of normal behaviour to such an extent that welfare is compromised.

ICFAW prefers hens to be reared in well-designed, well-managed outdoor systems. However, good welfare can be achieved in both indoor and outdoor systems. Key features of systems that can provide good welfare include the ability for hens to lay their eggs in a nest and to carry out perching, foraging (pecking and scratching) and dust-bathing behaviour as well as fresh air, enough space and good lighting. ICFAW is opposed to the use of cages, and works toward an end to beak trimming and much reduced levels of bone fractures and osteoporosis.

ICFAW welcomes the emphasis placed by the OIE on welfare outcomes, but believes that the OIE chapters should give equal weight to resource and management-based inputs, as guidance on how to produce desired outcomes will be helpful to producers. Good inputs, for example regarding nests, perches, litter and stocking density are essential for creating acceptable welfare potential. In addition, good husbandry and management are required for that potential to be fulfilled. In short, the quality of resources and management cannot be ignored as, if these are poor, one cannot expect to achieve good welfare outcomes.

ICFAW hopes that the OIE standards will address the following matters:

Barren battery cages

Modern farmed chickens retain the strong desire to perform the behaviour of their wild ancestors.[4] Scientific research has established that hens have powerful drives to lay their eggs in a nest, forage by ground pecking and scratching, perch and dust-bathe.[5,6] None of this behaviour is possible in a battery cage.[7] The inability to perform strong instinctive behaviour causes great frustration and stress in hens.[8]

One source of frustration is the lack of nesting opportunity.[9] Nesting behaviour is triggered internally by changes in hormone levels,[10,11] and hens are highly motivated to lay their eggs in a private,

secluded nesting location.[12,13] The internal dive to nest remains, even when hens are confined to a battery cage.[14]

The lack of sufficient floor space and height in battery cages reduces welfare by preventing hens from adopting certain postures - such as an erect posture with the head raised - and performing particular movements such as wing flapping and wing stretching.[15,16]

High levels of egg production in today's hens result in the use of excessive calcium for egg shell formation, at the expense of structural bone.[17] This, together with the severe restrictions on movement in battery cages, results in bone weakness and osteoporosis which lead to a high incidence of poor musculoskeletal health, chronic pain and bone breakages at depopulation.[18,19,20]

Battery cages are responsible for a variety of injuries. Foot and claw damage are more frequent in cages than in other systems, with lesions, fissures and hyperkeratosis on the feet and overgrown, twisted or broken claws.[21] Damage to the sole of the feet is caused by the high, localised pressure from thin floor wire.[22] The cages' wire mesh can lead to feather wear.[23] Caged hens, not exposed to new stimuli, and unable to retreat from potential threats, are also more fearful.[24,25,26]

The 2012 EU ban on barren battery cages was based on a report by the European Commission's Scientific Veterinary Committee. The report was highly critical of battery cages, concluding that "It is clear that because of its small size and its barrenness, the battery cage as used at present has *inherent* severe disadvantages for the welfare of hens".[27]

Subsequent reports have reached similar conclusions. A report by the European Food Safety Authority (EFSA) shows that restriction of movement is the main cause of bone fragility in egg laying hens, and that the inability to behave naturally and the high levels of osteoporosis pose a particularly severe threat to the welfare of hens kept in barren battery cages.[28] The *LayWel* report, prepared for the European Commission, concludes that "Conventional cages do not allow hens to fulfil behaviour priorities, preferences and needs for nesting, perching, foraging and dustbathing in particular. The severe spatial restriction also leads to disuse osteoporosis. We believe these disadvantages outweigh the advantages of reduced parasitism, good hygiene and simpler management".[29] The report stresses that "the welfare of laying hens is severely compromised in conventional cages" and that these cages do not have the potential to provide satisfactory welfare.

Increasing move away from cages

Legislative advancements and corporate policy changes are leading a global shift in the egg industry toward cage-free hen housing systems. The use of barren battery cages has been prohibited in the EU since 2012.[30] In the U.S. five States—California, Michigan, Oregon, Washington and

Massachusetts—have prohibited barren battery cages and a sixth –Ohio– has enacted a moratorium against the construction of new battery cage facilities. The Animal Welfare Board of India has issued an advisory to all state governments stating that battery cages should not be used and existing ones should be phased out by 2017.[31] The Australian Capital Territory has prohibited the use of battery cages[32] and Tasmania has prohibited new battery cage operations from 2013.[33]

Many leading national and global food businesses are cage free or are committed to going cage free in the eggs they sell and use. Cage free commitments refer to both battery and enriched cages (see below for a discussion of the limitations of enriched or furnished cages). All of the top 25 U.S. food retailers are now committed to going cage-free within ten years or less.[34] The Retail Council of Canada will be cage-free in its sourcing of eggs by 2025.[35] All the UK's major supermarket chains have now either gone cage free or have pledged to do so.[36] Many leading EU retailers are cage-free.[37] Prominent South African retailer Woolworths sells only free range eggs; they are also changing to free range eggs for food ingredients.[38] All the major retailers in Australia have committed to phasing out cage eggs–Coles (Coles branded eggs), Woolworths, and Aldi.[39,40,41]

McDonald's has pledged to go cage-free in the U.S., Canada and Latin America by 2025.[42,43] McDonald's is already cage free in the EU,[44] and in New Zealand and Australia they have announced they will use only cage-free eggs by the end of 2016 and 2017, respectively. Burger King is committed to being cage-free globally.[45] The company is already cage-free in the EU and aims to become so in the U.S., Canada and Mexico by 2025.

Unilever is committed to being cage-free and 45% of its global egg supply was cage-free in 2015.[46] Nestlé has pledged to only use cage-free eggs in the U.S. by 2020.[47] Sodexo, one of the world's largest food service companies has announced that it will source only cage-free eggs (both shell and liquid) worldwide by 2025.[48] Compass Group, one of the world's leading food and support services companies, has committed to source 100% cage-free eggs (both shell and liquid) globally by 2025.[49]

PepsiCo is committed to using 100% cage-free eggs in North America by 2020 and globally by 2025.[50] Grupo Bimbo, the leading Mexican and global baking company has pledged to eliminate battery cages from its liquid and shell egg supply chain and only purchase cage-free eggs in Mexico and globally by 2025.[51] Starbucks' goal is to be cage-free by 2020.[52] Many other large and small companies—too numerous to list—have made similar commitments and new announcements are being made on a regular basis.

> ***ICFAW recommendation on barren battery cages:*** ICFAW is opposed to the use of barren battery cages during both the rearing and laying periods as they have severe inherent disadvantages for the welfare of hens. The OIE chapter should not endorse the use of barren battery cages; it should make it clear that they are detrimental to hen welfare and cannot deliver acceptable welfare outcomes.

Enriched cages

EU law provides detailed requirements for enriched cages. It stipulates that such cages must provide a minimum floor space of 750cm^2 per hen (600cm^2 of which has to be "usable"). The hens must be provided with perches allowing at least 15cm per hen, a nest and litter "such that pecking and scratching are possible".[53]

Before the EU ban on barren cages came into force these cages legally had to provide 550cm^2 of floor space per hen. Accordingly, the legal requirement that enriched cages must provide 600cm^2 of

usable space per hen represents an increase of just 50cm^2 per hen. As a consequence, hens' ability to move and exercise continues to be seriously restricted in enriched cages. EFSA has concluded that due to the limited space in enriched cages "the behavioural repertoire is still restricted compared with birds in non-cage systems".[54] EFSA also states that "space availability and height in an enriched cage system may be quite restrictive".[55]

The limited height in enriched cages also imposes severe restrictions on the birds' behavioural expression. EU law requires enriched cages to have a height of at least 45cm. This is too low to allow hens to perform a proper range of normal movements such as head stretching, wing flapping and body shaking which, if carried out, can lead to stronger wing bones.[56,57] Research indicates that, if given the opportunity, hens will use up to 56cm of height.[58]

The ability to perch in enriched cages is constrained by the limited height and floor space. EFSA states that "Perch height is necessarily restricted by the dimension of the enriched cage, which in some cases may not be ideal for maximising perch use." EFSA adds that normal hen movement between nesting and dust-bathing areas, or feeders and drinkers, may cause disruption of perching.

The litter provided in enriched cages is generally too sparse (e.g. the layer of litter is too thin) and the space available too limited to enable hens to properly fulfil their need to dust-bathe.[59] The duration of dust-bathing bouts in enriched cages is shorter than reported under natural conditions.[60] Dust baths in cages are frequently interrupted and terminated by disturbing influences such as pecking by other hens. Sham dust-bathing in enriched cages often takes place on the wire mesh floor despite the provision of a dust-bath area which suggests that the dust-bathing facility is unsatisfactory.[61] Research indicates that "dust bathing in cages will never be optimal"[62] and that normal dust-bathing behaviour is "highly restricted" in enriched cages.[63]

A review of the literature indicates that foraging behaviour is low in enriched cages compared with non-cage systems.[64] It is clear that hens' need to forage and dust-bathe cannot be properly fulfilled in enriched cages.

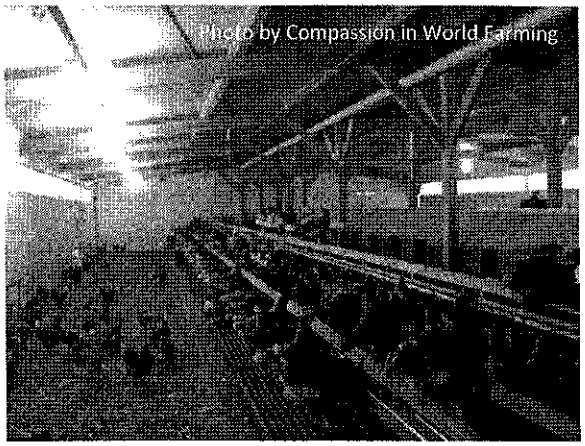
In conclusion, enriched cages provide hens with slightly more space than barren cages and the opportunity to perform some of their natural behaviour to a very limited extent. Despite the modifications, these cages provide an unacceptably restrictive amount of space per bird and fail to properly meet the hens' physical or behavioural needs. Consumers do not distinguish between different types of cages, and there is little support for their continued installation. Germany has banned enriched cages with effect from 2025 (with certain exceptions allowing the use of these cages until 2028).[65] As indicated above, many major food businesses are committed to not selling or using eggs from either barren or enriched cages.

> ***ICFAW recommendation on enriched cages:*** ICFAW is opposed to the use of enriched cages during both the rearing and laying periods as they fail to properly meet the hens' physical or behavioural needs. The OIE chapter should not endorse the use of enriched cages, but instead recommend a transition to cage-free systems.

Barn Systems

Barn systems allow free movement within an indoor environment if stocking densities are adequate. They can provide hens with more space and more opportunity to perform natural behaviour—such as foraging, dust-bathing, nesting and wing flapping—than in cage systems.[66,67] Exercise has been

shown to increase the bone strength of hens.[68,69] Barn systems include both flat-deck (also known as single-tier) and multi-tier (or aviary) systems, of which there are a variety of different designs. Multi-tier can provide a greater level of complexity for birds, giving more opportunity to exercise and explore and providing access to higher areas for roosting, resting or refuge from other hens; hens have been shown to have a preference for high resting areas at night.[70]

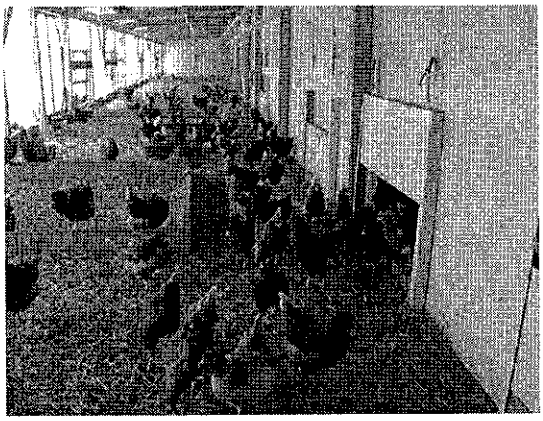


EU Directive 1999/74/EC requires that the stocking density within the house must not exceed 9 hens per m^2 of usable area which equates to around 1111cm^2/hen.[71] An appropriate space allowance within the house helps to prevent crowding and enables birds to rest undisturbed; research shows that hens use between 655 - 1217cm^2 and 800 - 1977cm^2 for scratching and preening behaviour, respectively.[72]

The EU Directive requires the provision of litter, nests and perches; these enable hens to satisfy important natural behaviour. Litter enables dust-bathing, ground-pecking and scratching.[73] Frustration and a redirection of foraging behaviour to pecking other birds' feathers may occur when birds do not have access to litter or the condition of the litter is poor.[74] Litter needs to be maintained in a friable condition. [75] Under the EU Directive at least 250cm^2 of littered area per hen, with the litter occupying at least one third of the ground surface, must be provided. Additional environmental enrichment in the form of pecking objects can further enrich the birds' environment and promote normal foraging behaviour.[76]

Hens are motivated to find a suitable nest site;[77] nest boxes should provide a quiet, secluded area for egg laying.[78] The EU Directive requires the provision of at least one nest for every seven hens or at least 1m^2 of nest space for a maximum of 120 hens for group nesting.

Hens are highly motivated to perch, particularly at night.[79] The EU Directive requires that adequate perches, without sharp edges and providing at least 15cm per hen must be provided. The provision of 15cm of raised perching has been shown to reduce fearfulness, reduce aggression and improve body condition.[80] Perch design and placement is important to prevent crowding which can compromise the accuracy of birds' landings and lead to injury. [81,82]



Verandas (also known as wintergardens) provide hens with additional space for exercise and reduce the stocking density within the house.[83] They are a good location for additional foraging and dust-bathing facilities[84] and provide protection from adverse weather conditions, predators and wild birds[85] whilst giving birds access to fresh air and natural light.[86] In free range systems they can also help with maintaining litter quality, as they protect the house from adverse

weather and provide an area prior to the house where hens' feet can dry and mud is removed.[87]

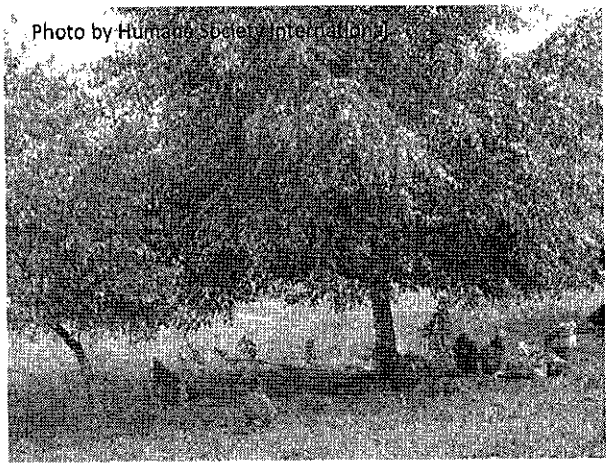
To help pullets better adjust to the laying environment and experience improved welfare during the laying period, it is highly beneficial for them to be reared in housing and with facilities similar to that of their destined laying unit[88,89]

> ***ICFAW recommendation on barn systems:*** The stocking density within the house must not exceed 9 birds per m^2. Hens should be provided with facilities which encourage activity and expression of natural behaviour, including at least: a $250cm^2$ littered area per hen, occupying at least one third of the ground surface - the litter must be maintained in a dry, friable condition; one nest box per seven hens or for group nesting at least $1m^2$ of nest space for a maximum of 120 hens; and 15cm of raised perching per hen. The design of housing and facilities, as well as placement of facilities, must be carefully considered for ease of movement through the system for hens and stockkeepers and to prevent crowding of the birds in any particular area.

Free-range

Free-range systems provide hens with housing as described in the 'Barn' section but with the addition of access to an outdoor range area which can add a greater level of complexity to the birds' environment.[90] Access to the outdoors can encourage natural behaviour, such as foraging and dust-bathing[91] and provides hens with natural light.

EU Commission Regulation (EC) No 589/2008 requires that the range is mostly covered in vegetation. Except during severe weather, hens must have continuous daytime access to the range and the maximum permitted stocking density is 2,500 hens per hectare of ground available to the birds or one hen per $4m^2$ at all times.[92]



Access to the range is provided via popholes from the house or veranda. Popholes should be spread across the length of the house and be wide and tall enough to enable easy access to the range.

The range needs to be actively managed to encourage birds to go on to, and to make full use of, the outdoor area.[93] Naturally wary of predators, hens may not venture outside of the barn unless there is overhead cover. The provision of shade and shelter, both natural or artificial, and environmental enrichment such as forage encourages birds onto the range. [94,95] Natural cover such as trees, hedges and semi-permanent vegetation (e.g. kale, artichoke) can also encourage birds to use the range and can reduce plumage damage from injurious pecking.[96]

Design and management of the range is important to ensure it remains in good condition and to ensure that access to range does not have a detrimental effect on the housing, for example litter quality within the house can be affected during wet conditions but this can be managed.[97] Access to range does increase the risk from predators;[98] an appropriate fence can help to exclude ground predators, while overhead netting can help with aerial predators. Flock size has been shown to have an effect on birds' ranging behaviour; hens in small and medium sized flocks access the range more often and for longer periods of time than hens in large flocks.[99] However larger commercial flocks may be separated into colonies within the house.

> ***ICFAW recommendation on free range:*** Range areas should be well maintained to prevent land degradation and a build up of disease or parasites. Importantly, the range area should include shade and shelter. An even distribution of natural cover such as trees and bushes, foraging opportunities and areas for dust-bathing encourage birds to access and make full use of the range area.

Bone fractures

There is an unacceptably high incidence of bone fractures in all housing systems for laying hens.[100] Bone weakness in laying hens mainly results from osteoporosis, which causes bones to be fragile and susceptible to fracture.[101] Osteoporosis is exacerbated by the great egg output of modern hybrids. Red jungle fowl, the modern hen's wild ancestor, lay 20 eggs a year. In 1930 a hen laid around 115 eggs in a year but today's hens can lay 300 eggs yearly. A hen's need for calcium for eggs exceeds her body reserves by about 30 times.[102] Osteoporosis is also related to, and greatly exacerbated by, the restriction of movement and lack of exercise in cage systems.[103] Exercise and activity are essential in order to build bone strength. Activity is important during both the rearing and laying phases, and the design of the rearing environment must be such as to develop bone strength as well as locomotor and balancing abilities.[104]

Hens with osteoporosis are particularly vulnerable to fractures when they collide with fixtures such as perches, or slip from a perch or aviary tier.[105] The high incidence of fractures due to collisions with such structures must be reduced by improved design and layout of laying houses and objects such as perches. The three-dimensional environment of the hens should be designed so that they can navigate safely between the different parts of the system[106], for example adding ramps to aid transition between tiers.[107] Lighting must also be considered; hens need sufficient light and contrast to make an appropriate jump and safe landing.[108] Careful handling during depopulation, such as catching birds by both legs rather than just one, can substantially reduce fractures.[109]

Bone strength may also be affected by diet. The grain-based diets of modern hens contain a high proportion of omega-6 fatty acids in relation to omega-3.[110] This contrasts with a hen's natural foraging diet which has roughly equal proportions of omega-3 and omega-6. Omega-3 fatty acids increase bone strength and density. Calcium uptake also needs to be improved.[111] Larger particle sizes of calcium have been shown to benefit skeletal health.

The incidence of osteoporosis can be lowered by genetically selecting for improved bone strength.[112] Bone strength has been found to be heritable, and genetic selection is extremely effective in improving bone strength and resistance to osteoporosis[113], with bone strength improving over just one or two generations.[114] A study by Fleming *et al* (2005) found that hens selected for improved bone strength also had significantly higher egg production.[115] The number of fractures sustained by

birds in cage-free systems should be addressed through a combination of selective breeding, optimised diets, plus improvements in the design, placement, and maintenance of structures in the shed, including perches. [116,117]

> ***ICFAW recommendation on bone fractures:*** Activity during both the rearing and laying phases is important to build bone strength. Hens should be reared in an environment similar to that in which they will live as adults. Hens destined to be housed in avaries during lay should be reared in avaries so that they become accustomed to using perches and a three-dimensional environment at an early stage. Multi-tier houses must be designed (for example, with careful placement of structures) to allow the hens to navigate safely between different parts of the system. Bone strength should be improved by genetic selection and careful attention to diet.

Feather pecking, beak trimming and plumage condition

There are two main causes of plumage deterioration: abrasion against equipment (e.g. wire mesh in cages) and/or feather pecking.[118] Plumage damage should be assessed regularly; systems for scoring this have been developed by, for example, the Welfare Quality project and AssureWel. [119, 120]

Beak trimming is regularly carried out to reduce the incidence and severity of feather pecking. The two main methods of beak trimming are hot-blade and infra-red. Both methods cause acute pain due to tissue and nerve damage. [121,122,123] Chronic pain can occur when birds are beak trimmed at one week of age or later.[124] Infra-red trimming is carried out on day old chicks at the hatchery. The UK has prohibited hot-blade beak trimming (other than in an emergency in order to control an outbreak of feather pecking); only the infra-red method is permitted.[125]

Some argue that infra-red trimming is less painful than the hot-blade method; however, research provides behavioural evidence that infra-red trimming also causes pain during the early weeks of life.[126] One study concluded that infra-red trimming "should not be viewed as the ideal solution to control cannibalism and feather pecking. Alternatives to trimming need to be investigated and implemented as soon as possible".[127]

A wide range of strategies have been developed for reducing the risk of injurious feather pecking.[128] The abnormal behaviour stems from redirected foraging or ground pecking.[129] Hence the provision of good, deep, friable litter during both rearing and lay is essential. Hens need plenty to peck at; the provision of pecking objects such as alfalfa blocks, straw and rope can help reduce feather pecking.[130]

Stress is a risk factor for feather pecking; the changes involved in the move from the rearing to the laying house can be very stressful.[131] The transition should be managed in ways that reduce the number of changes to the hens' environment. As far as possible, conditions in the rearing house should match those of the laying house.

The provision of a balanced diet is essential to ensure that nutritional deficiencies do not trigger pecking. Feeding mashed feed rather than pellets increases the time spent eating and decreases pecking. Birds fed on lower density diets with higher fibre levels spend more time feeding and less time on pecking behaviour.[132]

Beak trimming is not carried out Austria as it is prohibited by a national assurance scheme. Finland and Sweden have legislation that bans beak trimming. Denmark extended its voluntary industry-led ban on beak trimming caged hens to barn and free range birds in 2014. In certain German Länder,

the industry has signed a 'voluntary binding agreement' with the Government to stop beak trimming from August 2016 and to stop stocking pullets with trimmed beaks from January 2017. The Netherlands plans to ban beak trimming from September 2018, dependent on a satisfactory outcome of trials on non-trimmed, non-cage birds being reviewed in 2017.

> ***ICFAW recommendation on plumage condition, feather pecking and beak trimming:*** Plumage damage should be assessed regularly. Beak trimming is painful and should be avoided. All other strategies to avoid feather pecking should be implemented before resorting to beak trimming. These include providing an enriched environment with deep, friable litter during both rearing and lay, a balanced, mashed diet with adequate insoluble fibre content and low stocking densities. Feather pecking should be minimised by avoiding stress and the adoption of a range of management strategies set out in the FeatherWel publication *Improving Feather Cover*.[133] Where beak trimming is performed, it should be carried out in the hatchery by the infra-red method, and only using a hot-blade in an emergency where injurious pecking is compromising the welfare of the birds.

Foot health

Wet litter can cause footpad dermatitis.[134] The risk of footpad lesions can be decreased by the provision of dry, good quality litter, well-maintained perches made of soft materials (softwood, rubber-covered perches), perches that are rectangular rather than circular in shape and wider perches which increase the contact area.[135] EFSA recommends a perch width of between 3 and 6cm to minimise balance movements and reduce peak force under the footpads thus potentially reducing injuries.[136] If footpads become infected with bacteria such as *Staphylococcus aureus*, the condition can lead to bumblefoot.[137]

> ***ICFAW recommendation on foot health:*** Effective steps must be taken to minimise the incidence of foot problems. This includes the provision of dry, good quality litter, and well-designed and managed perches.

Light levels and regimes

Vision is the most developed sense in birds.[138] Foraging, exploration of the environment[139,140] and communication[141,142] all rely primarily on vision.

The EU Directive requires "light levels sufficient to allow all hens to see one another and be seen clearly, to investigate their surroundings visually and to show normal levels of activity". Visually mediated behaviour such as feeding and exercise are increased in brighter conditions. [143,144]

Continuous exposure to low light levels (<10 lux) can result in eye abnormalities such a buphthalmia[145] and impaired behaviour.[146] Various welfare assurance schemes require minimum lighting levels of 20 lux in 'activity' areas of the house; [147,148] lower lighting levels are preferred for resting behaviour (preening and perching).[149] These lighting levels should be measured at bird eye level. [150,151] Birds have a preference for brighter conditions at two weeks of age, but appear to prefer lower levels as they get older.[152]

Prolonged light periods are detrimental to welfare, increasing the risk of eye abnormalities;[153,154] birds raised in continuous lighting are more fearful.[155] Several welfare assurance schemes[156,157] require continuous dark periods of 8 hours. The EU Directive requires an "adequate uninterrupted period of darkness lasting, by way of indication, about one third of the day, so that the hens may rest and to avoid problems such as immunodepression and ocular anomalies".

Chicks are often reared in continuous light for their first days to enable them to find food and water. However this may be detrimental to both welfare and growth, depriving birds of sufficient rest.[158] Dark brooders which aim to mimic the presence of a mother hen allow chicks to choose between dark (resting) and light (active) areas. Demonstrable benefits include behavioural synchrony[159] and reduced injurious pecking behaviour[160,161] and fear[162] which continues into the laying period.[163]

Natural lighting may be provided by windows and/or verandas (winter gardens) as well as via popholes in free-range systems. Natural lighting exposes birds to the full spectra of light to which they are receptive. Whether lighting is natural or artificial, it is important that lighting is even.[164] Shafts or patches of bright light can result in bouts of severe injurious pecking.[165]

In artificially lit systems a dusk period should be provided,[166] whereby lighting is gradually dimmed, enabling birds to locate appropriate roosting spots; this also stimulates feeding behaviour during the daylight hours to prevent hunger during the nighttime period.[167] A short dimming period (less than 15 minutes) is shown to provide sufficient preparation time in experimental studies[168,169] although in commercial practice it may be more often 15-30 minutes; this longer period may be necessary for larger groups.

The use of LED lighting is increasing as producers adopt more modern systems. LED lighting is thought to provide some benefits over fluorescent and incandescent lighting, including a monochromatic spectrum[170] and an absence of flicker.[171]

> ***ICFAW recommendation on light levels and regimes***: Lighting patterns should provide a continuous dark period of at least 8 hours. Minimum lighting levels of 20 lux - whether natural or artificial - should be provided over feeders, drinkers and in the litter area. Dusk periods should be provided to enable birds to prepare for nighttime roosting.

Air quality and thermal environment

Exposure to dust, gases and airborne pathogens in laying hen housing[172] can have negative impacts on the health and well being of the hens.[173,174] Temperature and humidity have direct influences on birds' welfare but also affect levels of aerial contaminants. Each must therefore be monitored and maintained within limits that are not harmful to the birds.

Chronic exposure to raised levels of ammonia has been shown to reduce levels of certain behaviour including feeding, preening and resting,[175] cause damage to eyes and respiratory tracts, increase susceptibility to disease and secondary infection and increase the risk of keratoconjunctivitis (blind eye).[176,177] The current chronic exposure limit of ammonia for human health and safety of 25ppm is often cited as a maximum level for poultry[178,179] although hen preference tests suggest that lower levels are aversive to hens.[180] At least one welfare scheme requires ammonia levels not to exceed 15ppm at bird head height.[181] Manipulation of feed rations, good litter management and the use of manure belts can help to maintain acceptable levels of ammonia in cage-free environments.

The human chronic exposure limit for CO_2 of 3000 ppm is a requirement for broilers in the EU Directive for chickens kept for meat production,[182] though no requirements are provided in the EU legislation for laying hens.

Dust may be generated from the hens, their feed, insects, the litter and the outdoor environment, and may compromise the health and welfare of hens.[183] Bacterial concentrations in poultry housing

have been shown to increase with increasing dust levels[184] and may include strains resistant to antibiotics.[185] Concurrent exposure to pathogens, dust and ammonia resulted in more severe health reactions in broilers than exposure to just one or two of these factors.[186] In addition to ventilation, filtration methods, misting and effective cleaning can help to control levels of dust.

Higher temperatures expose birds to the risk of heat stress and even a small increase in air temperature can significantly influence ammonia levels.[187] However, it is often the case that ammonia levels are increased in lower temperatures as ventilation is reduced.[188] Cold stress and poor litter quality[189] can result from low environmental temperatures. Optimal temperatures for adult laying hens are between 21 and 22°C, although temperature ranges between 10 and 27°C may be comfortably tolerated. Animal keepers should look for signs of heat and cold stress during regular inspections, as a range of environmental (wind speed, humidity) and bird (feather cover, activity) factors may affect thermal comfort.[190]

Ventilation is the main means of controlling environmental conditions in poultry housing. Ventilation must be able to remove heat from the building in periods of hot weather, and sufficient to remove aerial contaminants during periods of low ventilation, i.e. in colder conditions.[191] To ensure ventilation is sufficient, the hens' environment must be regularly monitored at bird head height.[192] Where systems are automated, alarms must be present to alert keepers to any system failure.[193]

> ***ICFAW recommendation on air quality and thermal environment*:** Aerial contaminants should be monitored daily and ventilation and other management factors adjusted to minimise their levels. Ammonia levels should not exceed 25ppm and ideally should be less than 15ppm. Where ventilation systems are automatically controlled, alarm systems must be in place to alert stockkeepers in the event of a breakdown. Animal keepers should look for signs of heat and cold stress during regular inspections.

Piling

Piling involves birds massing together,[194] and may be due to panic, nest box or gregarious 'creep' smothers.[195] Panic smothers involve sudden flight, usually due to a one-off event, such as disturbance by predators, sudden noise, sudden increase in light intensity,[196] or non-routine stock keeper activities (such as repair works).[197] Creep smothers do not always have clear causal factors and can be recurring.[198]

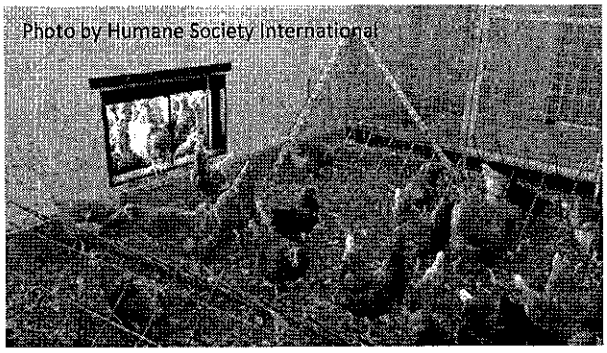


Photo by Humane Society International

Enrichment of the litter with grain or grit may help to reduce both panic and creep smothers by keeping the birds well occupied.[199] Reducing the contrast in illumination between indoors and outdoors and preventing the occurrence of bright spots inside the popholes, for example with better range cover or verandas, may also be useful interventions.[200] Many producers develop innovative solutions, such as sectioning off house corners,[201] and using A-frame wire guards (pictured), in an effort to reduce piling. The use of dark brooders in rear may have a positive impact with no smothers due to piling seen where dark brooders were present in one study.[202] Exposing young pullets to novel noises from an early age can prevent panic reactions in adult hens.

Nest box smothers occur when birds come into lay. It is thought that naive birds follow more experienced birds into nest boxes, resulting in piling.[203] Nest box design appears to have some role in nest box smothers[204,205] and nest box 'markers' to help birds identify individual nest boxes may alleviate such smothers. Stock keepers report regular nest box checks as a means of preventing smothers.[206]

> ***ICFAW recommendation on piling:*** Detailed records should be kept of smothering events to help identify the cause of smothers in individual flocks and develop tailored strategies to reduce their incidence depending on their aetiology.

Disease

At a flock level, a range of measures including biosecurity, good husbandry and management and a veterinary health programme, can be implemented to reduce the risk of disease challenge. Incorporating these measures into a formal plan, in conjunction with the farm's veterinarian, can help to improve bird welfare.

Stock-keepers must be able recognise signs of disease and ill-health[207] to enable any such signs to be quickly investigated and appropriately treated. Detailed flock performance records can help to identify changes indicative of a flock health problem; changes in water consumption[208] and egg production[209] can be reliable early indicators of illness. Early detection and treatment can help to reduce the spread of infectious disease.[210]

Management and husbandry practices such as pasture rotation in free-range systems,[211] effective air quality management[212,213] and 'all-in all-out' flock systems[214] also play a role in disease control.

> **ICFAW recommendation on disease:** All farms should develop and maintain farm specific Veterinary Health and Welfare Plans drawn up between the farmer and experienced poultry veterinarians. Effective biosecurity measures and good husbandry and management should be implemented to reduce the risk of and spread of disease.

Inspection

Regular and thorough inspections of hens by competent persons allow any welfare concerns to be rapidly identified and addressed, thereby preventing the escalation of welfare problems. Regular inspections also habituate birds to human presence. [215,216] EU legislation requires that hens be inspected at least once a day when they are kept in systems "in which their welfare depends on frequent human attention".[217] Evidence and experience suggests that more frequent inspections are beneficial, with more regular human contact shown to reduce fear and improve production. [218,219] Light levels should never be altered in order to carry out an inspection as this is associated with increased risk of injurious pecking.[220]

The quality of the inspection is as important as the frequency. Inappropriate interactions such as rough, unpredictable or aversive handling and movement in the shed can lead to increased fear within the flock.[221] Fearfulness is associated with reduced egg production,[222] poor eggshell quality, reduced growth and feed conversion[223] and an increase in severe feather pecking. [224,225] Inspections should be calm and deliberate.

Flock managers and all those responsible for bird welfare and conducting inspections should be knowledgeable regarding health and welfare and normal and abnormal behaviour. They should be able to recognise signs of ailing hens, injurious pecking and other welfare concerns, and be

competent in correct handling and humane euthanasia.[226] Inspections should ensure all housing and equipment is well maintained, functional and safe.

> ***ICFAW recommendation on inspections***: Inspections should be carried out a minimum of twice daily, by competent and knowledgeable persons, and records kept. Where possible, farms should be members of a farm accreditation scheme.

Stockpersonship and management

Awareness of the importance of stockpersonship can facilitate improvements in animal welfare whereby stockpersons with knowledge of the human-animal bond can have an increased understanding of animals, and therefore a positive impact on animal welfare.[227]

Good stockpersonship, i.e. the knowledge, skill, attitude and behaviour necessary to handle animals in a manner that enhances animal welfare and the human-animal relationship, is an essential component of any farming system, and stockpersons should always interact with animals in a caring and compassionate manner.

Key considerations include:

- animals are handled in a gentle manner which minimises distress,
- those responsible for the hens are able to identify sick or injured birds and carry out appropriate treatment,
- stockpersons are able to monitor and notice any changes in health or behaviour, and have a good understanding of hen behaviour, as well as good access to veterinarians.

Harsh handling can depress immune function as well as cause bruises, dislocated joints and broken bones. Handlers with positive attitudes towards animals often achieve improved commercial productivity. Management and stockpersonship as well as staff training should be standardised in order for industry to optimise management practices and hen welfare. Animal handling and productivity can be improved through training programmes, and training in specific skills can also be beneficial.[228]

> ***ICFAW recommendation on stockpersonship:*** Good stockpersonship is crucial to animal welfare in any housing system. The selection and training of those responsible for the care of hens represents important opportunities to enhance animal welfare as well as productivity. Stockpersons should always be appropriately trained and competent, and always interact with animals in a caring and gentle manner.

Mortality

The main causes of mortality include disease, cannibalism, piling, injury[229] and in free-range flocks, predation.[230] Through good management, good prevention practices and good flock health it is possible for loose housed systems to achieve low levels of mortality,[231, 232] comparable to cage systems.[233]

> **ICFAW recommendation on mortality:** All farms should maintain and monitor records of mortality including reasons for mortality. High levels of mortality should instigate an investigation into the cause, and prompt action should be taken to prevent further mortalities, injury or suffering from occurring.

Importance of the rearing system

Conditions during rearing can have a significant impact on the welfare of the birds both while they are pullets and later as adults during the laying period.[234] Many welfare problems in laying hens are influenced by the environment in which pullets were reared from hatch.[235] For example, birds provided with litter during rearing are less likely to feather peck as adults.[236]

Ensuring that the rearing and laying environments match each other as closely as possible can reduce stress during the transition to the laying system and can prepare hens for the conditions they will experience during lay.[237] Increased environmental complexity during the rearing period can reduce the fearfulness of adult laying hens.[238]

Hens that are to be kept in aviaries during lay must learn how to navigate a complex three dimensional system during the rearing phase.[239] Flight accidents may be more prevalent in adult hens reared without perches than in those provided with perches from an early age. Aviary-reared hens use aviary platforms and fly and jump more often as adults than floor-reared hens.[240]

Hens that do not have access to perches during the rearing period can experience difficulty using perches later in life. Rearing without early access to perches causes low muscle strength, a lack of motor skills, the inability to keep balance, and impaired cognitive spatial skills, with long-lasting effects on welfare.[241] Therefore, providing perches during the rearing period enhances ability to utilise them in the laying period, and also reduces the incidence of floor eggs.[242,243] The rearing system should provide constant access to perches.[244]

> ***ICFAW recommendation on rearing systems***
> Pullets should be housed in rearing environments that are as similar as possible to the laying environment to reduce stress during the transition and to ensure optimal welfare and utilization of resources at lay. Perches should be provided from around seven days of age at the latest to ensure optimal perch use in the adult birds. Pullets should have constant access to appropriate litter throughout the rearing phase.

Forced moulting

Starvation forced moulting entails the withholding of feed for up to 14 days; this may be combined with 1-2 days of water deprivation.[245] Hens suffer enormously during forced moulting.[246] It leads to substantially increased mortality, stress, cage pecking and stereotyped pacing. In 2011 the Animal Welfare Board of India issued an order to the egg industry, banning starvation force moult regimes and noting that the practice is in violation of India's Prevention of Cruelty to Animals Act of 1960.[247] Forced moulting - when it involves depriving hens of feed for long periods of time - is prohibited by EU law.[248] In its voluntary US certification program, the United Egg Producers does not permit feed withdrawal moult methods; it requires feed to be provided during the moult using a specialised diet.[249]

> ***ICFAW recommendation on forced moulting:*** Feed withdrawal forced moulting should not be permitted. Alternative diets for non-producing hens can be substituted for full feed withdrawal. Water should be permitted at all times during the molt, birds should be monitored closely and mortality should not increase.

On-farm culling

Any method of on-farm culling should render the animal immediately unconscious, ensuring insensibility to pain. Signs of unconsciousness include absence of nictitating membrane reflex,[250] loss

of posture and loss of neck tension;[251,252] these should be monitored to evaluate the effectiveness of the procedure. Stock keepers must be competent and trained in the method employed.

The most common method of on-farm culling is manual cervical dislocation (MCD), i.e. dislocation of the neck by hand. When carried out effectively, the spinal cord will be severed and blood flow to the head will be restricted resulting in unconsciousness. However, research suggests that it is difficult to achieve a consistent result.[253] For this reason, EU legislation restricts the number of birds that can be killed by MCD to 70 per day for a single operator and it must never be carried out on birds weighing more than 3kg.[254] Stock keepers must be trained and competent to carry out such a procedure to ensure it is applied consistently and effectively.

Mechanical cervical dislocation, i.e. cervical dislocation with the use of a specially designed tool, aims to improve on the consistency of MCD.[255] However, research suggests that often the spinal cord is crushed rather than severed and brain activity suggests birds are still conscious.[256] Devices which crush the spinal cord should not be used.[257] Neck crushing does not sever the common carotid arteries. Therefore, it does not cause cerebral ischemia and hence loss of consciousness. EU legislation prevents the use of any crushing devices by requiring that any mechanical device stretches and twists the neck.[258]

Decapitation does not result in immediate loss of consciousness[259] and therefore is not acceptable on welfare[260] or legal (EU) grounds.

Captive bolt devices can render birds immediately unconscious. Such equipment (e.g. CASH poultry killer; TED captive bolt), when properly applied, can provide a reliable, humane method of killing, which is shown to be more effective at reducing brain activity than cervical dislocation or neck crushing.[261] Improper use (e.g. poor placement of equipment on the head), ineffective bird restraint[262]or poor maintenance of the equipment may result in an ineffective cull, thus training in using and maintaining the equipment is critical.

Gas is another on-farm method used to kill laying hens. Specialized equipment, Modified Atmosphere Killing (MAK) carts, is sold in some countries. While these are commonly used for depopulation of entire flocks, they may also be used to cull or euthanize individual birds. Inert gases (nitrogen or argon), are thought to be less aversive than carbon dioxide for rendering birds unconscious and killing them.[263]

> **ICFAW recommendation on on-farm culling**: The use of a captive bolt device resulting in immediate unconsciousness and death and the use of non-aversive gases are the preferred methods of on-farm culling. Where such equipment is not available, manual neck dislocation may be used for small numbers of birds. Individuals must be trained and competent in the method of culling employed and must be able to recognise signs of an effective cull. Birds should be confirmed dead prior to disposal. Neck crushing equipment and decapitation should not be used for on-farm culling on welfare grounds.

End-of-lay catching

Removing hens from cages can result in injuries as the hens are pulled at great speed out of the cages. Catchers usually carry the birds upside down often holding them by one leg with 2-4 hens in each hand. Such rough handling of hens that - due to the calcium demands of high levels of egg production and lack of exercise in cages - have fragile bones, leads to a high incidence of bone

fractures.[264] During depopulation, gentle handling and catching and carrying hens by two legs rather than just one reduces stress and bone breakages.

The Humane Slaughter Association,[265] United Egg Producers[266] and the RSPCA[267] have formulated good practice advice on catching; some of the main aspects of this advice are set out in the ICFAW recommendations below.

The Dutch organisation Eyes on Animals is providing training for what they refer to as 'The Swedish Method' of catching.[268] Here a maximum of two hens at a time are carried in an upright position with support under their chest and are then placed upright and calmly into the transport crates. Rondeel, a company that operates four chicken farms in The Netherlands, has agreed to switch to this method.[269]

ICFAW recommendation on catching:

- Hens should be caught and carried by both legs to reduce injuries;
- Catching teams should never put speed of operation before hen welfare;
- Hens should be removed from cages individually;
- The bird's breast should be supported during removal from the cage or a breast support slide used;
- Catching should take place in blue or low lighting;
- Hens should always be handled gently and compassionately;
- Hens should be lowered gently into the transport containers onto their breasts and allowed to regain their balance before further birds are added to the tray.

Killing of day old chicks

The routine killing of male day old chicks is widely recognised to be unethical. A method for identifying the gender of chicks at an early stage of embryonic development has been established by researchers at the University of Leipzig.[270] This method allows males to be culled at around 11 days while they are still in the egg before when is thought to be the onset of pain perception. Research is also ongoing into another in-ovo method[271] that determines the gender of chicken embryos at just three days of incubation and then sorts the eggs automatically by gender. These options should be ready for large-scale commercial use in hatcheries in the reasonably near future.

ICFAW recommendation on killing of day old chicks:

The killing of chicks after hatching should be replaced by the culling of embryos before the development of pain perception, as soon as a method for identifying the gender of chicks at an early stage of embryonic development is commercially available. This will allow embryos to be culled before they are sentient and able to feel pain. Another approach is the use of dual purpose chickens, where the females lay eggs and the males produce meat. Where day-old chicks are killed, the only methods that may be used are (i) maceration that provides immediate death and (ii) exposure to a non-aversive gas mixture. Smothering unwanted chicks in bags or containers should not be carried out.

Resources on good hen welfare

The RSPCA, an ICFAW member, has produced *Welfare Standards for Laying Hens* which can be found at https://science.rspca.org.uk/sciencegroup/farmanimals/standards/layinghens. They have also produced *Welfare Standards for Pullets* which can be found at https://science.rspca.org.uk/sciencegroup/farmanimals/standards/pullets

These standards, which are set at the limit of what is achievable in terms of animal husbandry and commercial viability, aim to deliver improved animal welfare above and beyond 'standard' or typical production. The standards, which are updated approximately every two years to take into account the latest scientific research and practical farming experience, have been used for over 20 years by the RSPCA's farm assurance and food labeling scheme RSPCA Assured (formerly Freedom Food).

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[1] The member organisations of the International Coalition for Animal Welfare include: Animals Australia, the Animal Welfare Institute, Compassion in World Farming, Eurogroup for Animals, Four Paws, Humane Society International, the International Fund for Animal Welfare, Japanese Society for Animal Welfare Science, the National Council of SPCAs, the Pan African Animal Welfare Alliance, the Royal Society for the Prevention of Cruelty to Animals, RSPCA Australia, World Animal Net, World Animal Protection, and World Horse Welfare.

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