THE HUMANE SOCIETY OF THE UNITED STATES

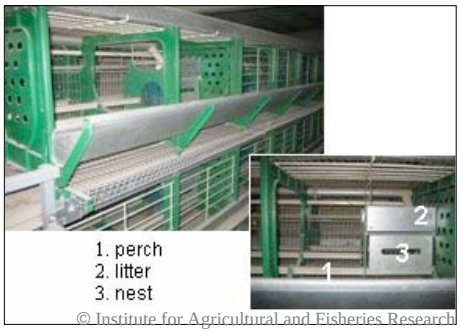
An HSUS Report: Welfare Issues with Furnished Cages for Egg-Laying Hens

Abstract

Furnished cages were developed in response to criticisms about conventional battery-cage confinement of laying hens in commercial egg production. Battery cages—small, barren, wire enclosures—restrictively confine the birds, depriving them of the opportunity to display many important patterns of behavior. In contrast, furnished cages are typically equipped with a nest box, perch, and dustbathing area, thereby providing more behavioral outlets than conventional cages. However, similar to conventional battery cages, furnished cages provide an unacceptably limited amount of space per bird; prevent many important locomotory activities, including running, jumping, flying, and wing-flapping; and constrain perching, dustbathing, and nesting. The severe locomotory restriction of cages also prevents hens from obtaining normal amounts of exercise, which in turn leads to poor skeletal strength and other pathologies. While allowing for some natural behavior denied in conventional cages, furnished cages remain unable to adequately provide for an acceptable level of welfare for hens kept in commercial egg production.

Egg Production Systems

Battery Cages



Furnished Cages

Cage-Free Aviary

In U.S. commercial egg production, 95% of laying hens are confined in battery cages,[*] small wire enclosures that afford each hen 432.3 cm^2 (67 in^2),[1] an amount of space smaller than a single sheet of letter-sized paper. These cages are placed side by side in rows and stacked in tiers commonly 4-8 levels high in industrial egg production operations. Each cage may hold 5-10 birds,[2] and hundreds of thousands of hens may be confined within a single building. Battery cages are barren and invariant environments,[3] and the welfare of caged hens is severely comprised.

Although battery cages have been sharply criticized by scientists for many reasons,[4] among the most significant is their severe restriction of movement. Battery-caged hens are not only unable to display many of their natural behavior patterns, such as nesting, perching, dustbathing, scratching, foraging, exploring, and engaging in comfort movements, including wing-flapping, they are also prevented from receiving adequate exercise. This

[*] For more information, see "An HSUS Report: The Welfare of Animals in the Egg Industry" at www.hsus.org/farm/resources/research/welfare/egg_industry.html.

relative inactivity compounds the severe osteoporosis and accompanying propensity for bone fractures that most egg-laying hens endure.[†]

Furnished cages (also known as enriched, colony,[5,6] or modified cages) were developed as an attempt to improve conventional cages by providing outlets for known strong behavioral priorities[7] and are in use in several European countries, including the United Kingdom, Sweden, Norway, Germany, and Denmark,[8,9] though not commonly in the United States.[10] Furnished cages are similar to battery cages except they typically include a nest box, perch, litter area for dustbathing, and greater height. While they do allow caged hens to engage in a larger array of natural behavior patterns, furnished cages do not enable hens the freedom of movement and environmental conditions necessary to achieve an acceptable level of welfare.

Size and design of furnished cages vary, with 10-12 birds in smaller models, 15-30 in medium cages, and 60 in the largest.[11] According to an August 2008 article in the trade journal *Poultry World*, most enriched cages are built for vertical stacking 6-12 tiers high, with catwalks between every third tier.[12] Although the arrangement of furnishings varies between different cage models, the nest box is usually situated to one side or in a corner, and the dustbath—typically a box or mat with added litter—is placed to one side or on top of the nest box.[13] There may be one perch running parallel to the feed trough, multiple parallel perches, a T-shaped perch arrangement, or perches running cross-wise, both parallel and perpendicular to the cage front.[14] Directive 1999/74/EC of the European Union stipulates that each bird in a furnished cage be given at least 600 cm^2 (93 in^2) of usable space in addition to the space within the nest box itself, totaling 750 cm^2 (116.3 in^2 or 0.81 ft^2) of space per hen.[15]

Cage-free alternatives already in use worldwide include barns and free-range systems. In barns, hens are not afforded outdoor access, but are provided with nest boxes and often perches and areas with loose substrate (litter) for natural dustbathing, scratching, and foraging behavior. Structurally, they may be single- or multi-level. Multi-level barns are also known as aviaries or percheries. The different levels in aviary systems utilize vertical space within the building and enable hens to move between multiple different stories. Stocking densities vary—e.g., the EU legal directive stipulates that each bird should be given 1,111cm^2 (172.2 in^2 or 1.2 ft^2) of space per hen[16] and U.S. egg industry guidelines require 929-1,393.5 cm^2 (144-216 in^2 or 1-1.5 ft^2) per bird, depending on the space provided on perches and elevated levels within the barn.[17] Free-range systems, whether small, backyard flocks or large-scale production operations, generally provide both a protected indoor shelter or barn area, as well as outdoor access.

Conventional cages are being phased out throughout the entire European Union. By 2012, it will be illegal to confine hens in battery cages throughout the 27 member states.[18,19] In the United States, California voters overwhelmingly passed a 2008 ballot measure[20] that effectively bans the use of both conventional battery cages and furnished cages in the state. The law, a first in the United States, will take effect in 2015. Michigan followed in 2009 with similar legislation.[21]

Welfare Concerns with Furnished Cages

Compared with cage-free barn, aviary, and free-range systems, furnished cages are inadequate. Space allowance in both the horizontal and vertical dimensions of the enclosure impedes movement, limiting important natural behavior. As well, the restrictive design of furnished cages prevents the hens from exercising, leading to disuse osteoporosis, liver pathology, and skeletal weakness, which leaves hens prone to skeletal fractures during depopulation, when they are removed from the cages. Further, scientific evidence suggests that birds kept in cages are more fearful of other birds and of employees, compared to hens in cage-free environments. Though there are very few studies that directly compare furnished cages to cage-free systems,[22] many studies

[†] For more information, see "An HSUS Report: A Comparison of the Welfare of Hens in Battery Cages and Alternative Systems" by Drs. Shields and Duncan at www.hsus.org/farm/resources/research/practices/comparison_hen_welfare_cages_vs_cage_free.html.

demonstrate that sizable problems related to cage confinement are unaddressed by modifying cages with additional furnishings.

Lack of Space

While slightly more spacious than typical battery cages, the amount of space allocated to each hen in a furnished cage is still deficient. Studies of natural spacing behavior measuring the distance between "nearest neighbors" demonstrate that hens use a relatively large amount of space when given the opportunity to do so. In one study of small flocks of a medium hybrid strain, the distance observed between two birds varied from 0.35 m (1.15 ft) when the birds were standing and ground pecking, to more than 3.3 m (10.8 ft) when they were moving while foraging.[23] Another study concluded that any space allowance of 0.5 m^2 (5.4 ft^2) or less per bird imposes at least some constraint on hen behavior.[24] Under typical free-range conditions, hens are able to disperse throughout the outdoor area and are provided with the opportunity to move away from flock mates and to distance themselves in a more natural way.

The dynamics of crowding and space utilization in large-scale, commercial production are complex. However, critical thinking by scientists about the space needs of hens and other animals has revealed interesting insights about space availability in various enclosure sizes. Because animals can time-share space (i.e., use the same spatial locations at different times) in large enclosures, there is more functional area for the display of behavior, although local crowding may occur in floor systems.[25,26] Further, hens are not stocked as densely on cage-free operations,[27,28] so the overall space allowance is far more generous than in conventional or furnished cages. This allows more freedom of movement for behavioral expression and movements that serve to provide exercise.

Constraints on Behavior

Cages of all types prevent the full expression of many critical natural behavior patterns. Walking and exploring are reduced;[29,30] perching is constrained by the cage height,[31] and locomotory behavior such as running, jumping, flying, and wing-flapping are prevented completely. There are also concerns about whether dustbathing can be fully accommodated in the limited space provided in a furnished cage[32] and whether the EU directive's requirements for nesting space in furnished cages is adequate.[33] In contrast, cage-free facilities allow hens to move over greater distances and often between different levels,[34] provide more choices for nesting space, and usually feature larger littered areas. As such, cage-free operations better accommodate the behavioral needs of hens than conventional as well as furnished cages.

Perching and Roosting

Birds require both vertical and horizontal space for behavioral expression, particularly at night when, under natural conditions, chickens perch in trees.[35,36] Roosting, an ancient behavior pattern shared by ancestral Jungle Fowl,[37] is thought to protect birds from predation during resting hours.[38] Studies have shown that hens prefer perches that are placed higher off the ground than those that are closer to the floor.[39,40,41,42] In a cage, however, this is severely limited by the distance from the floor to the ceiling, while in cage-free facilities, there is much more vertical space to include elevated perches. In a furnished cage, perches are generally situated only 6-8 cm (2.36-3.15 in) above the cage floor.[43] The cage height requirement in EU legislation is a minimum of 45 cm (17.7 in); however, research by Marian Dawkins, Professor of Animal Behaviour at the University of Oxford, has shown that when caged hens were tested, they "shunned" any cage height of less than 46 cm (18.1 in).[44] The cage height requirement was debated during drafting of EU directive 1999/74/EC, and some scientists and political leaders argued for a higher minimum than what was legislated.[45]

Feather pecking is an abnormal behavior performed by laying hens that may result in injury.[46] The etiology of feather pecking is complex, and numerous factors are thought to influence its prevalence, but it is related to frustrated foraging attempts.[47] To reduce injurious pecking in commercial egg production systems, the end 1/3-1/2 of the birds' beaks are routinely cut off with a heated blade[48] or infrared energy treatment[49] shortly after the

birds hatch. If positioned high enough, perches can protect hens from feather damage caused by injurious pecking, as hens standing on the floor are unable to reach those who are perching.[50] In contrast, perches in furnished cages are not elevated off the cage floor high enough to offer the same protection. As a result, feather pecking can lead to vent cannibalism and subsequent high mortality in hen flocks with intact beaks.[51]

Hens use perches of different heights for different types of behavior, tending to stand or walk on lower perches, while sitting or sleeping on higher ones. Both lower and higher perches can be offered in cage-free environments to accommodate this behavioral differentiation, whereas furnished cages can provide only low perches.[52] In one study, hens in non-cage systems with both low and high roosting locations made use of the perches more during the day compared to hens in furnished cages.[53] This suggests that the proximity of the perches to the cage floor in furnished cages may make them less attractive.

Exploratory Behavior

Hens are naturally inquisitive, curious animals, but furnished cages do not allow the full expression of exploratory behavior,[54] an activity scientists have identified as important to animals in many ways. Exploration creates agency and competency, satisfies the motivation to acquire information about the surrounding environment, and is also an end in itself.[55,56,57] It has been suggested that exploratory behavior is a behavioral need of hens.[58]

Complexity in cage-free systems offers more opportunities for hens to engage in exploratory behavior,[59] and this is particularly true of free-range facilities, as the day-to-day changes in an enriched outdoor environment offer a degree of diversity and novelty that indoor conditions cannot provide. The rich outdoor environment stimulates exploratory behavior and elicits pecking and scratching,[60] satisfying the biological drive to investigate, manipulate, and interact daily with a variety of natural stimuli. In contrast, cage confinement can lead to greater inactivity: Hens confined in furnished cages spend more time simply standing and sitting than birds in non-cage systems.[61]

Dustbathing and Foraging

In the European Union, cage-free systems must supply litter over at least one-third of the floor space.[62] This requirement, coupled with the stocking density requirement discussed above, provides more litter availability[63] and room for the display of scratching, pecking, and dustbathing behavior compared to furnished cages in which litter is sparse[64] and the total floor space available for these activities is variable but often quite limited.

Studies of dustbathing in furnished cages have reported a variety of results. In one study, only 26.7% of dustbaths were actually performed in the area provided within the enclosure, with the rest displayed on the wire cage floor. When access to the dustbath was restricted during the peak egg-laying period, the percentage dropped to 8.3%.[65] Conversely, in another study of the same type of furnished cage, all dustbathing occurred in the dustbath.[66] A 2008 study of litter types in furnished cages found that the use of the dustbathing area was highly variable, with some hens visiting the dustbath a great deal and others not at all.[67] This may indicate that for some hens, the dustbath provided in furnished cages is somehow inadequate.

One possibility is that there may be competition for the limited dustbathing area in a furnished cage. Dustbathing is normally a social activity, and the sight and sound of dustbathing hens are triggers for other birds who observe the behavior.[68] In a furnished cage, where there may be space for only one[69] or two[70] individuals, multiple birds attempting to gain access at the same time can lead to crowding in the dustbath.[71]

Access to litter boxes for dustbathing may also be limited by the automated, timed door in furnished cages. In order to ensure that eggs are not laid in the dustbath, the doors may be closed during the early hours of the day, when most eggs are laid, and open only during the last hours of light period.[72] However, dustbathing activity normally peaks at mid-day.[73,74,75] This means that access may be thwarted during the time period in which hens

are most motivated to use the dustbath. Hens may attempt to dustbathe on the wire cage floor if they do not have access to the dustbath at the appropriate time.[76] Dustbathing bouts are shorter and more frequent when performed on wire flooring as compared to loose litter and differ qualitatively, with less scratching, vertical wing-shaking, and rubbing. Scientists studying sham dustbathing have proposed that these behavioral patterns may indicate frustrated attempts at more complete dustbathing bouts.[77]

Additionally, even when dustbathing does occur in the dustbath provided in a furnished cage, the behavior is excessive compared to dustbaths in deeply bedded, cage-free systems. In floor housing, dustbaths typically occur once every other day and last 20-30 minutes; in furnished cages, hens dustbathe in short, frequent, incomplete bouts, with more than 80% of hens dustbathing daily. Scientists have concluded that the shorter dustbaths are due to disturbance by other birds, and, as it is impossible to supply a thick layer of litter in cages, "dust bathing in cages will never be optimal."[78]

There are few direct comparisons of dustbathing in cage and cage-free systems. In a 2006 study, hens displayed more dustbathing behavior in furnished cages than in an aviary; however the observation period was short (two weeks) and began immediately after the birds were introduced from battery cages into the multi-level cage-free system, prompting the researchers to suggest that birds in the aviary may have adjusted slowly to the new, more complex environment.[79] In a 2008 study of multiple farms, there was no difference in the amount of dustbathing behavior observed in furnished cages and a cage-free system, but most of the dustbathing that did occur in furnished cages was sham dustbathing on the wire cage floor.[80] In a 2009 German study, the complete dustbathing behavior of aviary hens was expressed in a natural circadian pattern, but in contrast, hens in furnished cages displayed incomplete dustbathing patterns in the absence of the normal diurnal rhythm. The length of the dustbathing bouts was also different: In furnished cages, dustbaths lasted 4.62-4.77 minutes while in the aviary the median value for the length of a dustbath was 14.87 minutes. The study authors concluded that normal behavior was "highly restricted" in the furnished cages.[81]

Dustbaths are also difficult to manage in furnished cages. The substrate, often sand or wood shavings, may get displaced by vigorous body movements during normal dustbathing and scratching activities, and it can be time-consuming to replenish the litter manually. Dust in the atmosphere can also interfere with the bearings of drive units operating doors to the nest box and dust bath,[82] and sawdust can become lodged in automated systems.[83]

Foraging is another behavior that is vitally important to hens, as it is to many animals. Hens spend more than 50% of their daily time budget in foraging-related behavior when they are given outdoor access[84,85] and continue to forage for food even when the exact same feed is freely available in a trough.[86,87] Hens in non-cage systems display more foraging behavior and walking in the littered area compared to hens confined in furnished cages.[88] Lack of loose substrate for pecking and manipulation in certain furnished cage designs has been implicated as a causal factor in the development of abnormal feather-pecking behavior.[89] Ground-scratching, a component of natural foraging behavior, serves to wear down the claws, but the claws of hens kept on wire floors can become overgrown in cages.[90] An abrasive strip attached to the egg guard behind the food trough at the front of a cage can enable hens to maintain an appropriate nail length,[91] but is not an adequate substitute for natural foraging behavior.

In cage-free farms, proper litter management is important to ensure good air quality [92,93,94] High dust levels may lead to respiratory problems, but these elevated levels are not typically reached in commercial egg production systems.[95] Clay pellets and sprinkler systems can be used in cage-free facilities if atmospheric dust becomes problematic.[96]

Nesting Behavior

Nesting behavior is so important to the laying hen that it is often used as a prime example of a behavioral need.[97] Decades of scientific evidence show that hens are frustrated, distressed, and that they suffer in conventional battery cages because there is no outlet for normal nesting behavior.[98,99,100,101,102,103,104] To address this need,

furnished cages are equipped with nest boxes. However, the degree to which nest boxes in cages adequately satisfy the needs of hens is questionable. Hens normally remain on the nest for 1-2 hours during egg-laying under natural conditions.[105] They also usually lay their egg early in the morning, and nest box use is proportionally greater during this time period.[106] This situation may create competition for the nest box[107] when all hens need lengthy access during the same short time period.

The nest space requirement for furnished cages set forth in the EU directive stipulates that the total area per hen including the nest box is 750 cm^2 (116.3 in^2),[108] as discussed above. However, since 600 cm^2 (93 in^2) must be "usable space," this leaves only 150 cm^2 (23.3 in^2) per hen for the nesting area.[109] This space allowance may not be large enough, as crowding can occur when multiple birds try to use the nest box at the same time. When this happens, birds may struggle as they move into or out of the nest, and push or climb over each other, possibly causing feather damage.[110]

Nest site selection is also important. Hens examine several different potential nesting locations before choosing a final nesting site. In cage-free housing systems, hens are able to select from many different nest boxes, and studies have shown that hens will inspect several before making a choice.[111,112] Hens vary in their individual preferences for different nest types.[113] They may show considerable ingenuity in accessing alternative nesting sites, sometimes even prying open the closed door to the dustbath to lay their egg in an area they find more suitable.[114] In a furnished cage, hens are highly limited in their choice of nesting sites, whereas in a cage-free system, they have much greater opportunity to lay their egg in a location they find attractive.

In cage-free systems, certain nest boxes, such as the ones at the ends of the house, may be preferred nest sites. This can lead to crowding on the nest and potentially to localized mortality; however, modifications such as removing the nesting material in popular nests or utilizing vertical panels next to nest entrances can mitigate this problem.[115]

The design of furnished cages assumes that we have identified all of the important behavioral priorities of the laying hen. However, there may be important aspects of behavior that science has yet to discover. Currently, we simply do not know how valuable freedom of locomotion is to a hen,[116] and until more scientific investigation is completed, conclusions should not be made prematurely to the detriment of the welfare of hens. Animals are biologically designed for regular movement, and housing systems should provide ample opportunity for them to do so.

Inability to Exercise

One of the most important welfare problems with cages is that they severely restrict locomotion,[117] limiting the ability of hens to get adequate amounts of exercise. Laying hens are prone to osteoporosis. Poor skeletal bone mass of laying hens is thought to have occurred as a consequence of selective breeding to maximize egg production,[118,119] as calcium needed for shell formation is diverted from bone.[120] The chronic lack of exercise in cages compounds problems with osteoporosis[121] and leads to bone fragility and impaired bone strength.[122,123,124,125] Skeletal weakness can also lead to bone fractures.[126,127,128]

Although the opportunity to perch[129,130] and the provision of added space in furnished cages improve bone strength compared to conventional battery cages,[131,132,133,134] hens in cage-free systems are able to exercise more fully and subsequently have stronger wing and keel bones than hens confined in furnished cages.[135,136,137,138] Scientists have found that while hens in modified cages execute more leg movements compared to those in battery cages, wing movements may still be inhibited.[139] Although one study found that bone strength of hens in furnished cages was "partly comparable" to aviary and free-range systems,[140] another study noted that any exercise caged hens are able to perform is "insufficient to prevent bone degeneration."[141]

In commercial egg operations, hens are "depopulated"—removed and killed—at the end of what egg producers consider to be their productive life and replaced with new, younger birds. Hens removed from conventional cages break bones with alarming frequency. Studies report that 16-25% of hens have newly broken bones when

handled and removed from cages at the end of the laying period.[142,143,144] It is thought that the incidence of bone fractures is worsened by lack of exercise,[145] because only slightly more than 10% of hens from barn and free-range housing systems suffer bone breaks when they are caught during depopulation.[146]

Despite the greater bone strength of hens in cage-free systems, they can experience bone fractures during the laying period, which are identified as old bone breaks when the hens are examined at depopulation. Though it is thought that hens in barn and aviary systems can break bones due to collisions and falls,[147,148] as they miss a perch,[149] or as they fly down between levels, even birds in conventional and furnished cages, as well as single-level cage-free systems, where the risk of crash landings would be expected to be low, can have old bone fractures.[150,151,152] A study published in 2008 comparing furnished cages to cage-free systems found high levels of fractures of the keel bone in all systems, with greater numbers of and more severe fractures in non-cage systems;[153] however, as previously stated, it is important to recognize that this problem is related to genetic selection for egg production and it has been shown that selective breeding for improved bone strength is possible.[154,155] Although bone fractures sustained during the laying period is indeed a serious problem, it is within the means of the egg industry to resolve this problem.

The inability of highly productive hens to exercise, combined with the high-energy diet they receive, can lead to fatty liver hemorrhagic syndrome—an increase in adiposis, fat deposition around organs and tissues. Fatty deposits in the abdomen and around the heart can lead to hernia and circulatory disorders, respectively. In severe cases, as pressure builds up in the cells of the liver, the organ may rupture, causing the hen to bleed to death. In a direct comparison of furnished cages and an aviary system, it was found that, in agreement with previous studies, laying hens with more freedom of movement in the cage-free system were less affected by abdominal and cardiac (heart) fat mass and fatty liver.[156]

Fearfulness

Using a variety of behavioral tests, several studies have found that hens confined in both conventional battery cages[157,158,159] and furnished cages[160] are more fearful than those kept in cage-free housing. In one study of battery-caged hens, the researchers found lower overall fear levels in an aviary system compared to conventional cages and concluded that cage-free systems would offer a higher level of welfare.[161] In another study, the scientists noted that hens can escape from barn staff and other birds in cage-free systems, and distance themselves from potential threats, whereas in furnished cages, there is limited space for avoidance of people or cage-mates.[162] This observation is key. In cages, it is nearly impossible for hens to avoid an aggressive hen or one who feather-pecks, while in cage-free systems, hens have more options for hiding or escape.[163] The opportunity for a prey animal such as a hen to exhibit a flight response when feeling threatened is likely a very important feature of their welfare.

Potential for Injury

Complexity in artificial environments, such as furnished cages, creates more opportunity for hens to get stuck in or injured by enclosure fittings, especially if there are moving parts, such as timed doors, and as the cages deteriorate with age. Although newer cage designs have overcome some of the previous design flaws that were common in conventional cages,[164] the possibility that hens could become trapped in furnished cages is extremely troubling and unacceptable. Trapped birds who cannot extricate themselves may suffer from severe trauma or death. Scientists have noted that the trapping of body parts in this way is almost always due to cage housing.[165]

Mortality

Mortality rate is one clear and obvious indicator of hen well-being in various egg production systems. Because there are few direct comparisons of furnished cages to cage-free systems[166] and fewer still that compare mortality rates between the two, it is difficult to draw conclusions, particularly as reports are somewhat conflicting. While a 2008 study of six flocks in furnished cages and seven flocks in cage-free systems in the

Netherlands, Belgium, and Germany found higher rates of mortality in cage-free systems,[167] as did a German study comparing floor pens to enriched cages published in 2003,[168] a 2009 dissertation found that the mortality rate was 14-15% in enriched cages, but only 7% in an aviary system.[169] The LayWel project, a collaborative research effort among working groups in seven different European countries including data from 230 different flocks with special emphasis on furnished cages, found no overall statistical effect, only that differences in mortality rate depended on whether or not the study was carried out under commercial production conditions or in an experimental study.[170] A comprehensive analysis of mortality in conventional cages and cage-free systems has shown that the genetic strain of the hens is important.[171] Indeed, in the 2008 study mentioned above, two bird strains (ISA Brown and Bovans Goldline hens) had lower mortality compared to others observed in non-cage systems. Among the study's conclusions was the statement that "[t]hese hybrids may be better suited for non-cage systems than other hybrids used."[172] Good management—including selection of appropriate hen strains—in cage-free systems is likely very important for helping to keep mortality rates low.

Group Size, Space Allowance, and Injurious Pecking Behavior

Part of the rationale for developing furnished cages was that smaller group sizes in cages might reduce the likelihood of an outbreak of abnormal feather-pecking behavior. Some sources contend that there is a higher risk for the development of injurious pecking that can lead to cannibalism in large group sizes.[173,174] This is in part because there is greater potential for birds to imitate the injurious pecking behavior of other hens in a large group[175] and because individual birds who learn to feather-peck will have many more potential victims.[176,177]

Under experimental conditions, feather pecking has been shown to increase with group size among flocks varying between 4-368 birds.[178,179,180,181] However, in a study of egg production facilities with group sizes ranging from 225-9954, there was no correlation between the number of hens in the group and the incidence of cloacal cannibalism.[182] This suggests that the group size effect may have an upper limit,[183] and thus may not apply to larger, commercial-sized flocks. A systematic review of multiple studies found that cannibalism rates were not different between beak-trimmed hens of the same strain raised in cage (small group) and cage-free (large group) conditions.[184] According to the scientists of the LayWel project, the ideal group size is still a matter of much intense research, as the optimal and maximal number of birds per group has not yet been elucidated.[185]

Furnished cages for large groups, up to 60 birds,[186] are used despite the fact that this contradicts the purported benefit of small group size in cages, reduced cannibalism and feather-pecking. In a comparison of two furnished cage types, more hens died in groups of 60 compared to in groups of 40 in one cage design, and over 50% of the mortality in this study was related to cannibalism.[187] In another study of furnished cages, more hens died in groups of 40 or 60 hens compared to groups of 10 or 20, largely due to cannibalism.[188] However, cannibalism can also be very high in groups of 10-20 birds in furnished cages, if birds are not beak-trimmed.[189] To help prevent injurious pecking behavior and to reduce its impact, commercial egg operations routinely sear off 1/3-1/2[190,191] of the end of hens' beaks,[192] as discussed above.

Feather-pecking and cannibalism should not be confused with aggressive behavior,[193] as feather-pecking is thought to be redirected foraging pecks.[194] Studies have demonstrated that aggressive behavior appears to be lowest at either end of the spectrum, in both small, tightly confined groups and in large, crowded flocks. One study of small groups (3 or 6 hens housed at approximately the same stocking density) found more aggression in experimental floor pens, where birds had more space per bird than in cages. The researchers postulated that crowding affects the social behavior of the birds and that aggressive behavior is constrained in cages because reducing the space available for agonistic encounters reduces the social triggers that lead to aggression.[195] However, in another study of group sizes ranging from 72-368 birds, aggression was lowest in the largest group sizes with higher stocking densities, prompting the scientists to write that the hens adopted a "non-social, non-aggressive" social strategy in these conditions.[196] A 2006 study found that in the first two weeks after being introduced to the new system, aggression was higher in an aviary compared to furnished cages when hens were

transferred there after being reared in battery cages,[197] which may have been due in part to the once restricted birds' attempts to establish their social order with new flock mates in an enlarged area.

Indeed, research has shown that the social dynamics are very different in cages and cage-free systems. In a large group, there are more potential aggressors to peck at subordinate hens, but conversely, there is also more opportunity to hide in a large group, and in a crowded environment, a single individual is less conspicuous. At least one study has demonstrated that submissive hens prefer large groups even more strongly than hens classified by the authors as aggressive individuals, which led the researchers to suggest this may be due to the opportunity to avoid persecutors in a larger flock.[198]

Research has also shown that hens tend to choose a large flock given a greater space allowance over a small group in a more confined area. In a preference testing experiment, there was a tendency for hens to choose to join a large group (120 hens) in a large space (9 m^2 or 96.9 ft^2) compared to a small group (5 hens) in a small, enclosed space (1 m^3 or 35.3 ft^3), and a small group in a large space was significantly preferred. The authors noted that the hens seemed to have an aversion to the small space used in the study, prompting the scientists to propose that their research "provides strong evidence in favour of alternative non-cage systems."[199]

Conclusion

While an improvement over conventional, barren, battery cages, furnished cages still severely restrict movement and do not provide the standard of welfare that well-managed cage-free systems can provide. The behavior of hens in furnished cages is highly constrained, and exercise is severely limited. Low levels of exercise contribute to osteoporosis and can lead to liver pathology. Hens in furnished cages are more fearful, and the potential for injury to hens by complex moving parts in furnished cages is troubling. Problems with furnished cages have prompted one European country (Austria) to phase out their use completely by 2020,[200] and Switzerland has banned their use already.[201] Germany is also considering banning them,[202] and there is a proposal in Belgium to prohibit furnished cages by the end of 2024.[203]

The welfare potential of a given housing system is increasingly being seen as a more meaningful way of characterizing the adequacy of egg production operations. Although some scientific evaluations find furnished cages acceptable,[204,205,206] the shortfalls of cage confinement are not and cannot be fully addressed by these modified cages and research to date has shown that even with substantial additional modifications, there will still be inherent welfare problems with such cages. It is entirely possible to house hens commercially in a way that affords them much more freedom of movement, and it is important that industry strive for a system in which all of the behavioral and physical needs of the hens can be met. The inherent lack of space in furnished cages makes this impossible.

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