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Welfare, Health, and Hygiene of Laying Hens Housed in Furnished Cages and in Alternative Housing Systems

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The aim of this review was to compare welfare, health, and hygienic status of laying hens housed in furnished cages and in alternative systems. In alternative systems (floor housing and aviaries), birds have more freedom of movement and a more complex environment than in furnished cages. However, housing birds in much larger flocks in alternative systems leads to an increased risk of feather-pecking. Furthermore, air quality can be poorer in alternative systems than in furnished cages. This can affect health and hygienic status. There are only limited data on a direct comparison between furnished cages and alternative systems. Therefore, there is a need for an on-farm comparison of welfare, health, and hygienic status in these systems.

Conventional cage housing for laying hens will be prohibited from 2012 in the European Union (EU), following EU directive 1999/74. From 2012 on, only fur-

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nished cages and alternative systems (floor housing and aviaries) will be allowed. With the ban on conventional cages coming closer, a strong effort has been put into the further development of furnished cages and alternative systems. In some countries, such as Germany and The Netherlands, the poultry industry is moving toward alternative systems. Germany even is considering banning all cage systems, including furnished cages. In The Netherlands, furnished cages are allowed, but economic and societal forces make the construction of alternative systems more attractive for the poultry industry. In other countries, such as the United Kingdom and Sweden, furnished cages are used as well as alternative systems. In Belgium, the poultry industry is moving toward furnished cages, although a definite decision has yet to be made.

In furnished cages, hens have more space than in conventional cages (750 cm^2 vs. 550 cm^2 per bird). In addition, they have access to a nest; a perch; and an area with some litter for pecking, scratching, and dust-bathing. Depending on the system, birds are kept in relatively small groups, ranging from 5 to 100 birds. Alternative systems can be aviaries or floor housing systems. In both types of system, birds are kept in large groups with a minimal space allowance of 1,111 cm^2 per bird. Birds have access to nests, perches, and a large pecking and scratching area with litter. In aviary systems, birds also have access to different tiers. The major differences between furnished cages and alternative systems—with regard to welfare—are related to group size, freedom of movement, and complexity of the environment (see Table 1). In alternative systems, group size and freedom of movement are larger than in furnished cages, and the environment is more complex. These differences between the systems may affect welfare, health, and hygiene. The aim of this study was to compare welfare, health, and hygienic status of laying hens housed in furnished cages and alternative housing systems.

TABLE 1
Major Differences in Design Between Furnished Cages and Alternative Systems

	Furnished Cages	*Alternative Systems*
Group size	Small	Large
Freedom of movement	Limited	Yes
Space allowance per bird	750 cm^2	1,111 cm^2
Space allowance per group	Small	Large
Complexity of the environment	Medium	Complex
Litter	Limited amount	Large amount
Perches	Low	High
Access to different tiers	No	Yes (aviaries) No (floor housing)

GROUP SIZE

Group size has a major impact on the social behavior and organization of laying hens. Douglis (1948) found that laying hens could recognize and react to 27 conspecifics. Guhl (1958) reported a dominance hierarchy in a flock of 96 birds. In much larger groups, birds do not recognize each other individually. This does not lead, however, to a high incidence of aggression in large groups (Hughes, Carmichael, Walker, & Grigor, 1997). There is evidence that birds in large groups (> 100 birds) use other signals, such as body size and comb size, to establish dominance relationships—the larger bird with the bigger comb being the more dominant (D'Eath & Keeling, 2003; Pagel & Dawkins, 1997). In small (0 to 20 birds) and large (> 100 birds) groups of laying hens, aggression does not appear to be a problem. Intermediate group sizes of about 30 birds may constitute social problems that can affect production (Keeling, Estevez, Newberry, & Correia, 2003). Keeling et al. (2003) compared groups of 15, 30, and 60 floor-housed birds and found that groups of 15 or 60 birds had a better performance than groups of 30 birds. Therefore, it may be advisable to avoid group sizes of about 30 birds.

Group size also affects the risk of *feather-pecking*, the pecking at, and pulling out of, feathers of conspecifics. It is a form of redirected pecking behavior, developing either from food pecking (Wennrich, 1974), ground pecking (Blokhuis, 1986), or pecking during dust-bathing (Vestergaard & Lisborg, 1993).

There are different forms of feather-pecking—gentle and severe feather pecking (Savory, 1995). Mainly, severe feather-pecking will lead to feather damage and result in denuded areas. Pecking in these denuded areas can lead to wounding of the victim and to the development of cannibalism (Savory, 1995).

A separate form of cannibalism is *vent-pecking*. Pecks at the vent can lead to serious wounding and death of the victim (Savory, 1995). More feather-pecking is observed in large groups than in small groups (Bilcík & Keeling, 2000; Nicol et al., 1999). Nicol et al. (1999) compared groups of 72, 168, 264, and 368 birds in percheries and found the most feather-pecking in the largest groups. Bilcík and Keeling (2000) found similar results with groups of 15, 30, 60, and 120 birds in floor pens. There is evidence that birds can learn feather-pecking behavior from other birds (Zeltner, Klein, & Huber-Eicher, 2000), although McAdie and Keeling (2002) found evidence only for transmission of gentle feather-pecking and not for transmission of severe feather-pecking.

However, even if severe feather-pecking does not spread from feather-peckers to nonfeather-peckers, a feather-pecker in a large group of birds can do much more damage than a feather-pecker in a cage with a small group. Furthermore, it is very difficult to identify feather-peckers in large groups of laying hens; once an outbreak of feather-pecking or cannibalism takes place in an alternative system, it will be very hard to stop. An advantage of alternative systems with respect to feather-pecking is that the birds have more opportunities to hide (perches, tiers) and space to escape, than they do in furnished cages, which can let them avoid feather-peckers. Furthermore, the genetic background of the birds used affects the risk of feather-pecking (Bessei, 1984; Kjaer & Sørensen, 1997; Rodenburg et al., 2003). Alternative systems often use hybrids who are more docile and who have a lower propensity to develop feather-pecking than the traditional hybrids used in conventional cages.

In cages, feather-pecking and cannibalism also can cause problems, and abrasion can damage the feathers (Hughes, 1980). A. A. Taylor and Hurnik (1994) compared the feather condition of 3-year-old birds in conventional cages with birds in an aviary system and found that caged hens had poorer feather cover than did hens in the aviary system. At the Provincial Centre for Applied Poultry Research in Gheel, Belgium, feather conditions of laying hens in furnished cages and in an aviary system were compared in two subsequent experiments. In the first experiment, feather condition was much better in the aviary system than in the furnished cages. In the second experiment, however, there were no major differences in feather condition between the two systems (Zoons, personal communication). In a survey among farmers, Pötzsch, Lewis, Nicol, and Green (2001) studied the risk factors for vent-pecking in alternative systems. They identified the following risk factors: dim light around the nestboxes (to encourage nest use), diet changes, use of hanging bell drinkers, and early onset of lay. The first three factors also were shown to increase the risk of feather- pecking.

These results indicate that changes in housing and management can help minimize the risk of feather-pecking and cannibalism in alternative systems. Rearing also plays an important role. Huber-Eicher and Sebö (2001) showed that chicks who had access to litter from 1 day of age spent more time foraging and less time feather-pecking at 5 and at 14 weeks of age than did chicks who had access to litter from 2 weeks of age. Nicol et al. (2001) found similar results. They showed that early experience with litter reduced the chance of feather-pecking in later life and stimulated ground-pecking and dust-bathing.

Group size also can affect fearfulness in laying hens. Bilcík, Keeling, and Newberry (1998) showed that birds from groups of 120 had longer, tonic, immobility responses than did birds from groups of 15, indicating that the former birds were more fearful. Feather-pecking has been associated with fearfulness (Hughes & Duncan, 1972), groups with feather damage being more fearful than groups without feather damage. Furthermore, Rodenburg et al. (2004) found that birds who are fearful at a young age have a stronger propensity to develop high levels of pecking as adults. Hansen, Braastad, Storbråten, and Tofastrud (1993) compared fear in laying hens in conventional cages and those in aviary systems. They found that there was no difference between systems at 30 weeks of age. At 70 weeks of age, however, birds in cages were more fearful than were birds in aviaries. The authors concluded that fearfulness of birds in cages increased considerably over time, whereas the lower fearfulness of birds in aviaries suggests that freedom from fear is more secured in this system.

The spatial distribution of birds over the system can be affected by group size. Channing, Hughes, and Walker (2001) compared group sizes between 323 and 912 birds and found a large variation in density of birds within specific areas of the pen, varying from 9 to 41 birds/m^2. This variation was greatest in the larger group sizes. Extremely high stocking densities in specific areas of the pen can result in birds' suffocating when other birds pile on top of them (Channing et al., 2001).

FREEDOM OF MOVEMENT

Birds in alternative systems have more space than do birds in furnished cages. Especially for comfort behaviors such as wing flapping, stretching, body shaking, and tail wagging, a relatively large amount of space is required. Albentosa and Cooper (2004) compared furnished cages with 762 cm^2 per bird (eight birds/cage) with cages with 3,048 cm^2 per bird (two birds/cage) at two different cage heights (38 cm and 45 cm). Birds showed more wing and leg stretches and more tail wags in two-bird cages than in eight-bird cages, but levels of comfort behavior were low in all groups. No effect of cage height was found. Appleby et al. (2002) found similar results: Comfort behavior, although infrequent in both furnished and conventional cages, was less frequent in conventional cages.

Appleby (2004) studied the spatial requirements of laying hens and concluded that birds in large groups have more freedom of movement. He also calculated the minimum space requirements in furnished cages: eight hundred square centimeters per bird for groups of eight or more, 850 cm^2 per bird for groups of four to seven, and 900 cm^2 per bird for groups of three or fewer. In this analysis, that laying hens synchronize certain behaviors—nesting, perching—was taken into account. According to this study, the space allowance of 750 cm^2 in the current EU regulations may provide the birds with too little space to display all behavior for which they are motivated, particularly when group sizes are small (Appleby, 2004).

The greater freedom of movement in alternative systems allows the birds to walk, run, and fly. Such exercise also provides the birds with stronger bones than those of birds who are housed in conventional cages (Nørgaard-Nielsen, 1990). Olsson and Keeling (2000) showed that laying hens are highly motivated to perch and, if offered a choice, choose a high perch (63 cm) over a low perch (23 cm). In addition, cage height can affect perch use. Struelens et al. (2004) used perches with seven different heights in cages measuring 45 cm, 50 cm, 55 cm, and 150 cm in height and found that the birds preferred high perches but that they were limited by cage height (distance from perch to roof). A negative side of high perches in alternative systems is that birds may injure themselves and even break bones when they miss the perch. Research shows that the following affect the risk of inaccurate landings:

1. Direction of the jump (with jumping downward being more risky).
2. Material of the perch (with PVC or metal being more risky than wood).
3. Light intensity in the house.
4. Color of the perch (Moinard et al., 2004; Scott, Hughes, Lambe, & Waddington, 1999; Scott & MacAngus, 2004; Taylor, Scott, & Rose, 2003).

Furthermore, rearing plays an important role. Gunnarsson, Yugvesson, Keeling, and Forkman (2000) showed that rearing without early access to perches impairs the spatial skills of laying hens.

Traditional housing systems for laying hens frequently have used square wooden perches. In modern systems, round metal perches are used. Lambe and Scott (1998) compared different perch materials and designs and found no particular preferences. They found that wooden perches are difficult to clean and provide attractive hiding places for red mites (*Dermanyssus gallina*). An infestation with red mites can lead to reduced weight gain, anemia, and even increased mortality (Kilpinen et al., 2005). Tauson and Abrahamsson (1996) compared wooden and plastic perches and found that plastic perches led to a higher incidence of leg problems (bumble foot) than did wooden perches—even when the perch was fitted with a soft rubber cover.

COMPLEXITY OF THE ENVIRONMENT

To fulfill their behavioral requirements, laying hens need a complex environment with opportunities for feeding and drinking, pecking and scratching, nesting, perching, hiding, and performing comfort behavior. Alternative systems offer a more complex environment than do furnished cages (Cooper, Albentosa, & Redgate, 2004; Olsson, Duncan, Keeling, & Widowski, 2002; Olsson & Keeling, 2000; Olsson, Keeling, & Duncan, 2002). As a group, the birds in an alternative system have a large floor space available and free access to perches and litter. In alternative systems, litter covers one third of the floor space. This allows the birds to display pecking, scratching, and dust-bathing behavior. In furnished cages, the total floor space available to a group of birds is limited. Birds cannot move over long distances or between different tiers.

In furnished cages, a limited amount of litter is supplied in the pecking and scratching area, resulting in reduced opportunities for foraging and dust-bathing behavior compared with alternative systems. Cooper et al. (2004) reported higher levels of sham dust-bathing than of actual dust-bathing in furnished cages, indicating that birds had too little space for dust-bathing in litter. Lindberg and Nicol (1997) discussed whether pecking at the feed in the feed trough during sham dust-bathing in a cage environment could provide a substitute for access to litter. In their study, birds showed dust-bathing in the dustbox, in the nestbox, and by the feed trough. It is possible that hens start dust-bathing in other parts of the cage because they see another hen dust-bathing in the dustbox (social facilitation). Olsson, Keeling, and Duncan (2002), however, found no evidence that this is the case. They found some evidence that early experience may play a role: If chicks are prevented from dust-bathing and develop sham dust-bathing, they may persist in this behavior even though litter is available. Furthermore, Olsson, Duncan, et al. (2002) showed that sham dust-bathing does not fulfill a hen's motivation to dust-bathe, as birds who had been sham dust-bathing previously were as motivated to dust-bathe in litter as birds who had not been sham dust-bathing. Nestboxes are available both in furnished cages and in alternative systems.

Struelens et al. (2005) studied laying hen preferences for nesting material in furnished cages. They found that, for egg-laying, the birds preferred peat or artificial turf over a coated, wire-mesh floor. The absence of nesting material also will increase the chance that hens lay their eggs in the litter area or in the main cage. In alternative systems, there sometimes are problems with the distribution of the birds over the available nests, especially at the beginning of the laying period. Nests at the front and in the back of the house are crowded, and nests in the middle are empty. This can lead to increased mortality when the birds pile up on top of each other. Practical solutions include vertical panels on the perches in front of the nests, removing the nesting material of the first nestboxes in a row, or closing the first nestboxes altogether. Modifying the nest color may be another solution. Huber-Eicher (2004) showed that hens prefer a yellow nest to other nest colors. This preference seems related to color preferences in early life, as birds who showed a preference for yellow at an early age were indifferent to all nest colors as hens, whereas all other birds preferred yellow nests during the laying period.

Compared with conventional cages, furnished cages offer a more complex environment. Appleby, Smith, and Hughes (1993) showed that pre-laying behavior and dust-bathing behavior were more settled in furnished cages than in conventional cages and that the perches were used intensively. Abrahamsson, Tauson, and Appleby (1996) also concluded that the facilities provided in furnished cages—if properly constructed and managed—were used extensively.

HYGIENE

Hygiene is relevant not only for health and welfare but also for food safety. The large amount of litter and the high level of bird movement in alternative systems are considered potential risk factors: They result in higher levels of bacteria and fungi in the air and in higher dust levels compared with conventional and furnished cages. Furnished cages do not seem to lead to higher levels of bacterial contamination than do conventional cages. De Reu, Grijspeerdt, Heyndrickx, Zoons, et al. (2005) compared the bacterial eggshell contamination of eggs laid in conventional cages with eggs laid in the nestboxes of furnished cages. They found a comparable contamination with total aerobic mesophilic bacteria for either cage system (4.0 to 4.5 log CFU/eggshell). For Gram-negative bacteria, this also was the case (ca. 3.0 log CFU/eggshell). Similarly, Cepero, Yanguela, Lidon, and Hernandis (2000) and Ceparo, Maria, and Hernandez (2001) found no differences in counts of aerobic mesophilic bacteria but reported a higher prevalence of coliforms on shells of eggs laid in furnished cages. Mallet, Guesdon, and Nys (2004) studied the hygienic aspects of eggs laid at different locations in furnished cages compared with eggs laid in conventional cages. Overall, a small but statistically significant difference was observed between eggs from furnished cages (4.8 log CFU/eggshell) and eggs from conventional cages (4.56 log CFU/eggshell). This was due to the eggs being laid outside the nest in the litter area (4.96 log CFU/eggshell) or in the cage (4.94 log CFU/eggshell). The bacterial load on eggs laid in the nests of the furnished cages (4.51 log CFU/eggshell) was similar to the load found in conventional cages (4.56 log CFU/eggshell). The microbial load recorded by Cepero et al. (2001); Mallet et al. (2004); and De Reu, Grijspeerdt, Heyndrickx, Zoons, et al. (2005) in furnished cages remained below 5 log CFU/eggshell and sometimes below 4.5 log CFU/eggshell, limits that could be considered to refer to eggshells with an acceptable hygienic quality.

A higher contamination of eggshells with total aerobic mesophilic bacteria in alternative systems was found compared with conventional and furnished cages (Protais et al., 2003b; De Reu, Grijspeerdt, Heyndrickx, Zoons, et al., 2005). The increase was more than 1 log unit (up to 5.1 to 6.0 log CFU/eggshell), with much higher counts on those eggs laid on the floor (up to 7 log CFU/eggshell). There was a poor relationship between visual soiling of eggs and shell bacterial load (ignoring ground eggs). For Gram-negative bacteria, no significant differences were found among the three housing systems (De Reu, Grijspeerdt, Heyndrickx, Zoons, et al., 2005).

De Reu, Grijspeerdt, Heyndrickx, Uttendaele, and Herman (2005) analyzed the critical control points in different egg production chains of consumption eggs and reported that the most critical point for contamination of eggs in an organic aviary system was the initial contamination at the nestboxes. This was not the case in cage systems, indicating that contamination in alternative systems more frequently takes place immediately after laying and, in cage systems, possibly during processing.

It remains unknown whether the differences in bacterial numbers among eggs produced in different housing systems have an impact on the quality of eggs and egg products. Only Petrak, Petrak, Jelic, Nedjeli, and Hraste (1999) found a direct relationship between initial eggshell contamination and what later is found in egg products. Harry (1963); Smeltzer, Orange, Peel, and Runge (1979); and De Reu et al. (in press) reported a correlation between bacterial eggshell contamination and egg infection. In the studies by Cepero et al. (2001; Cepero et al., 2000), the higher prevalence of coliforms on the shells of eggs laid in furnished cages was not correlated with signs of coliform contamination in egg yolk or albumen.

The total count of aerobic mesophilic bacteria in the air of the poultry house was correlated with the bacterial eggshell contamination at the henhouse (De Reu, Grijspeerdt, Heyndrickx, Uyttendaele, & Herman, 2005; De Reu et al., in press; Protais et al., 2003a, 2003c). Averages of 4 log CFU/m^3 air for the conventional and furnished cages were found, compared with a 2 log units higher average (> 6 log CFU/m^3) in the aviary housing. Zoons (personal communication) reported a contamination of dust five times higher in aviaries than in furnished cages (10.1 mg/m^3 vs. 2.1 mg/m^3). Ellen, Bottcher, von Wachenfelt, and Takai (2000) reported that dust levels are four to five times higher in alternative systems than in conventional cages. Michel and Huonnic (2004) reported a concentration of dust 15 times higher in aviaries than in conventional cages (a maximum of 31.6 mg/m^3 vs. 2.3 mg/m^3). Larsson, Larsson, Malmberg, Martensson, and Palmberg (1999) found 2 mg/m^3 dust in conventional cages and 4 mg/m^3 in alternative systems (aviaries). They also found a tendency for a stronger inflammatory reaction and increased bronchial responsiveness in humans who worked in alternative systems, compared with humans who worked in conventional cages.

Only a small part of the airborne particles are bacteria, but bacteria can negatively affect animal health (Pedersen et al., 2000) and the health of the farm workers (Larsson et al., 1999). In addition, it can lead to higher levels of eggshell contamination (De Reu, Grijspeerdt, Heyndrickx, Zoons, et al., 2005). To date, little is known about the effect of housing system on *Salmonella* contamination of eggs and egg products or about the relationship with human salmonellosis. A study of the U.K. Food Standards Agency did not find significant differences in *Salmonella* spp. contamination on the eggshell due to the housing system (Food Standards Agency, 2004).

AMMONIA

High levels of ammonia in the air also can cause problems. Emission rates of ammonia are higher for alternative systems than for cages, with aviary systems managing lower ammonia rates than floor housing systems (Groot Koerkamp et al., 1998). Kristensen, Burgess, Demmers, and Wathes (2000) showed that laying hens, when given a choice, prefer fresh air over air with 25 parts per million or 45 parts per million ammonia, indicating that the birds can detect ammonia in the air and show an aversion. High levels of ammonia in the house well may lead to welfare and health problems, both for the animals and for the caretakers. Von Essen and Donham

(1999) stated that high endotoxin, ammonia, and dust levels contribute to acute and chronic respiratory symptoms in farm workers. Wathes, Jones, Kristensen, and McKeegan (2004) reported that chronic exposure to ammonia increases susceptibility to respiratory pathogens in poultry; may lead to impaired performance; and—after exposure to high levels—to eye problems.

HEALTH IN RELATION TO HOUSING SYSTEM

The effect of housing system on health parameters has been investigated in a number of studies. Abrahamsson et al. (1996) compared health of birds in conventional and furnished cages. They found some differences in foot health between the systems and more keel bone lesions in the furnished cages. The highest mortality was registered in the get-away cage, a type of furnished cage.

Furthermore, it has been found that birds from furnished cages had stronger bones at slaughter, compared with birds from conventional cages. Abrahamsson, Fossum, and Tauson (1998) studied mortality and health in an aviary system. Mortality varied between pens and between batches and generally ranged between 3% and 8% per laying period. In some pens and batches, mortality was much higher (16% to 21%). The major causes of mortality were salpingitis (inflammation of the oviducts) and cannibalism. In some batches, coccidiosis, lymphoid leucosis (big liver disease), and red mite infestations caused problems. Other abnormalities found were keel bone deviations and foot abscesses, both increasing with age. Michel and Huonnic (2004) compared the health of laying hens in conventional cages and aviary systems and found that mortality was higher in aviaries but remained within acceptable limits (up to 5%) and that the rate of injurious pecking was low.

Mortality in the aviary systems mainly was due to problems with adapting to environment (smothering). Feather quality was better in aviaries than in cages, probably because of abrasion. The incidence of injuries was higher in aviaries than in cages. Birds in aviaries had stronger bones, with the strongest bones found in the birds who were raised in a system with perches (Michel & Huonnic, 2004). As mentioned previously, access to perches also can lead to broken bones. Gregory, Wilkins, Eleperuma, and Balantyne (1990) studied new and old bone fractures in laying hens from various housing systems after depopulation. They found 31% new breaks (due to depopulation) in battery hens, whereas only 5% of the birds had old breaks (due to the housing system). In hens from a perchery, 10% had new breaks; 25% had old breaks.

ON-FARM WELFARE ASSESSMENT

A method to assess welfare on farms would allow a comparison between farms and housing systems. In recent years, a number of different welfare assessment methods have been developed and evaluated. On-farm welfare assessment methods are based on a range of welfare parameters, which can be divided into two categories: (a) environment-based or (b) animal-based parameters (Johnsen, Johannesson, & Sandoe, 2001). Environment-based parameters are related to the system, the management, and the stockmanship of the farmer, whereas animal-based parameters record the "response" of the animals to that particular system.

Some environment-based parameters, such as space allowance or litter quality, are relatively easy to assess and have a good repeatability. Animal-based parameters, such as levels of stress hormones, abnormal behavior, or disease, are more direct measures of welfare; however, the recording and interpretation of animal-based parameters can be time-consuming and difficult (Johnsen et al., 2001). For laying hens, a limited number of welfare assessment methods is available. The main method based on environment-based parameters is the animal needs index or *TGI* (Bartussek, 2001; Striezel, Anderson, & Horning, 1994). This method includes one animal-based parameter, namely, general feather condition of the birds.

Mollenhorst, Rodenburg, Bokkers, Koene, and deBoer (2005) compared the animal needs index with two animal-based methods: (a) individual feather condition scoring and (b) behavioral observations of abnormal behavior and time budgets. They conducted all measurements on 10 farms with conventional cages and on 10 farms with deep litter systems and found positive correlations between the animal needs index, a high score indicating good welfare, and high levels of locomotion and comfort behavior. Furthermore, they found a negative correlation between the animal needs index and the amount of feather damage to the wings. The results of their study showed that the animal needs index was sensitive enough to show differences between different types of housing systems but not differences within the same housing system. Deep litter systems had a higher score, indicating better welfare, than did conventional cages (Mollenhorst et al., 2005).

Oden, Keeling, and Algers (2002) evaluated two types of alternative systems in Sweden. They used the distribution of the birds in the system and the frequency of aggression as indicators of differences in access to resources in the different systems. They found that access to litter and nestboxes was insufficient in both systems using stocking densities between 10 birds/m^2 and 19 birds/m^2. Other indicators in this study included feather-pecking behavior, dust-bathing activity, and fear reaction (Oden et al., 2002). It would be a valuable tool to be able to combine such different welfare indicators to an overall welfare score. However, to combine these separate indicators into an overall welfare assessment, their relative weights have to be compared.

Agrotechnology and Food Innovations B.V. (2004) developed a welfare assessment method for laying hens to evaluate systems and give them a score from 0 to 10. To assign weighting factors, they evaluated scientific literature on housing, management, and welfare of laying hens—based on the procedure described by Bracke (2001)—and created a model containing this information. They validated this model by comparing the scores produced by the model (based on scientific literature) with scores given by experts on poultry behavior and welfare and found a substantial agreement between the two. In their study, furnished cages and alternative systems scored, respectively, 2.3 and 5.8 out of 10 points using the model and 4.2 and 7.5 points using the expert opinions (Agrotechnology & Food Innovations B.V., 2004).

CONCLUSIONS

The aim of this review was to compare the welfare, health, and hygienic status of laying hens housed in furnished cages and in alternative housing systems. In alternative systems, birds have more possibilities to display various behaviors, resulting in stronger bones and higher levels of foraging, dust-bathing, and other comfort behaviors, than in furnished cages. Conversely, the large group size leads to an increased risk of feather-pecking, although some studies also have found a poorer plumage cover in furnished cages than in alternative systems. Air quality is poorer in alternative systems than in furnished cages: High levels of dust, bacteria, fungi, and ammonia can be detected. This can affect health and hygienic status. Data on a direct comparison between furnished cages and alternative systems are limited; therefore, an on-farm comparison of welfare, health, and hygienic status in these systems is needed.

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