Housing conditions and welfare of laying hens

Msc Thesis Environmental Biology
Track: Behavioural Ecology

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October 2011

Introduction

There are currently 5 billion laying hens around the world used in the egg production industry. Around 370 million laying hens are housed in the European Union and a significant number of around 45 million layers are housed in the Netherlands. Figures 1 and 2 show the number of laying hens in the top egg producing countries worldwide and in the EU. The Netherlands is the world largest egg exporting country (International Egg Commission 2011). In 2009 the Netherlands had more than 700 holdings with a capacity of more than 10.000 laying hens (LEI, CBS 2010). Huge amounts of layers within a single company implement an intensive egg production system. This mass production of eggs raises questions about the welfare of the laying hens housed in the egg production systems.

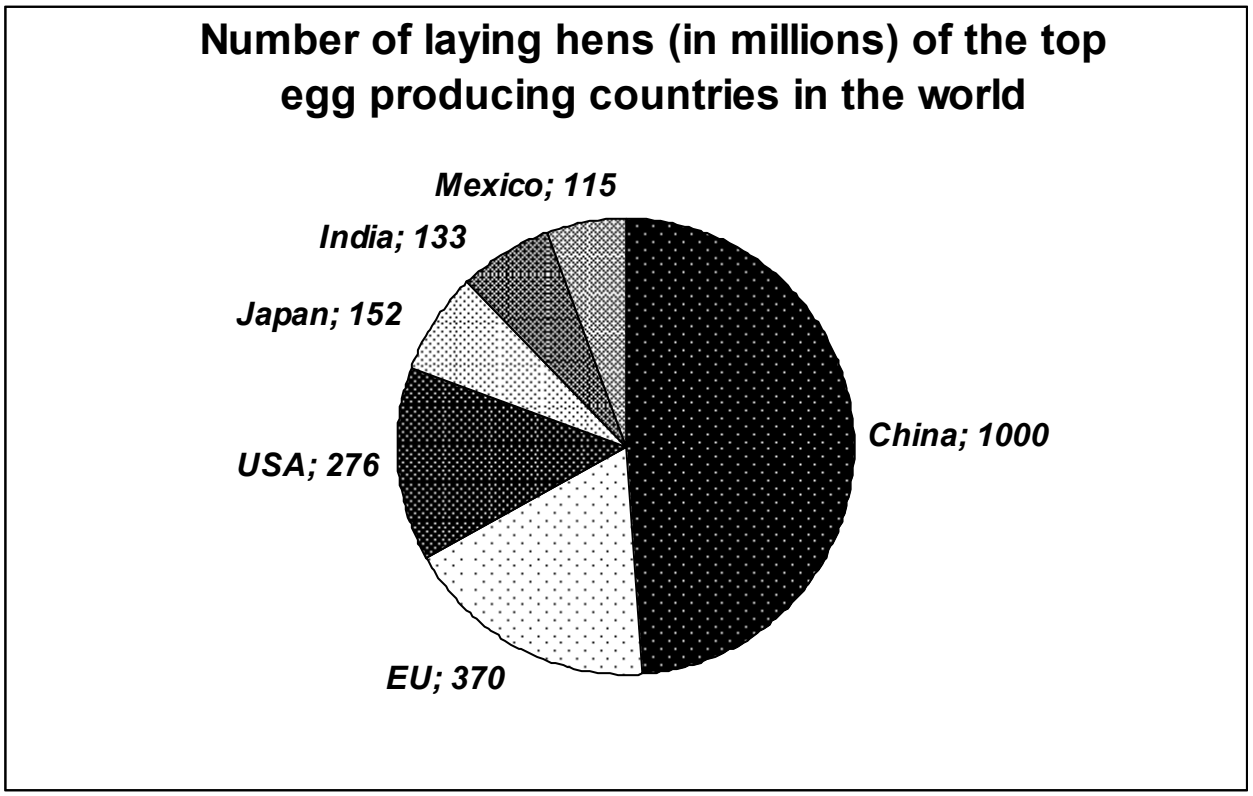

Fig 1. Countries were most laying hens are housed worldwide (International Egg Commission 2011).

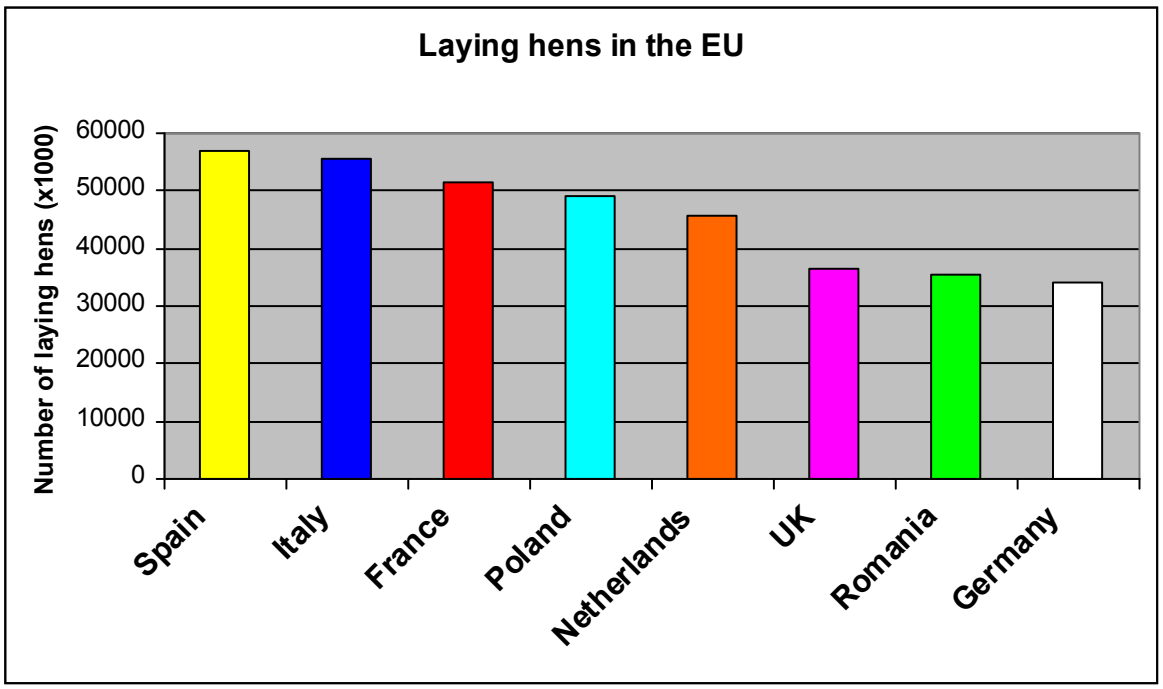

Fig 2. The top egg producing countries in the EU and their laying hen numbers. (Eurostat 2011)

When investigating if animal welfare is impaired in laying hens, one could start looking at its natural behaviour. The laying hen that provides today's world from eggs finds its ancestor in the Red jungle fowl (*Gallus gallus*). Comparing the behaviour of the Red jungle fowl with that of modern layers is questionable, because 8000 years of artificial selection has drifted the laying hen genetically away from its ancestor (Cooper, Albentosa 2003). However it is thought that the original behaviours (or instincts) do not disappear during domestication, only frequency and thresholds of these behaviours can be influenced by domestication (Hale 1962, Price 1998). Modern laying hens allocate resources differently compared with the red jungle fowl, but show the same behaviours as their ancestors (Schutz, Jensen 2001). A good example of natural bird behaviour is nesting behaviour. A study on this behaviour in laying hens showed an intrinsic urge to work for the opportunity to lay in an enclosed nest site (Cooper, Appleby 2003). All these findings make it plausible to assume that laying hens still possess behavioural instincts and needs inherited from their ancestors.

The Red jungle fowl habitat lies in the forest of Malaysia. The part of the forest where the red jungle fowl spend most of its time has a high percentage of bamboo plants, this bamboo is believed to provide protection from predators in the sky, like birds of prey (Stahl, Ruette & Gros 2002). Red jungle fowls live in social groups of about 20 to 30 animals (Collias, Collias 1996), are able to discriminate between group members (Bradshaw 1991) and use this ability to build and maintain a social hierarchy (Abeyesinghe et al. 2009).

The daily routine of the red jungle fowl starts with crowing of the roosters in the group at dawn, to clarify their territorial boundaries. As soon as daylight arrives chickens start to search for food and visit waters to drink (Collias, Collias 1967). Foraging behaviour takes up a high proportion (61%) of the day in the red jungle

fowl (Dawkins 1989). Another peak in drinking behaviour was found at the end of the day. The red jungle fowl seem to have different places in their territories with different behavioural functions; distinction was seen in places used for roosting, drinking and foraging (Collias, Collias 1967). As mentioned earlier nesting behaviour seems to be very important to hens. Research on laying hens in organic farms showed that most eggs were laid in the morning. The total event lasted for about 30 tot 45 minutes and started with the hen retreating from the group to a nest site, after a rest period on the nest lasting up to 30 minutes, the egg was laid. After another short rest period the hen left the nest and rejoined the flock (Bestman 2002). Dustbathing, a behaviour performed to clean the plumage of the hen is most seen in the middle of the day and is often performed in couples or in small groups, so hens can help each other cleaning their feathers (Vestergaard 1982). In organic laying hen systems, hens are allowed to go outside during day-time. Hens utilize this opportunity mostly in the morning and at the end of the day, just before dark (Bestman 2002). Other behaviours that belong to the natural behaviour of the red jungle fowl and are observed in the wild as well as in commercial flocks are wing flapping, tail flapping, and litter scratching. When it becomes dark, red jungle fowl search for a high placed branch to perch for the night.

All these natural behaviours have an intrinsic motivation. This motivation will not suddenly disappear when the environment of the laying hen provides no opportunities to perform this behaviour. When the environment is not satisfactory, the animal will be frustrated (Duncan 1998). This frustration sometimes even shows through abnormal behaviour, behaviour that is not shown in nature.

During the domestication of the *Gallus gallus* artificial selection was mainly focused on egg production. The red jungle fowl lays about 20 eggs a year, while the modern laying hen can produce more than 300 eggs a year. This massive grow in egg production has shifted the resource allocation of the laying hen. Compared to the red jungle fowl, laying hens spent less time on foraging, exploratory and social behaviour (Schutz, Jensen 2001) , but as explained above these behaviours still exist in the laying hen. Unfortunately during the domestication there was no selection in favor of stress resistant chickens or for chickens that would fit in an intensive bio industry.

Animal welfare has become a subject of main interest during the last decades. When several studies stated that many animals (e.g. mammals and birds) were conscious and able to suffer from pain and stress, people started to ask questions about the circumstances of animals in the food production industry. A moral debate created by these questions still has not led to consensus about the housing and management systems that account for natural needs of laying hens. Although no definitive answer is found yet on what to do with all the animals in the bio industry, concerns on animal welfare have led to legislation on the welfare of farm animals in some developed countries (EU countries and Switzerland). Other countries with many farm animals, like America, China and Brazil still have inadequate legislation on animal welfare (Tauson 2005, Van Horne, Achterbosch 2008).

About 20 years ago almost all laying hens in the commercial egg industry were housed in conventional laying cage systems. The housing conditions in these so called battery cages led to animal welfare concerns on laying hens. The EU countries decided in Council Directive 1999/74/EC to phase out all conventional cage systems by 2012. Furthermore an EU egg code was introduced. This egg code is visible on every commercial egg and tells the consumer in what kind of housing system the egg is produced. Unfortunately this new legislation does not mean one can stop asking questions about the laying hen welfare in the egg production system. This thesis will investigate laying hen welfare in different housing conditions. To assess animal welfare the framework of (Ohl, van der Staay 2011) is used:
"An individual is in a positive welfare state, when it has the freedom to display normal behaviour patterns that allow the animal to adapt to the demands of the prevailing environmental circumstances and enable it to reach a state that it perceives as positive."
In addition the ability to perform natural behaviour and the absence of abnormal behaviour will be assessed as positive welfare indicators. At last also the 5 animal freedoms are used as a guideline when looking at laying hen welfare. These freedoms are stated as follows (FARM ANIMAL WELFARE COUNCIL 1992):

1) Freedom from hunger and thirst
2) Freedom from discomfort
3) Freedom from pain, injury and disease
4) Freedom to express normal behaviour
5) Freedom from fear and stress

With these frameworks as main paradigms on animal welfare an answer is searched on the following research question:

What is the influence of the different housing conditions on the welfare of laying hens?

Different housing systems

All eggs sold to consumers in the EU have an egg label. The first number of this label represents a certain housing system. The features of these housing systems are shown in table 1 and will be explained further below. The hierarchy in the egg label numbers intends to give the consumer an indication of the welfare of the laying hens in these systems (where a lower number represents a better state of welfare). The housing system is only classified by its features and not by its management. During the rearing period (first 16-18 weeks of life), hens are housed at different locations and with different circumstances. These circumstances do not have an influence on the egg number. Worldwide around 85% of the laying hens are housed in the conventional cage system (International Egg Commission 2011), fortunately numbers already look better in the EU (shown in figure 2).

Table 1: Different housing system as referred to by the egg number. **CC**: Conventional cage. **FC:** Furnished cage (LayWel 2006)

Number	Housing system	Description
3	Cage (CC & FC)	CC: At least 550cm² per hen. FC: at least 750cm² per hen, cage is enriched with e.g. nest and perch
2	Barn	Hens housed in large groups in barns, sometimes multi-tiered, not more than 9 hens per m²
1	Free range	Same as barn, with as addition outdoor area available (one hen per 4 m² in the outdoor area)
0	Organic	Same as Free range, but more space inside barn (6 hens per m²) and feed with organic food.

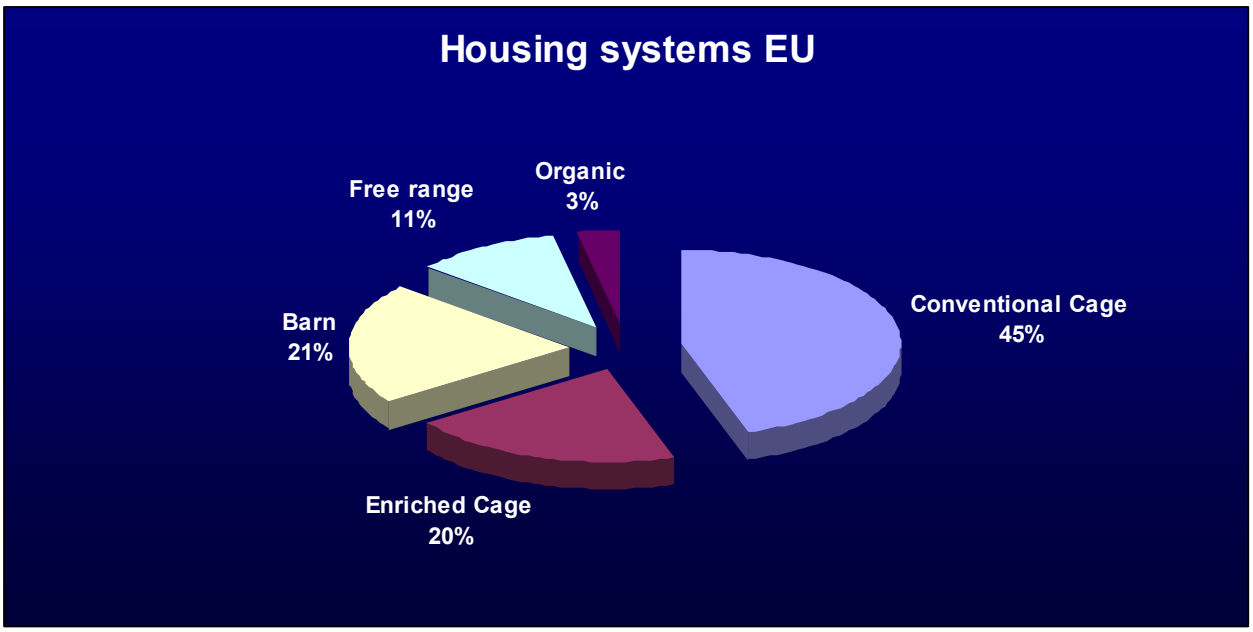

Fig 3. Distribution of laying hens over the different housing systems in the EU (EU Management Committee 2011)

Cage systems

The conventional cage (CC) system will be banned in the EU from 1 January 2012, but is still the most used system worldwide and therefore will be taken into account. In a CC laying hens are housed with a couple of other hens (3-5 hens per cage). Food and water is provided ad libitum and claw shortening devices must be provided (in the EU), but no further items are mandatory to enhance the welfare of the laying hens in CC.

In a furnished cage (FC) hens have more space and some features of the FC provide space for expressing natural behaviours. For instance nest boxes are provided so the hen can perform nesting and laying behaviour. Furthermore perches give the hen a chance to perch and litter is present for pecking and scratching behaviour (i.e. foraging behaviour). FC house either small groups (<15) or large groups (>30) of hens (Blokhuis et al. 2007).

Barn

There a two common types of barns. A barn can either be a single level barn or a multi-tiered aviary (at least 2, but not more than 4 levels) (LayWel 2006). This housing system is often referred to as a non-cage system (NC). For both types of NC the same rules apply. Nest sites must be placed and at least one third of the floor space must be occupied by litter. At least 15 cm of perch space per hen must be provided. Laying hens in barn systems are often housed in large numbers and never leave the barn during their life span; they may even never see sunlight.

Free range

Free range (FR) systems have the same characteristics as barn systems but in addition provide access to an outdoor area. A sufficient number of pop holes must give access to this outdoor area. There are no rules concerning the design of the outdoor area, often the area consists of open pasture without any cover provided by plants or trees.

Organic

An organic housing system looks similar to a FR system, but laying hens have more space inside the barn (6 hens per m^2 as opposed to 9 hens per m^2 in FR systems) and no more than 3000 hens should be housed together. Furthermore the food is restricted to organic food and medication for the laying hens is limited. In all the above described housing systems beak trimming (to prevent feather pecking) is allowed, except in organic systems, where beak trimming is forbidden.

New Alternative systems

Concerns about laying hen welfare have led to new housing systems (like the furnished cages). One of these new housing systems is the so called “Rondeel” housing system, developed by a combination of farmers and animal scientists from the University of Wageningen. The purpose of the rondeel system is to obtain a environment, where the hen can perform its natural behaviours and welfare is not impaired. Following the EU norms rondeel is classified with an egg number 2 (Barn).

Laying hen welfare problems

This section will describe the many problems occurring in the egg industry regarding laying hen welfare.

Natural behaviour problems

A great portion of the housing systems for laying hens is not able to meet the standard of the 5 animal freedoms. The only freedom that is met in all the housing systems is the freedom from hunger and thirst. Many problems occur when laying hens are not able to perform natural behaviour. One of the most important natural behaviours is nesting behaviour. When a nest is not present, pre laying behaviour is prolonged (Wood-Gush 1975), nesting behaviour is not possible and this will result in frustrated gakel calls (Zimmerman, Koene 1998) and in an increased amount of frustration pacing (Yue, Duncan 2003).

Dustbathing behaviour is another natural behaviour that laying hens seem to be willing to perform daily. When dustbathing facilities are not installed in the cage or barn laying hens will perform so called "sham-dustbathing" behaviour. This sham-dustbathing decreases when litter or other substances to dustbath in are provided (Lindberg, Nicol 1997). Natural body movements like wing flapping and tail wagging are often restricted by stocking density. When stocking density is lowered, rebound behaviour occurs regarding wing flapping and tail wagging (Nicol 1987).

Flock density / flock size problems

Flock size seems to have a more severe effect on laying hen welfare than flock density. Increasing flock size seems to correlate with increasing fear (Bilcik, Keeling & Newberry 1998), and lower body weight (Keeling et al. 2003). In housing systems with an outdoor area, the percentage of hens that dares to go outside is negatively influenced by both stocking density (Bubier, Bradshaw 1998) and flock size (Hegelund et al. 2005). As explained before, the ancestors of laying hens tend to form social groups of 20 to 30 chickens. In all non cage systems the flock size is enormously large compared to this natural number. Experimental research has shown that laying hens are able to distinguish between familiar and non-familiar conspecifics (Dawkins 1981).There is however a limit to the number of group members a laying hen is able to remember, 100 individuals seems to be the maximum number of conspecifics that can be remembered by a laying hen (Nicol et al. 1999). Social recognition is a prerequisite for establishing a social hierarchy. Therefore, a social hierarchy can not be established in large flocks (Pagel, Dawkins 1997).

Feather pecking

Absence of social hierarchy, food source, large flock sizes and density all seem to have an influence on the occurrence of severe feather pecking (SFP). SFP is one of the major problems in the egg production industry (Blokhuis, Vanderhaar 1989). SFP should not be confused with gentle feather pecking, which probably has a social function when it is used to preen or groom another hen. Gentle feather pecking does not result in plumage damage (Lambton et al. 2010). SFP on the other hand means pecking at feathers or plucking out feathers of other hens and sometimes this feather pecking even results in cannibalism. Cannibalism in combination with SFP accounts for about one third of all the deaths occurring in the laying hen industry (Blokhuis et al. 2007). SFP is often regarded to be a form of redirected foraging behaviour, studies in which foraging opportunities where increased (e.g. providing mashed food in stead of pellets) showed a decrease in SFP (Lambton et al. 2010, El-Lethey et al. 2000). In multiple studies no relation was found between stock density and SFP (Appleby, Hughes & Hogarth 1989)(Carmichael, Walker & Hughes 1999), but SFP increased when the flock size increased (Nicol et al. 1999, Bilcik, Keeling 2000). The mean aggression rate of the whole flock is decreased in a larger flock size (Nicol et al. 1999, Estevez, Newberry & Keeling 2002, Estevez, Keeling & Newberry 2003). This can be explained by the fact that no social hierarchy has been established. Normally aggression is used to establish and maintain a social hierarchy for instance by controlling a food source by aggression, but when this hierarchy is absent, laying hens could switch to a social tolerance strategy (Estevez, Newberry & Keeling 2002, Estevez, Keeling & Newberry 2003, Hughes et al. 1997). Lower aggression in large groups does not implement that problems with SFP also decrease. Although the general level of aggression is lowered, some individuals show despotic behaviour and cause severe feather damage on other hens (Estevez, Keeling & Newberry 2003). A minority of the laying hens become victims of SFP. When feathers are damaged they elicit more SFP and this can eventually lead to the dead of the victim (McAdie, Keeling 2000).Victims often develop hiding strategies, using high placed perches (if present) (Cordiner, Savory 2001). Sometimes SFP victims have limited access to water and food, resulting in lower body weight (Freire et al. 2003). It is obvious that elevated stress levels will be found in hens that are feather pecked. However it is shown that the laying hen performing the severe feather pecking is also more stressed (El-Lethey et al. 2000) and feather pecking laying hens are more fearful according to the results of Tonic Immobility tests (Vestergaard, Kruijt & Hogan 1993). These observations suggest that stress could be a cause of the development of SFP behaviour.

Diseases and injuries

Besides the impaired laying hen welfare caused by feather pecking there are several other problems regarding the physical health of layers. Bumble feet is one of them, caused by bacterial infections and occurring on a large basis mainly in the CC system (Lay et al. 2011). Non cage systems often have to deal with ectoparasites living in the nests of the laying hens, one of these parasites is the infamous red mite. The red mite is presently a paramount problem in the EU non cage laying hen systems and often impairs the health of the hen and sometimes can even lead to death (Rodenburg et al. 2008). Impaired bone structure occurs often in the CC systems, were limited mobility leads to weaker bones and sometimes even osteoporosis (Shimmura et al. 2010, Webster 2004). Perches provided in NC systems are seen as an environmental enrichment for the hens, because perches foresee in the need to perch. However falls from high placed perches are the main cause of bone fractures (Lay et al. 2011). In all housing systems bone fractures can occur during transport and depopulation (Lay et al. 2011).

Comparison of the different housing conditions

Having discussed the welfare problems occurring in the egg production industry, the next section will describe the differences in laying hen welfare in the different housing conditions. This will be done on the basis of the 5 animal freedoms.

1. Freedom from hunger and thirst

This is the only freedom that seems to be the least endangered in the current housing systems. No differences were found between the housing systems regarding hunger and thirst (Shimmura et al. 2010). Beak trimming, performed in all systems except in the organic systems, can reduce the food intake, but this effect is often only temporary visible (Lee, Craig 1991). No major problems occur with hunger and thirst in the egg production industry.

2. Freedom from discomfort

For this freedom management of the housing systems is of great importance. Factors such as the light schedule, adequate drinkers, the managements of the outdoor area and the litter have a huge influence on the welfare of laying hens (Green et al. 2000, Potzsch et al. 2001, Nicol et al. 2003). Each farmer has his own management and therefore is it difficult to compare the different housing system on this freedom. However, there are some general differences. To provide sufficient freedom from discomfort, the environment of the laying hen must provide shelter and comfortable resting areas (FARM ANIMAL WELFARE COUNCIL 1992). CC only provides shelter with a roof on top of the cage, but shelter from other hens within the same cage can not be obtained. CC systems also lack sufficient resting areas. FC systems provide perches for resting and hens are able to seek shelter and lay eggs in the enclosed nesting boxes. Barn, FR and organic systems all provide resting areas. Shelter is very important in the outdoor area. The FR and organic systems outdoor area are often not provided with cover, reducing the amount of hens that dare to go outside (Mahboub, Müller & von Borell 2002). Laying hens get scared of flying objects like airplanes, probably associated with birds of prey, when no cover is provided in the outdoor area (Jones 1996) and consequently they stay close to the barn (Bubier, Bradshaw 1998). Therefore the outdoor area should be inspired by the natural environment of the red jungle fowl, providing shelter in the form of vegetation (bushes and trees) (Bubier, Bradshaw 1998).

Hens in a barn systems with adequate management could suffer less from discomfort than hens in an organic system with an impaired management regime (e.g. no cover in outdoor area, bad litter quality etc). In general the CC will have the least freedom from discomfort.

3. Freedom from Pain, Injury and Disease

On this subject the main dilemma is between severe feather pecking and beak trimming. Feather pecking is associated with stress and will therefore be discussed later on, but certainly causes pain (sometimes even severe injuries or death) on the victim. The beak is the most important sensory part of the body of a chicken and is densely innervated. Beak trimming will therefore always cause short term pain (Kuenzel 2007), chronic pain can be prevented by trimming before day eight of the life and by reducing the beak length not more than 50% (Glatz, Lunam 1994, Gentle et al. 1997). Beak trimming is performed in all housing systems, except the organic. Obviously the organic housing systems scores higher regarding the reduction of pain involved with beak trimming, other systems are dependable on the beak trimming procedures. The absence of beak trimming in organic systems often implies a higher occurrence of feather pecking (Tauson 2005), the consequences hereof will be discussed later on.

When comparing the housing systems on the third animal freedom, multiple articles have assigned the FC (Furnished Cage) as the systems with the most freedom from pain injury and disease. One article found more cannibalism in housing systems with a large group size (Barn and FR) (Shimmura et al. 2010). In another study a higher mortality due to bacterial or viral infections was found, which can easily spread through a dense and large flock housed in a NC (Non Cage: Barn, FR and Organic) systems compared with FC (Rodenburg et al. 2008). Furthermore air quality is often impaired in NC systems caused by a high density of dust particles in the barn, causing problems with nest parasites such as the red mite (Lay et al. 2011). In FC and CC systems parasites are less frequently present (Tauson 2005).

Barn systems are not performing well on the third freedom. One study found no significant differences between CC, FC and FR, but the barn system received a significantly lower score on the third animal freedom. In the barn system laying hens had more stress and old keel bone fractures. Unacceptable amounts of death, mainly caused by cannibalism were found in this system (Sherwin, Richards & Nicol 2010). This finding was corroborated in another study (Lay et al. 2011), which in addition concluded that mortality was lower in FC compared with CC systems. Another important factor on the mortality rate is the genotype of the laying hens. There are differences in vulnerability between different genotypes. Brown hens for instance have a higher mortality than white leghorn laying hens (Blokhuis et al. 2007).

Osteoporosis caused by the impaired movement of laying hens in cage systems is a major welfare problem. In CC systems around one third of all the deaths are caused by osteoporosis (Webster 2004). Although FC and CC laying hens both have weaker bones compared to NC systems, is the occurrence of bone fractures much higher in the NC systems. The percentage of fractures in a NC system, mainly keel bone fractures caused by falling off high placed perches, is as high as 52 to 73% (Freire et al. 2003). Two others studies confirmed the observation that more keel bone

fractures were seen in the NC systems compared with all other housing systems (Nicol et al. 2003, Wilkins et al. 2004).

Altogether barn systems seem to have the most problems in fulfilling the demands of the freedom from pain, injury and disease. Meanwhile the FC systems score high on this part of the laying hen welfare. Group sizes are small, which reduce the appearance of cannibalism and feather pecking. Nestparasites, viruses and bacterial infections are uncommon because of the high standards of hygiene in a cage system. Bone fractures do not occur very often, simply because the cages are not very high.

4. Freedom to express normal behaviour

CC systems obviously do not meet the criteria for an adequate environment for performing normal (natural) behaviours. Nest sites are not included and therefore nest behaviour is not performed in CC systems (Weeks, Nicol 2006). Dustbathing places are not provided, which results in sham-dustbathing (Lindberg, Nicol 1997). Perches are not present and there is no room to perform foraging behaviour. FC systems are developed to fulfil more of the behavioural needs of laying hens and are equipped with perches, enclosed nest boxes, litter and dustbathing substrate. Although the latter does not seem to meet the criteria that layings have for a proper dustbathing place (Blokhuis et al. 2007, Olsson, Keeling 2005). All NC systems provide similar enrichments and provide more space for movement behaviours, such as wing flapping and tail wagging.

FR systems were ranked highest in the freedom to express normal behaviour, followed by the barn systems and the FC systems, CC systems were performing worst (Shimmura et al. 2010).

5 Freedom from fear and distress

Although there are different theories concerning the origin of SFP (severe feather pecking) behaviour in a flock of laying hens, a high association between stress and SFP was found (El-Lethey et al. 2000). Therefore SFP will be discussed in this section. The CC laying systems perform low on this freedom as well. This could very well be related to low score on the fourth freedom, being not able to perform natural behaviour often leads to higher stress levels. Several studies have found higher stress levels in laying hens in CC systems compared with the other housing systems (Shimmura et al. 2010, Shini 2003). As described earlier one study observed more stress in hens in barn systems (Sherwin, Richards & Nicol 2010).

Feather pecking occurrences show a completely different picture. SFP is found in 40 to 80% of the NC housing systems, cannibalism in 20% and feather conditions are better in small FC systems compared with NC systems (Blokhuis et al. 2007). FR systems had more SFP and cannibalism than all other systems in the study done by (Bubier, Bradshaw 1998) and cannibalism occurred more in FR, barn and large FC

systems, which made the authors conclude cannibalism rises with bigger group sizes (Shimmura et al. 2010). Earlier studies already showed there is no relation between group density and SFP (Appleby, Hughes & Hogarth 1989, Carmichael, Walker & Hughes 1999, Gunnarsson, Keeling & Svedberg 1999, Oden, Keeling & Algers 2002), but instead group size is the determining factor in the occurrence of SFP (Nicol et al. 1999, Bilcik, Keeling 2000).
This could be an explanation for the fact that even in organic housing systems SFP still is a major welfare problem (Bestman, Wagenaar 2003). Although organic layers have significant more space per individual, they still live in large groups, much larger than the groups of their ancestor the red jungle fowl.

A so far underexposed factor on laying hen welfare is the welfare conditions during the rearing period of a laying hen. This period is of special importance for coping with distress later in life. Some research is done on the effect of the rearing period and the presence of SFP behaviour as an adult. Floor reared laying hens had better plumage conditions than cage reared layers (Blokhuis et al. 2007). Related to this study other research showed that the absence of litter during the first four weeks of life resulted in more SFP during the laying period (Bestman, Wagenaar 2003). The same researcher found that when chicks were transported earlier in life from the rearing system to an organic housing system, less SFP behaviour would occur later in life (Bestman, Wagenaar 2003). Furthermore hens that already performed SFP as a pullet had a higher chance of performing SFP as an adult (Newberry et al. 2007).

Discussion

One can conclude none of the current housing systems completely meets the criteria of animal welfare as stated in the introduction: *"An individual is in a state of welfare, when it is able to adapt to its environment, and thereby reach a positive state of mind."* Whether physical problems are occurring, like bone fractures and osteoporosis, or impaired mental conditions resulting in or deriving from severe feather pecking behaviour, there are always problems impeding the laying hens of reaching a positive state of mind.

It is difficult to say which of the current housing systems is doing best in laying hen welfare. Every housing system seems to have its pros and cons and not one housing system scores high on all freedoms. The subjective task of allocating value to the different factors involved in laying hen welfare would decide which housing systems comes out on top. However, in general one could conclude that the CC, large FC and the barn system have a more negative influence on laying hen welfare as compared with the small FC, the FR and the organic system.

There is still plenty of room for improvement of the current alternative housing systems. As discussed earlier it is very important to provide cover in the outdoor area of FR and organic systems. Otherwise raining will prevent hens from using the outdoor area (Shimmura et al. 2010), suggesting the use of a wintergarten (a covered outdoor area) in environments with regular rainfall. Computer models have shown that a covered outdoor area enhances the welfare more than an uncovered area (De Mol, R., Schouten, W., Evers, E., Drost, H., Houwers, W., Smits,A. 2006). Bushes and trees should be present to provide natural shelter and protect the hens from bright sunlight and the fear of predators from the sky. Introducing economically costly roosters (they do not lay eggs) could enhance the number of laying hens that dare to use the outdoor area and could reduce levels of fearfulness. Hens seek shelter and are less scared in the presence of a rooster (Bestman 2002). Roosters appear to be a good addition to a flock of laying hens, especially in FR and organic systems, because of the importance of roosters in the use of the outdoor area. Another change which could improve the welfare of laying hens is to reduce the group size. This could diminish the amount of feather pecking behaviour, but could also enlarge the amount of hens that dare to go outside (Bubier, Bradshaw 1998). Feather pecking will become an even larger welfare problem when beak trimming becomes forbidden in more EU countries (e.g. the Netherlands). Reducing the group size, enhancing the natural behaviour opportunities, mainly foraging behaviour could reduce the amount of SFP. On a genetic level, laying hens could be replaced with a newly developed low mortality breed. This new genetic line not only shows a lower mortality but is also less fearfulness (Nordquist et al. 2011).

The new "Rondeel" housing system has as an idea to satisfy the welfare demands of the laying hen. In cooperation with the Wageningen University a totally new housing concept has been developed. Beak trimming was performed on the first round of laying hens as precaution, but seems unnecessary and from now on no more

beak trimming will be performed in the Rondeel system. Because the system has just started no research has been done to compare its hen welfare with the conventional housing systems, but computer models have shown a far better laying hen welfare score for the Rondeel system compared with all the other systems (even organic) (De Mol, R., Schouten, W., Evers, E., Drost, H., Houwers, W., Smits,A. 2006). As mentioned earlier the Rondeel systems is classified as a barn system (eu code 2).

The preliminary success of the Rondeel system and the complicated differences between the current housing systems in laying hen welfare has shown the imperfections of the current EU-Code classification system. The order in the EU code suggest that Organic layers have better lives than free range hens, and FR chicks better than barn hens and that barn hens should have less welfare problems than laying hens living in a cage system. Unfortunately this is not always the case. The EU classification only focuses on a few factors, such as stock density (while stock size is maybe more important) and the presence of outdoor area. For the latter there are no rules on how the outdoor area should be designed, while several studies show the importance of a well designed outdoor area. The huge influence of other factors such as management, and design of the housing system are still underexposed. These factors have a large influence on the laying hen welfare but a merely taken into account when a housing systems is classified as one of the 4 EU codes. This resulted in the classification of the Rondeel system with a 2, while the welfare of laying hens in the Rondeel system seems to be far better than most other systems classified as 2.

A totally new way of classifying a laying hen housing system should be applied. Egg producing companies should be rated by the welfare of their laying hens rather than only on the space per hen and presence of outdoor areas. Tests, used so far only in research, should be used as measurements for a new EU egg code. These tests score laying hen welfare by looking at the feather condition, stress levels, performance of natural behaviours, air and litter quality and bone strength and fractures (Shimmura et al. 2011). Laying hen holders will directly benefit from an optimal welfare state of their laying hens, because of better health conditions, lower mortality and a higher egg classification (so they can sell their eggs at a higher price). One other aspect that should be taken into account when assessing laying hen welfare is the rearing period of the laying hen. The first 16 weeks of life, the laying hen spends in a separate location, which has a potentially negative influence on its behaviour later in life. For instance, hen chicks reared in aviaries with access to litter showed less feather pecking as an adult compared to laying hens raised on wire (Huber-Eicher, Sebo 2001). Ideally pullets would be raised on the same company as where they spend the rest of their lives. Thereby stress from transport is reduced and laying hens can have the same housing conditions their entire lives, which gives the egg code more value.

Altogether there is still a lot of work to be done on the housing conditions of laying hens. Welfare scientist should try to find a solution to feather pecking behaviour. Laying hen holders should have more interest in laying hen welfare and

authorities should adjust their assessment criteria, and inform the consumer better on the welfare of their egg providers.

Literature

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