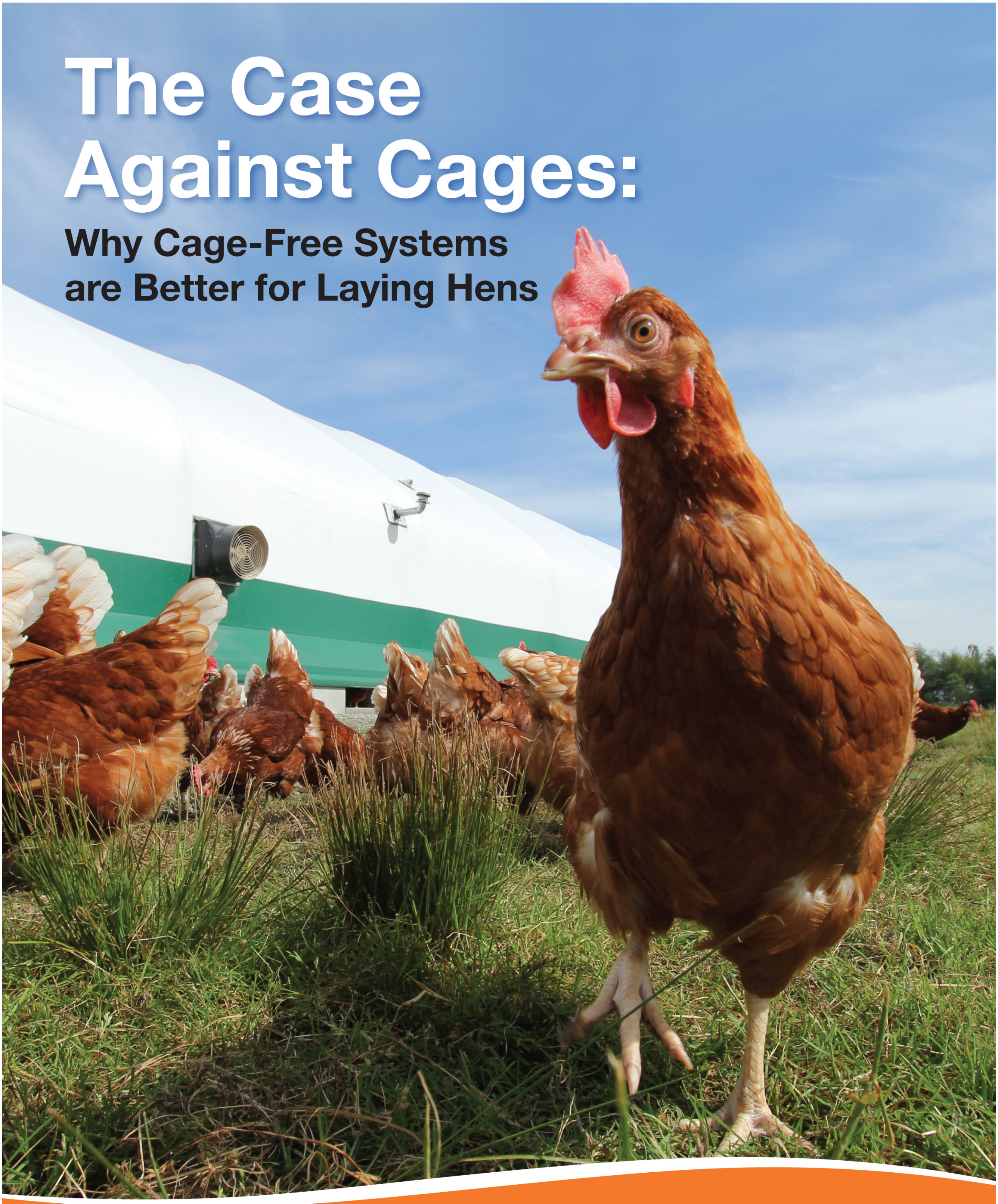
The Case Against Cages:

Why Cage-Free Systems are Better for Laying Hens



World Society for the Protection of Animals

WSPA

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Introduction

Despite the public's strong opposition to caging farm animals and growing support to improve their welfare (Harris/Decima, 2010; Lusk, 2010; Norwood, 2010; Technomic Information Services, 2007), the vast majority of egg laying hens in the U.S. and Canada are still kept in small, barren battery cages. Battery cages, according to the majority of published research, negatively impact hen welfare. As of January 2012, these cages were banned in the European Union and public pressure is forcing authorities, egg producer groups and the food industry to replace cages with more humane housing systems in North America, as well. Three U.S. states and one Canadian province[1] are already phasing-out battery cages, and a federal bill was introduced in 2012 that would ban their use in the U.S.. Progress to improve hen welfare is happening at a quicker pace in the corporate sector, where some of the largest food businesses in the world are telling their suppliers to stop caging hens.

Egg farmers across North America are undoubtedly taking heed of this growing concern for hen welfare and considering whether to transition to furnished cages (also known as modified, colony or enriched cages) or cage-free housing (aviary, free-run, free-range, organic etc.).

While an improvement from battery cages, this paper demonstrates that furnished cages do not provide for all of a hen's physical and behavioral needs. Today's commercially available cages restrict a hen's ability to run, jump, fly and flap her wings. The resulting lack of exercise can contribute to a number of physical ailments, including bone weakness (osteoporosis) and liver pathology. The lack of space also restricts a hen's ability to fully express natural behavior such as nesting, dustbathing, foraging and roosting. Cage-free systems have the capacity to allow for the expression of these behaviours resulting in less frustration, fear and unrest, better plumage, stronger bones, and fewer foot lesions and other physical injuries.

There are certainly advantages and disadvantages with every type of hen housing system and cage-free systems are not without welfare concerns. However, this paper further demonstrates that practical solutions to those issues exist and have been successfully implemented. All of the welfare disadvantages associated with cage-free systems can be addressed through better management and genetic breed selection; the same cannot be said for the welfare disadvantages of cage systems. If managed well, there is considerable evidence that cage-free systems offer a higher level of hen welfare and are best placed to meet future market demand.

[1] In March 2010, the Manitoba Egg Farmers passed a policy that "ensures egg farmers who build new facilities, or undertake a major retrofit after 2018 would be required to have either enriched cages or, an alternative housing system that supports the Five Freedoms." Since battery cages do not provide for the Five Freedoms, they would be eventually phased out. www.mbegg.mb.ca/PDF/News%20Release%20on%20Policy.pdf

Welfare Impacts of Cage and Cage-Free Housing Systems

Restriction of Space

Battery Cages

Conventional battery cages are small enclosures with welded wire mesh sloping floors that cause eggs to roll out onto a collection tray or belt. While manufactured in different sizes, the old A-style frame cages are still used in North America and typically measure 12 inches (30 cm) wide, 16 inches (40 cm) deep, 18 inches (45 cm) high in the front and 16 inches (40 cm) high in the back. Farmers with these cages generally put four hens in each cage. The newer models measure approximately 24 inches (60 cm) wide and 22 inches (55 cm) deep (M. Jendral, personal communication, July 31, 2012). While designed to house five hens, it is not uncommon to find eight birds per cage (American Veterinary Medical Association [AVMA], 2012; Duncan & Rollin, 2012; Humane Society of the United States [HSUS], 2010; Weise, 2010). These cages were designed to be stacked vertically, allowing farmers to keep thousands of hens in one barn. According to the United Egg Producers (UEP, which represents the majority of U.S. egg producers), more than 95 percent of the eggs produced in the U.S. come from companies with more than 75,000 hens (Agralytica, 2012). In Canada, the average flock size is approximately 20,000 hens (Egg Farmers of Canada [EFC], 2011), but the largest operations have more than 400,000 (Agriculture and Agri-Food Canada [AAFC], 2012).

Photo courtesy of CCFA/VHS

If cages are built and used according to the Recommended Code of Practice in Canada and the UEP standards in the U.S., each adult white hen should be provided with at least 67 in^2 (432 cm^2) of floor space, and brown hens should have approximately 75 in^2 (483 cm^2) (United Egg Producers [UEP], 2010; Canadian Agri-Food Research Council [CARC], 2003).[2] Even if the North American industry standard is adhered to, each hen has less space than a standard sheet of notebook paper, severely restricting her ability to move.

[2] For more information see “Comparison of Hen Housing Standards in the U.S. and Canada” in the Appendix.

Furnished Cages

If furnished cages are built and used in accordance with E.U. standards, each hen would have 93 in^2 (600 cm^2) of useable floor space, plus a nest.[3] This additional space, compared with standard battery cages, is roughly the size of a postcard. While an improvement, furnished cages still restrict hens' ability to turn around and walk (Albentosa & Cooper, 2002), and prevent them from running, jumping, flying, foraging and flapping their wings (HSUS, 2010; Lindberg, 1997). The subsequent lack of exercise can contribute to a number of physical ailments, including bone weakness (osteoporosis) (Gregory & Wilkins, 1991; Nicol, Brown & Glen et al., 2006; Wilkins, Brown, Zimmerman, Leeb & Nicol, 2004) and liver pathology (HSUS, 2010). This lack of space also restricts a hen's ability to express natural behavior like nesting (Appleby, 2003), full dustbathing (Lindberg & Nicol, 1997), foraging and perching/roosting – all of which are important for good hen welfare. Vertical space is also very important and research shows that hens will avoid cages with vertical heights less than 18 inches (46 cm) (Dawkins, 1985) - the typical height of a furnished cage (battery cages are generally a bit lower at 16 to 18 inches (40 to 46 cm).[4] Lack of vertical height prevents hens from flapping their wings which is very important for wing loading (the capacity of wings to bear weight) and bone health. It may also limit perching behaviour, which is not only important to permit perching expression, but also preening, which is often performed while birds perch (M. J. Jendral, personal communication, August 27, 2012).

Photo: Dr. Michelle Jendral

Studies demonstrate that hens will use a relatively large amount of space when it is provided, preferring to space themselves out more than they can in cages (Keeling & Duncan, 1989; Nicol, 1987). Laying hens require 158 – 262 in^2 (1,019 – 1,690 cm^2) of space to turn around

[3] The European Council Directive 1999/74/EC requires furnished cages to have a minimum floor space of 116 in^2 (750 cm^2) per bird, of which 93 in^2 (600 cm^2) is at least 45 cm high.

[4] The European Council Directive 1999/74/EC requires all cages to provide at least 45 cm of headroom for hens and many cages are designed to simply meet the minimum standard.

comfortably and require 175-420 in^2 (1,129 – 2,710 cm^2) to flap their wings (Dawkins & Hardie, 1989).

After compiling the latest available scientific evidence on laying hen welfare, researchers at Wageningen University in the Netherlands indicated that more than 310 in^2 (2,000 cm^2) of space per hen provides the best level of welfare (De Mol et al., 2006).

Cage-free Housing

Cage-free systems, on the other hand, generally provide each hen with more space and give them more opportunity to space themselves out in a more natural way. If the industry's voluntary guidelines are followed, each adult brown hen must have at least 295 in^2 (1,900 cm^2) of floor space in Canada (CARC, 2003) or 173 in^2 (1,116 cm^2) in the U.S. (UEP, 2010). However, an increasing number of cage-free farms in North America are certified by independent animal welfare assurance schemes, which have larger space requirements than what is stipulated in the industry's guidelines. These mandatory requirements are verified by independent third party inspectors. Hens kept in cage-free systems have more space for comfort behaviour such as wing flapping, stretching, body shaking and tail wagging (Rodenburg et al., 2005). They also spend more time walking than those kept in cages (Tanaka & Hurnik, 1992). Since cage-free hens are able to exercise more they tend to have stronger wing and keel bones than

■ **Hens in an aviary - a type of cage-free system that provides multi-level perches.**

hens confined in battery or furnished cages (Leyendecker et al., 2005). Despite improved bone preservation, cage-free hens can still suffer from osteoporosis and bone fractures. This needs to be addressed through genetic selection for structural bone preservation and improved housing environments that permit movement and bone loading behaviour (M. J. Jendral, personal communication, August 27, 2012). This is discussed further on pages 18 and 19.

The impacts of restricted space on natural behaviour are discussed in the following sections.

Nesting Behaviour

Nesting behaviour is extremely important to hens and they feel frustrated when it is prevented (Duncan, 1970; Wood-Gush & Gilbert,1969; Yue & Duncan, 2003). Research has shown that hens are highly motivated to find a nest when they are about to lay an egg, and they will work very hard to push open a weighted door to reach a nest site (Cooper & Appleby, 2003; Follensbee, Duncan & Widowski, 1992). In fact, they will work equally hard to reach a nest as they would to access feed after being deprived of it for 28-30 hours (Duncan, 2011). The best laying strains currently lay 320 eggs per year under good management, meaning the lack of suitable nest sites will cause severe frustration seven days out of eight (Duncan and Rollin, 2012). Hens deprived of nests show signs of frustration for one to 1½ hours before the egg is due to be laid. These signs include stereotypic pacing (Yue & Duncan, 2003) (Jendral, 2008), increased aggression (Jendral, 2008), displacement preening (Duncan, 2011), restlessness (Jendral, 2008), vacuum nesting and a specific vocalization called the gackel-call (Zimmerman, Koene & van Hooff, 2000). When a hen retains an egg for a prolonged period while seeking a nest, it can result in an additional layer of calcium on the eggshell which is more visible on brown eggs (Duncan, 2011). According to Dr. Michelle Jendral, there is “widespread acceptance that preventing hens from performing prelaying behaviour is a severe welfare concern and that providing hens with a suitable nest site is an essential welfare requirement (Jendral, 2008).”

Battery cages do not provide hens with nests, and there is typically only one nest area per furnished cage.[5] Because the largest furnished cage systems in North America are designed to house up to 60 (possibly up to 115) (LayWel, 2006) birds and nesting has become a gregarious behaviour pattern that hens like to perform together, they may have to compete to use the nest area. Some will choose to stay in the nest area when not laying eggs, as it is the only private area where a hen can seek refuge from the other birds. Since hens prefer a private nest area, this prevents other hens from laying their eggs in the occupied area.

■ **Hens outside nest box in furnished cage.**

In cage-free systems, hens typically have multiple nest boxes to choose from and studies show they will inspect many potential nest sites before making a choice (Meijsser & Hughes, 1989). The Canadian Recommended Code of Practice suggests that free-run egg farms provide 20 nests for every 100 hens, and the British Columbia Society for the Prevention of Cruelty to Animals (BC SPCA) requires farmers to adhere to this ratio in order to receive their certification. The cage-free guidelines adopted by UEP (2010), recommend 9 ft^2 (.84 m^2) of community nest space per 100 hens.

■ **Multiple nest boxes in a cage-free system.**

[5] As judged by furnished cage displays presented by Big Dutchman, Farmer Automatic, Hellmann Poultry Equipment and FDI Cage Systems at the Poultry Show in London, Ontario Canada on April 12, 2012.

Perching Behaviour

Modern egg laying hens retain the strong perching instinct that is seen in their ancestor, the red jungle fowl. Perching helps to conserve body heat and maintain bone volume and strength (Duncan, Appleby & Hughes, 1992; Hughes, Wilson, Appleby & Smith, 1993; Wilson, Hughes, Appleby & Smith, 1993). Hens will push open a weighted door to gain access to a perch and will show signs of unrest when deprived of this opportunity (Olsson & Keeling, 2000; Olsson & Keeling, 2002).

Hens use perches of different heights for different activities – they will stand and walk on lower perches but prefer to perch higher off the ground (Newberry, Estevez & Keeling, 2001; Schrader & Müller, 2009; Struelens et al., 2004), especially when sleeping (Baxter, 1994; Olsson & Keeling, 2002; Struelens et al., 2009). Research demonstrates that when hens are provided the option of different perch heights, they will choose the highest perches available at night (Olsson & Keeling, 2000; Struelens et al., 2008). Higher perches also allow vulnerable hens to escape the more assertive ones, reducing the potential of injury from feather pecking (Appleby & Hughes,1991; Wechsler & Huber-Eicher,1998).

Battery cages do not provide perches for hens. As most furnished cages have only 18 inches of vertical space, similar to the height of the average hen, perches are just 6-8 cm (2.4 – 3.2 inches) above the cage floor. This is not sufficient to permit natural perching behaviour, and can result in frustration.

Dustbathing

Dustbathing is a natural behaviour which helps to remove stale oil and damaged feathers to keep hens' plumage in good condition (Olsson & Keeling, 2005; Shields, 2004; Van Liere & Bokma, 1987). Battery cage systems do not provide hens with either space or litter to dustbathe. Not all furnished cage models have dustbaths, and those that do, cannot provide sufficient depth or area for the full expression of dustbathing behavior (Cooper, Albentosa & Redgate, 2004; LayWel, 2004; Lindberg & Nicol, 1997; Rodenburg et al., 2005). Because dustbathing is a social activity, the sight and sound of hens dustbathing likely motivates others to join them (Duncan, Widowski, Malleau, Lindberg & Petherick, 1998). There is adaptive value in hens dustbathing together, as it makes them less vulnerable to predation during this time- and energy-consuming behavior. However,

■ **Hens compete to use dustbath in a furnished cage.**

the motivation to dustbathe together can result in competition to use the limited dustbathing space and substrate available in furnished cage systems. While some hens can dustbathe in a furnished cage, others are unable to as they are disrupted by other hens while trying (M. Jendral, personal communication, August 27, 2012).

Some furnished cage systems are designed with automated doors that restrict access to dustbathing areas for a portion of the day in order to discourage hens from laying eggs in the litter. While the results of studies vary, some indicate that most dustbathing activity in furnished cages happens on the wire cage floor (Rodenburg et al., 2008). This is called 'sham dustbathing' and may be a sign of frustration.

Research indicates that dustbathing leads to pleasure and is therefore important for animal welfare. Animal welfare and behavior experts agree that welfare should be more than just the avoidance of suffering (Widowski & Duncan, 2000). Indeed, expressing behaviours that encourage a positive affective state is part of good welfare and overall well-being.

■ **Hens dustbathing in a free-range system.**

Foraging

Despite easy access to a constant supply of feed, caged hens still retain the natural motivation to forage. Studies show that they will choose to forage rather than just eat the feed available in a feeder (Dawkins, 1989; Duncan & Hughes, 1972). Scientists believe that the process of seeking, investigating and manipulating feed items can be nearly as important as consuming them (Newberry, 2003). Because evidence suggests that feather pecking is a type of misdirected foraging behavior (Dixon et al., 2010), providing a foraging substrate is important for reducing the risk of injurious pecking.

The wire floor of battery and furnished cages prevents hens from foraging and scratching. The resulting lack of exercise can lead to weak bones (Dawkins, 1989; Savory, Wood-Gush & Duncan, 1978), and the lack of opportunity to scratch in the ground can cause overgrown claws (Lay et al., 2011), which can break off easily, causing open, bleeding wounds and increased susceptibility to infection. Research shows that cage-free hens display more foraging behavior and walk more than hens confined to furnished cages (Rodenberg et al., 2008). In fact, they will spend 50 to 70 percent of their time foraging when given outdoor access (Dawkins, 1989; Duncan, 2010; Savory, Wood-Gush & Duncan, 1978).

Exploratory Behaviour

Like other animals, hens are naturally inquisitive and strongly motivated to explore their environment to gather information and this behavior is important for their overall well-being and health. Animals do not just react to stimuli, they are ‘agents’ who initiate interactions with their environment. Exploration is an expression of this agency and when it is suppressed it can reduce the range of behaviors performed, negatively affect an animal’s emotional state and increase fear and anxiety (Špinka & Wemelsfelder, 2011). Cage-free housing systems, particularly those with outdoor access, can offer far more complexity and choices to stimulate a wider range of behavioral activity and movements including exploration (Rodenberg et al., 2005). In contrast, hens confined to battery and furnished cages spend most of their time standing or sitting on the wire floor (Rodenberg et al., 2008).

Avoidance Behaviour

Freedom from fear is an important requirement of good animal welfare. Studies show that hens in cages are more fearful than those kept in cage-free housing systems (Hansen, Braastad, Storbråten & Tofastrud, 1993; Rodenberg et al., 2008). Hens kept in cages have less room to distance themselves from other hens and farm workers and few – if any – places to use for hiding or escaping. Cage-free systems typically have elevated perches and a variety of nest boxes which hens can use to escape from a potential threat, and offer more space for hens to exhibit a flight response.


Photo: i.c. productions

Animal Welfare Inspections

Duncan estimates that it would take about 30 minutes to walk through a 30,000-hen free-run barn to assess the health and welfare of 95 percent of the birds and identify injured or sick hens. In contrast, it would take roughly 200 minutes if the same number of hens were kept in a battery cage system (Duncan, 2010), and likely longer in a furnished cage system (I.J.H. Duncan, personal communication, June 29, 2012). Unfortunately, thorough inspections rarely happen (Duncan, 2011). Typical inspections of cage houses are done much more quickly, and little if anything can be done beyond identifying dead hens. With multiple tiers of cages, inspectors may not be able to see hens in upper tiers from ground level other than through the cage floors.

Physical Injuries

All modern laying hens suffer from bone weakness due to the high levels of calcium depleted from their bodies to form increasingly high numbers of eggshells. However, restricting their movement through caging exacerbates this problem (Whitehead & Fleming, 2000). Research indicates that caged hens have a higher incidence of weak bones attributed to osteoporosis (Cransberg, Parkinson, Wilson & Thorp, 2001; Knowles & Wilkins, 1998), and that hens housed in environments where they are free to move and exercise will have stronger bones (Fleming, Whitehead, Alvey, Gregory & Wilkins, 1994).

Caged hens' bones are thus more prone to break when they are removed from cages – often roughly - and transported to slaughter (Knowles, Broom, Gregory & Wilkins, 1993). Studies indicate that hens raised in more extensive cage-free systems have stronger bones and suffer fewer breaks during depopulation (Knowles & Wilkins, 1998). One study found that as many as 31 percent of caged birds had freshly broken bones, compared with 14 percent of birds from free-range systems (Gregory, Wilkins, Eleperuma, Ballantyne & Overfield, 1990). There is also a greater chance that caged hens will injure themselves during catching and removal due to the potential that they will come into contact with a solid object, as well as the small size of the cage opening (Knowles & Wilkins, 1998). As Knowles and Wilkins state, "from the point of view of welfare, such large numbers of animals with broken bones is entirely unacceptable. Most people would agree that such extreme physical damage is indicative of an inability to cope and shows very poor welfare. The pain associated with such damage is likely to be great" (Knowles & Wilkins, 1998). The market for meat from spent hens is small in North America, and most is further processed into soups and pastes. However, the high incidence of bone fractures means that there is a risk of bone splinters in the processed meat – a risk companies are reluctant to take (I.J.H. Duncan, personal communication, September 4, 2012) (Whitehead, 2000).There is therefore a commercial argument as well for reducing bone fractures.

Caged hens also have a higher incidence of foot lesions, such as hyperkeratosis, from standing on a sloping wire floor (Duncan, 2001). The slope causes pressure on the claw fold of excessively overgrown claws which leads to tearing to the soft tissue at the claw fold; hyperkeratosis results from infection in the tear.

■ **Caged hen with toe pad hyperkeratosis.**

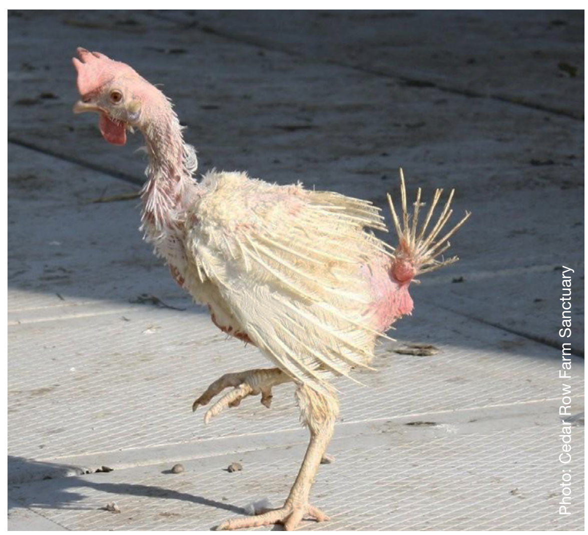
Welfare Disadvantages of Cage-Free and Solutions

All of the welfare disadvantages associated with cage-free systems can be addressed through better management and breed selection, while the same cannot be said about the welfare disadvantages of cage systems.

Injurious Pecking

Feather pecking and cannibalism, together called injurious pecking, are behavioral abnormalities that are influenced by various factors, including barren conditions, high stocking density and large group size. Severe feather pecking can lead to stripped plumage and the resulting areas of bare skin can stimulate cannibalism (Newberry, 2003; Rodenberg, Komen, Ellen, Uitdehaag & van Arendonk, 2008). While it is a common misconception that these are aggressive acts, research demonstrates that these are foraging pecks that have been redirected toward feathers (Blokhuis, 1986; Dixon, 2008; Huber-Eicher & Wechsler, 1997).

Injurious pecking occurs in all hen housing systems. Most modern laying hen breeds will result in flocks including a few birds that have a strong tendency to feather peck regardless of the environment. While cages minimize the number of hens these 'primary peckers' can directly access, hens that are not confined are at least able to escape. Also, many aspects of the cage environment can exacerbate feather pecking. For example, overcrowding, barren environments, lack of loose litter, lack of foraging opportunity (Dixon, 2008), lack of perches during early rearing, and the genetic strain of the hen (selected for production traits over welfare) can all contribute to injurious pecking. Feather pecking has also been associated with fearfulness, and studies have found caged hens to be more fearful than hens in cage-free systems (Rodenberg et al., 2005).



■ This spent hen with severe feather loss was kept in a battery cage system.

Solutions for controlling injurious pecking

Successful control of feather pecking and cannibalism requires an integrated approach that considers three main factors: genetics, early-life experiences and the environment (Rodenberg, Komen, Ellen, Uitdehaag & van Arendonk, 2008). Additionally, proper management of lighting, crowding and feed can mitigate the problem.

Genetics

- **Select more docile breeds and strains that have a lower propensity to develop feather pecking.**

■ **An ISA Brown hen.**

Feather pecking, cannibalism and associated mortality have a genetic component, which means that breeding programs can select against these traits (Brunberg, Jensen, Isaksson & Keeling, 2011; Hocking, Channing, Robertson, Edmond & Jones, 2004; Rodenberg et al., 2009; Ellen, Visscher, van Arendonk & Bijma, 2008). A comprehensive analysis of mortality in cage-free systems found the hen's genetic strain to be very important, with ISA Brown and Bovans Goldline hens having lower mortality than the other strains in the study (Aerni, Brinkhof, Wechsler, Oester & Frohlich, 2005). The same study found no difference in cannibalism rates between beak-trimmed hens of the same strain in cage versus cage-free systems.

The Lohman Silver bird is a commonly-used breed in the Netherlands, Germany and Denmark where battery cages have been banned. They are not aggressive or flighty and show a low incidence of feather pecking, and their hardy body condition makes them suitable for free-range systems (Jendral, 2008). According to Duncan and Rollin (2012), evidence suggests that incidences of feather pecking and cannibalism may have increased via unintentional genetic selection. Fortunately, researchers have produced a line of birds that shows a low level of feather pecking when not beak trimmed. Calm birds with a more robust temperament are better able to cope with stressful changes in the environment. Duncan and Rollin say that "The challenge will be to persuade the primary breeding companies to [produce these gentler breeds on a commercial scale]"(Duncan and Rollin, 2012).

To minimize the risk of feather pecking, breeds should be chosen that have a proven reputation for not feather pecking, and hens should be kept in as rich an environment as possible.

Early-life experiences

- **Introduce birds to pecking and foraging material at an early age.**

Providing appropriate pecking and foraging substrate soon after hatching) is critical in shaping adult pecking preferences (Huber-Eicher & Sebo, 2001; Rogers, 1995. These preferences are formed early in life, and are learned through experience (Rogers, 1995). Research shows that early access to loose litter – including wood shavings, sand and straw – can stimulate ground-pecking and dustbathing and is an important first step in reducing the incidence of feather pecking, cannibalism and mortality (Aerni, Brinkhof, Wechsler, Oester & Fröhlich, 2005; Huber-Eicher & Sebö, 2001; Johnsen, Vestergaard & Nørgaard-Nielsen, 1998; Johnsen, Vestergaard & Nørgaard-Nielsen, 1998). Studies also show that scattering grain or feed into loose litter for young chicks can help reduce injurious pecking (Knierim et al., 2008).

- **Avoid unnecessary changes to the hen's diet and environment when transitioning pullets (young hens who have not begun to lay eggs) to the laying house to minimize their stress.**

Feather pecking has been observed to begin shortly after stressful changes to a hen's life; for example, after moving pullets from the rearing to the laying house. Potential stressors could include changes in light intensity, diet, house layout and access to the outdoors. Stress can be partially alleviated by matching the birds' rearing and laying environments as closely as possible (Bright, 2009) and by not changing factors like diet and lighting at the time of a move or during a laying period (Green, Lewis, Kimpton & Nicol, 2000; Pötzsch, Lewis, Nicol, & Green, 2001).

Environment and management

- **Provide hens with access to pasture or another complex environment.**

Research shows that farms where hens make more use of pasture have lower rates of feather pecking (Bestman, 2001; Bestman, 2003; Green, Lewis, Kimpton & Nicol, 2000; Lambton, Knowles, Yorke & Nicol, 2010; Mahboub, Müller & von Borell, 2004; Nicol, Pötzsch, Lewis & Green, 2003; Nicol et al., 2003; Fiks-van Niekerk, 2001). Based on their research, Bestman & Wagenaar (2006) predict that if more than 66 percent of hens used outdoor runs, there would be no severe feather pecking. The provision of shelter, such as trees, shrubs or camouflage netting, gives hens more security from potential predators and encourages more frequent and extensive outdoor exploration. Including roosters in the flock can also increase outdoor use (Organic Agriculture Centre of Canada [OACC], 2009).

In indoor systems, scattering wheat, grain or shells daily encourages hens to scratch and forage. These materials increase hens' interest in floor substrate, redirecting pecking to the ground and away from other birds.

A more complex environment provides more opportunities for hens to forage and express a wider range of natural behavior (Rodenberg et al., 2005). Hens that are more stimulated by their surroundings have less motivation and less opportunity to peck at each other (Jendral, 2008).

- **Provide a proper, nutritious diet, accessible feeders and drinkers, perches and adequate lighting and heating.**

Dietary deficiencies can result in injurious pecking (Hughes & Duncan, 1972) and studies show that a mash diet, which takes longer to consume, sustains foraging behavior for a longer time and is therefore better than pelleted feed for preventing feather pecking and cannibalism (Aerni, El-Lethey & Wechsler, 2000; Lambton, Knowles, Yorke & Nicol, 2010; Newberry, 2003). A diet high in insoluble fiber, such as oat and rice hulls (Choct & Hartini, 2005; Hartini, Choct, Hinch, Kocher & Nolan; 2002), maize, barley-pea silage, carrots (Steenfeldt, Kjaer, Engberg, 2007), straw (Martrenchar, Huonnic & Cotte, 2003; Nørgaard-Nielsen, Vestergaard & Simonsen, 1993), seeds and cabbage leaves (Dixon, Duncan & Mason, 2010) has also been shown to help reduce and control injurious pecking.

- **Ensure that each hen has adequate access to food, water, nest boxes, perches and private areas to reduce competition. The provision of perches and private areas also enables subordinate hens to escape.**

A shortage of drinkers will bring many hens together in close proximity, which can heighten stress and stimulate feather pecking (Knierim et al., 2008; Pötzsch, Lewis, Nicol & Green, 2001; [United Kingdom] Department of Environment, Food and Rural Affairs, 2005). Frequent and equal distribution of feed throughout the barn will also help discourage aggression, and spreading substrate and adding straw and limestone blocks will redirect pecking (Jendral, 2008). Inadequate feeder access can also result in underweight birds who are more likely to fall victim to more dominant ones (OACC, 2009). Access to elevated perches can decrease cloacal cannibalism by giving low-ranking hens a safe place to avoid hens who would peck them from the floor (Gunnarsson, Keeling & Svedberg, 1999; Huber-Eicher & Audigé, 1999; Newberry, 2003).

- **Reduce stocking density or organize hens in more natural social groups.**

Some cage-free producers have reduced the incidence of feather pecking by putting their hens in more natural social groups. For example, smaller flocks can be sectioned off from the larger flock through netting or mobile shelters. Other farmers have found that the inclusion of roosters can reduce feather pecking (Bestman & Wagenaar, 2003; Graml, Waiblinger & Niebuhr, 2008). Some cage-free farms in Canada use both of these strategies and have found that it is not necessary to beak trim (Matlow, 2011).

■ **By including roosters, HOPE Eco-Farms in Aylmer, Ontario finds it unneccessary to beak trim and has no problem with feather pecking.**

Disease Exposure

Whereas cages physically separate hens from their feces, breaking the cycle of infection by reducing exposure to fecal pathogens (including parasites and bacteria), there is concern that cage-free birds raised on litter are more likely to encounter pathogens through closer contact with their feces. Hens raised on litter may have higher mortality due to viral diseases, such as Marek's disease and Newcastle disease, and to coccidiosis, a parasitic disease which attacks the hen's gut (Lay et al., 2011). However, other research demonstrates that coccidiosis, one of the most prevalent and economically damaging poultry diseases, and salmonella, the leading cause of food-related human hospitalization and death (United States Center for Disease Control, 2011), are more prevalent in large cage egg operations (Bell & Weaver, 2002; European Food Safety Authority [EFSA], 2007). Also, one study found a consistent decrease in viral disease (mostly Marek's disease) and parasitism (mostly coccidiosis and helminths) during the 12-year period after battery cages were banned in Switzerland (Kaufmann-Bart & Hoop, 2009).

In cage-free housing systems there is a risk of eggs being laid directly on litter, in close contact with feces, instead of in nest boxes. This can present a consumer food safety risk, if these 'floor eggs' enter the food chain, or an economic loss to farmers. However, as described below, many cage-free egg producers and housing system manufacturers have found creative and successful methods for deterring hens from laying eggs on the floor.

There is significant evidence that many diseases are becoming more prevalent with the increasing intensification of animal agriculture (Mennerat, Nilsen, Ebert & Skorping; 2010; Nierenberg & Garcés, 2005; Pip, 2012; Wigley, In press; World Health Organization [WHO], 2004). In the case of eggs, this intensification is characterized by increasingly large flock sizes kept in crowded cages on one site.

Solutions for improving hen health in cage-free systems

Management and animal husbandry knowledge and skills are essential for high-welfare cage-free egg production. Mortality in an Australian free-range system was reduced by 16 percentage points after introducing better management practices (Shini, Stewart, Shini & Bryden, 2008). Similarly, researchers found a consistent decrease in feather pecking, cannibalism, viral disease and parasitism in cage-free systems as a result of better management practices (Kaufmann-Bart & Hoop, 2009).

Regular walks through barns to monitor hens' health and welfare are also important. According to Steve Easterbrook of Rabbit River Farms, an organic egg farm in British Columbia,

> "If we have a hen that stays on the scratching area, we know that there may be a medical issue. We check her crop, we check her vent, we check her body for signs of damage and if she has a medical issue, we will remove her to a 'hospital cage' where she doesn't have to compete for food and water. Eighty percent of the time, that hen will recover and we return her to the general population. So we actually have a lower mortality rate than cage operations because it is easier to see the behaviour of a hen that is not getting enough food, not getting enough water or might have sustained some sort of injury" (S. Easterbrook, personal communication, June 20, 2012).

Walking through barns on a regular basis to inspect hens also helps birds become habituated to and less fearful of the presence of people. These birds respond better in unanticipated situations (e.g. loud noises or storms), and this reduction in stress will reduce the likelihood of outbreaks of injurious behaviour.

- **Encourage hens to lay eggs in nest boxes and defecate over slats.**

The proper construction and availability of suitable nest sites will help reduce the occurrence of floor eggs (Appleby, 1984; Appleby, Hogarth & Hughes, 1988; Duncan & Kite, 1989). Providing more nest choices and suitable nesting material, like peat or artificial turf, will encourage hens to lay eggs in the nest area (Rodenburg et al., 2005). Ensuring that nest boxes are secluded and the floor area is well lit will also discourage floor laying.

■ **Multiple nest boxes with privacy curtains.**

Collecting floor eggs soon after they are laid will discourage other hens from laying their eggs in the same location, and placing those eggs in the nest site will help hens find the appropriate laying area. Hens can also be encouraged to defecate on slats or perforated platforms so that manure can be removed from barns by conveyor belt and stored or composted immediately. Some farmers have effectively accomplished this by positioning the feeders, drinkers and perching areas above slatted floors (S. Easterbrook, personal communication, June 20, 2012).

■ **The perches, feeders and drinkers are over the slatted floor at Rabbit River Farms in Richmond, B.C.**

Providing perches to pullets can teach the jumping and flying behavior necessary to access the elevated nest boxes typically used in aviary systems (Colson, Arnould & Michel, 2008); this can help reduce the risk of floor eggs when these birds begin laying (Gunnarsson, Keeling & Svedberg, 1999).

Injuries

While caged hens are likely to have weaker wing and keel bones and osteoporosis, cage-free hens are more prone to keel bone fractures and deformation, and are at higher risk of injury when jumping from perch to perch.

Solutions to reduce injuries

- **Ensure the hen housing system is designed to reduce the incidence of bone deformation, fractures and foot infections.**

Because collisions with housing structures and other birds can lead to bone fractures, new aviary systems have been designed to reduce these injuries. Platforms should be no more than one metre apart, and terraces, connecting beams and ladders can facilitate safe movement between them.

Research shows that the shape of perches and the material used to construct them can have a significant impact on reducing pressure on the keel bone. For example, one study found that square perches reduced the peak force on the keel bone compared to oval or round perches, and soft surfaces (e.g. polyurethane rather than metal perches) could reduce foot pad and keel bone welfare problems (Pickel, Schrader & Scholz, 2011). However, plastic or soft wooden perches can reduce foot health, as manure and moisture are able to accumulate on the structure's top where the birds' feet rest (EFSA, 2005). This can lead to bumblefoot – a swelling of the footpad caused by local bacterial infection, which can eventually cause lameness (EFSA, 2005). Some hen breeds are more susceptible to bumblefoot than others, and the condition is typically associated with poor hygiene and improper perch design (E.U. Scientific Panel on Animal Welfare, 2005). Incidence of bumblefoot can be reduced by providing hens with hardwood perches that are approximately 1.5 inches in diameter with a flattened top (EFSA, 2005; Tauson & Abrahamsson, 1996) and by limiting walking exposure to mud and manure (LayWel, 2006).

Injuries are more likely to occur if perch design and layout requires hens to jump beyond their natural capabilities (Scott & Parker, 1994), resulting in missed landings, falls and subsequent injuries. Research indicates that hens can jump from one perch to another up to a maximum of 3 ft. (Scott & Parker, 1994), and at angles less than 45° (Scott, Lambe & Hitchcock, 1997). At a minimum, hens need 6 inches of perch space to take off and 6-9 inches to land (Moinard et al., 2005). Perches of approximately 1.5 inches in diameter are required for hens to maintain stable footing (Pickel, Scholz & Schrader, 2010; Struelens et al., 2009). Considering these factors when planning perch design in aviary systems can help reduce the incidence of injuries.

- **Provide hens with access to perches at a young age.**

Early access to perches teaches pullets to navigate the structures, shapes their cognitive spatial abilities as adult birds in aviary systems (Gunnarsson, Yngvesson, Keeling & Forkman, 2000) and can help reduce incidence of injuries.

- **Select breeds that have stronger bones and are more resistant to injury.**

Animal welfare scientists commonly refer to bone weakness as a production disease. While it is exacerbated by the hen's inability to exercise in a cage, it is primarily the consequence of selectively breeding more productive lightweight birds (i.e., birds that are able to lay more eggs over a longer period of time) (Fleming, McCormack, McTeir & Whitehead, 2006). A scientific review of skeletal problems in egg-laying hens concluded that genetic selection is the best solution (Whitehead, Fleming, Julian & Sørensen, 2003). Given the high degree of bone variation found within a highly productive flock, Whitehead (2000) suggests that "the problem of osteoporosis may be alleviated by genetic selection, perhaps without serious consequence for egg productivity."

Air Quality

Some research has concluded that cage-free, litter-based systems emit higher levels of ammonia and dust than cage systems (Rodenberg et al., 2005). High concentrations of ammonia are likely to be found in the housing system with the most manure stored inside the building. The amount of manure stored in a housing system is a key factor in determining likely ammonia concentrations, but temperature, moisture, litter, ventilation rate, air velocity, animal weight and animal density also affect the level of this harmful gas (Nimmermark, Lund, Gustafsson & Eduard, 2009). Increased ammonia levels can result in health and welfare problems for the hens such as eye inflammations (e.g., keratoconjunctivitis), respiratory diseases, reduced body weight and reduced feed intake (Nimmermark et al., 2009). Dust can also cause respiratory diseases and can be pathogenic if microorganisms attach to the dust particles (Nimmermark et al., 2010).

Solutions to improving air quality in cage-free systems

- **Remove manure from the barn on a regular basis.**

Frequent manure removal and proper manure and litter management are keys to improving air quality in cage-free systems. New aviary systems have been designed to allow frequent manure removal: feeders, drinkers and perches are placed over slatted floors to encourage hens to defecate over a manure conveyer belt, which can capture approximately 90 percent of fecal matter (Bos, Groot Koerkamp & Groenestein, 2003) (S. Easterbrook, personal communication, June 20, 2012). This minimizes the time manure is exposed to the air, decreasing ammonia emissions and improving air quality.

■ **Manure falls through the slatted floor and onto a conveyor belt in this cage-free housing system.**

- **Feeders and drinkers should be placed over slatted areas, not in the litter, to keep the litter dry, as well as to facilitate regular manure removal.**

- **Restrict access to the litter area at night.**

Since hens defecate more at night, preventing pullets from accessing litter at night and providing perches over slatted floors will help reduce defecation on the floor. That is why aviary systems, with their multi-level perches generally have lower ammonia rates than floor housing systems (Groot Koerkamp et al., 1998). If the aviary also allows the hens to access the outdoors, it will further improve the indoor air quality.

- **Encourage hens to dustbathe and forage in litter during the day through the provision of suitable substrates.**

Dustbathing, running and foraging help turn and aerate litter, so farmers should ensure that hens have adequate space to express natural behavior. Scattering wheat, grain or shells throughout the litter encourages hens to scratch, helping to rotate and dry the litter.

- **Install or improve the barn ventilation system.**

New ventilation systems that enhance water evaporation can further reduce ammonia emissions (Jendral, 2008). Clay pellets and sprinkler systems have also successfully been used to reduce dust (Gustafsson & von Wachenfelt, 2006).

Conclusion

The LayWel Study, the most extensive review of the welfare of laying hens in different housing systems to date, concluded that battery cages cannot provide satisfactory hen welfare (LayWel, 2006). In fact, the majority of published scientific research demonstrates that battery cages negatively impact hen welfare, and the growing consensus of the scientific community and the public is that these impacts outweigh any welfare advantages. For this reason, several countries have banned these intensive confinement systems. Sweden, Austria, Belgium and the Netherlands were the first countries to ban battery cages, and the E.U. passed a directive to phase out battery cages by 2012. California, Michigan and Ohio have passed state initiatives that will do the same over the next decade. The UEP is currently supporting a federal bill that would phase out battery cage use in the United States. While progress to raise farm animal welfare standards is slower in Canada, a provincial egg producers association is leading efforts to phase out the worst intensive confinement systems for egg laying hens. Manitoba Egg Farmers passed a resolution requiring egg farmers who build new facilities or undertake a major retrofit to meet the Five Freedoms of Animal Welfare.[6] As battery cages do not meet the Five Freedoms, this resolution would effectively phase them out. It seems other provincial egg producer associations will soon follow suit (Alberta Agriculture and Rural Development, 2012).

While furnished cages are indeed an improvement over barren battery cages,[7] there is considerable evidence that cage-free housing systems offer a higher level of potential welfare. A 2006 study published in the Netherlands Journal of Agriculture Science scored 22 different hen housing systems according to the relative importance of 25 different animal welfare attributes (including feeding level, space per hen, perches, water availability, nests, comfort behavior and litter handling) using the best available scientific knowledge. Each system was then ranked on a relative scale of 0 to 10. Battery cages received a score of 0 and furnished cages ranked only slightly higher, at 2.3. The typical cage-free housing system in North America ranked significantly higher, at 5.8, and the highest welfare commercially viable cage-free systems in use scored 9.6 (De Mol et al., 2006).

While debate will continue on the advantages and disadvantages of furnished and cage-free housing systems, public sentiment is leaning strongly in favour of cage-free systems. A growing number of consumers are concerned about how farm animals are treated in food production and are willing to pay more for cage-free eggs (including free-run, free-range, certified organic and SPCA certified). A 2010 poll found that 93 percent of Canadians surveyed would support laws to ensure that all farm animals can lie down, turn around, stretch their limbs and/or spread their wings (Harris/Decima, 2010). The same poll found that 72 percent would be willing to pay more (about 20 cents) per egg if it would lead to more humane treatment of animals, and 84 percent think grocery stores should stock more cage-free eggs. Several other studies indicate strong public support for cage-free eggs in North America (Bennett & Blaney, 2003; Harris/Decima, 2009; Lusk, 2010). Among the Canadians surveyed in 2010, animal welfare was one of their top three most important issues regarding corporate social responsibility (CSR) in the grocery and

[6] The Five Freedoms for Animal Welfare (FFAW) were established by the UK-based, Farm Animal Welfare Council. They state that all animals deserve 1) Freedom from hunger and thirst, 2) Freedom from discomfort, 3) Freedom from pain, injury and disease, 4) Freedom to express normal behaviour and 5) Freedom from fear and distress. The FFAW have been referred to as an effective framework for assessing animal welfare in a wide variety of situations and have been used in the development of animal welfare legislation and standards around the world.

[7] Furnished cages can increase expression of natural nesting, perching, bathing and/or foraging behaviour, as well as permit increased opportunity for bone loading movement.

restaurant sectors – ahead of the environment, local sourcing and organics (Harris/Decima, 2010). A U.S. consumer study conducted in 2007 produced similar results: animal welfare was among the top three most important social issues, and a key issue for 58 percent of Americans surveyed, receiving a slightly higher ranking than the environment and significantly higher than organics and local sourcing (Technomic Information Services, 2007). Through extensive research, agricultural economists Bailey Norwood and Jayson Lusk found that most Americans dislike caging farm animals and would never consider it to be ethical; educating Americans only intensifies their opposition to these cages (Norwood, 2010). No matter how big the cage and how many features are added, a cage is still a cage in the public eye.

Grocery and restaurant chains clearly pay attention to consumer trends, and it is increasingly common to see animal welfare commitments among their corporate social responsibility (CSR) policies and annual reports. Unilever, one of the world's largest corporations, has committed to using only cage-free eggs for its products worldwide, and Compass Group, the world's largest food service provider, has also implemented a policy to increase its use of cage-free eggs. A number of high-profile quick service chains, including Burger King, Wendy's, Arby's, Subway and Quiznos, are switching to cage-free eggs in their U.S. restaurants. Safeway, one of the largest grocery chains in North America, committed in 2008 to doubling the quantity of cage-free eggs available for customers by 2010 and launched its own private brand of cage-free eggs. Canada's largest grocery chain, Loblaw, committed to using only cage-free eggs for their private-label President's Choice brand.

Public opposition to caging hens has influenced Austria and Switzerland to phase out all cages – both battery and furnished– and Belgium and Germany are considering following suit. While furnished cages are still permitted in the Netherlands, "economic and societal forces make the construction of alternative systems more attractive for the poultry industry" (Rodenberg et al., 2005).

Like any animal housing system, cage-free egg production is not free of welfare problems but, they can all be effectively addressed through proper management and husbandry skills, while no level of management skill or innovation can provide adequate welfare in caged systems.

References

Aerni, V., El-Lethey, H., & Wechsler, B. (2000). Effect of foraging material and food form on feather pecking in laying hens. *British Poultry Science, 41*,16-21.

Aerni, V., Brinkhof, M.W.G., Wechsler, B., Oester, H., & Fröhlich, E. (2005). Productivity and mortality of laying hens in aviaries: a systematic review. *World's Poultry Science Journal,* 61(1), 130-142.

Agralytica. (2012). Economic Impacts of Converting US Egg Production to Enriched Cage Systems. A Report for the United Egg Producers. Alexandria, VA.

Agriculture and Agri-Food Canada (AAFC). (2012). *Poultry Marketplace: Canada's Egg Industry...at a glance*. Ottawa, ON. Retrieved from: http://www.agr.gc.ca/poultry/gleg_eng.htm

Albentosa, M.J., & Cooper, J.J. (2002). Effects of cage height and stocking density on the behaviour, perch use and distribution of laying hens in furnished cages. *British Poultry Science, 43*. (Supplement 1): S16-6.

Alberta Agriculture and Rural Development. (2012, June 25). "Recent Developments related to Animal Welfare in Egg Production". *Agri-News*. Edmonton, AB. p 4. Retrieved from: www1.agric.gov.ab.ca/$department/newslett.nsf/all/agnw19564

American Veterinary Medical Association (AVMA). (2012). *Welfare Implications of Laying Hen Housing.* www.avma.org/KB/Resources/Backgrounders/Pages/Welfare-Implications-of-Laying-Hen-Housing.aspx

Appleby, M.C., (1984). Factors affecting floor egg laying bydomestic hens: a review. *World's Poultry Science Journal*, *40,* 241-249.

Appleby, M.C., Hogarth, G.S. & Hughes, B.O. (1988). Nest box design and nesting material in a deep litter house for laying hens. *British Poultry Science, 29,* 215-222.

Appleby, M.C., & Hughes, B.O. (1991). Welfare of laying hens in cages and alternative systems: environmental, physical and behavioural aspects. *World's Poultry Science Journal, 47*(2), 109-128.

Appleby, M.C. (2003). The European Union ban on conventional cages for laying hens: history and prospects. *Journal of Applied Animal Welfare Science*, *6*(2), 103-121.

Baxter, M. (1994). The welfare problems of laying hens in battery cages. *The Veterinary Record*,*134(*24), 614-619.

Bell, D.D., & Weaver, W.D. (2002). *Commercial Chicken Meat and Egg Production*. Norwell, MA: Kluwer Academic Publishers. p 483.

Bennett, R. M. & Blaney, R.J.P. (2003). Estimating the benefits of farm animal welfare legislation using the contingent valuation method. *Agricultural Economics, 29*, 85-98.

Bestman, M.W.P. (2001). The role of management and housing in the prevention of feather pecking in laying hens. In. Hovi, M. and Bouilhol, M. (eds.), *Human-Animal Relationship: Stockmanship and Housing in Organic Livestock Systems. Proceedings of the Third NAHWOA*

Workshop (pp.77-86). Clermont-Ferrand, France: Network for Animal Health and Welfare in Organic Agriculture, University of Reading. Retrieved from: www.veeru.rdg.ac.uk/organic/ProceedingsFINAL.pdf

Bestman, M.W.P., & Wagenaar, J.P. (2003). Farm level factors associated with feather pecking in organic laying hens. *Livestock Production Science*, *80,* 133-140.

Bestman, M. & Wagenaar, J.P. (2006). Welfare of Organic laying hens. *Proceedings of the 1st IFOAM International Conference on Animals in Organic Production*. p. 34.

Blokhuis, H.J. (1986). Feather-pecking in poultry: its relation with ground-pecking. *Applied Animal Behaviour Science*,*16*, 63-67.

Bos, B., Groot Koerkamp, P.W.G. & K. Groenestein. (2003). A novel design approach for livestock housing based on recursive control – with examples to reduce the environmental pollution. *Livestock Production Science*, *84,* 157-170.

Bright, A. (2009). Time course of plumage damage in commercial layers. *The Veterinary Record*, *164,* 334-335.

Brunberg, E., Jensen, P., Isaksson, A., & Keeling, L. (2011). Feather pecking behavior in laying hens: Hypothalamic gene expression in birds performing and receiving pecks. *Poultry Science*, *90,* 1145-1152.

Canadian Agri-Food Research Council (CARC). (2003). *Recommended Code of Practice for the Care and Handling of Pullets, Layers and Spent Fowl*. Ottawa, ON: CARC. Retrieved from: www.nfacc.ca/pdfs/codes/Poultry%20Layers%20Code%20of%20Practice.pdf

Choct, M., & Hartini, S. (2005). Interaction between nutrition and cannibalism in laying hens. In Glatz, P.C. (ed.), *Poultry Welfare Issues: Beak Trimming*. (pp.111-115). Nottingham, U.K.: Nottingham University Press.

Colson, S., Arnould, C., & Michel, V. (2008). Influence of rearing conditions of pullets on space use and performance of hens placed in aviaries at the beginning of the laying period. *Applied Animal Behaviour Science*, *111,* 286-300.

Cooper, J.J. , Albentosa, M.J. & Redgate, S. E. (2004). The 24-hour activity budgets of hens in furnished cages. *British Poultry Science*, *45*, S38-S39.

Cooper, J.J., & Appleby, M.C. (2003). The value of environmental resources to domestic hens: a comparison of the work-rate for food and for nests as a function of time. *Animal Welfare*, *12*(1), 39-52.

Cransberg, P.H., Parkinson, G.B., Wilson, S. & Thorp, B.H. (2001). Sequential studies of skeletal calcium reserves and structural bone volume in a commercial layer flock. *British Poultry Science*, *42,* 260-265.

Dawkins, M.S. (1985). Cage height preference and use in battery-kept hens. *The Veterinary Record*, *116,* 345-347.

Dawkins. M.S. (1989). Time budgets in Red Jungle Fowl as a basis for the assessment of welfare in domestic fowl. *Applied Animal Behaviour Science*, *24,* 77-80.

Dawkins, M.S., & Hardie, S. (1989). Space needs of laying hens. *British Poultry Science*, *30,* 413-416.

De Mol, R.M., Schouten, W.G.P., Evers, E., Drost, H., Houwers, H.W.J., & Smits. A.C. (2006). A computer model for welfare assessment of poultry production systems for laying hens. *Netherlands Journal of Agricultural Science (NJAS) , 54*(2).

Department of Environment, Food and Rural Affairs. (2005). *A guide to the practical management of feather pecking & cannibalism in free range laying hens.* London, U.K.: Defra Publications. Retrieved from: http://www.defra.gov.uk/publications/files/pb10596-feather-pecking-050309.pdf

Dixon, L.M., Mason, G.J., & Duncan, I.J.H. (2007). What's in a peck? A comparison of the motor patterns involved in feather pecking, dustbathing and foraging. In F. Galindo & L. Alvarez (eds.), *Proceedings of the 41st International Congress of the ISAE* (p. 47). Merida, Mexico: International Society for Applied Ethology.

Dixon, L.M. (2008). Feather pecking behaviour and associated welfare issues in laying hens. *Avian Biology Research*, *1*(2), 73-87.

Dixon, L.M., Duncan, I.J.H., & Mason, G.J. (2010). The effects of four types of enrichment on feather-pecking behaviour in laying hens housed in barren environments. *Animal Welfare*. *19,* 429-435.

Duncan, I.J.H. (1970). Frustration in the fowl. In B.M. Freeman & R.F. Gordon (Eds)., *Aspects of Poultry Behaviour* (pp. 15-31) Edinburgh,UK: British Poultry Science Ltd.

Duncan, I.J.H. & Hughes, B.O. (1972). Free and operant feeding in domestic fowls. *Animal Behaviour*, *20*, 775-777.

Duncan, I.J.H. & Kite, V.G. (1989). Nest site selection and nest-building behaviour in domestic fowl. *Animal Behaviour*, *37,* 215-231.

Duncan, E.T., Appleby, M.C., & Hughes, B.O. (1992). Effect of perches in laying cages on welfare and production of hens. *British Poultry Science*, *33*(1), 25-35.

Duncan, I.J.H, Widowski, T.M., Malleau, A.E., Lindberg, C. & Petherick, J.C. (1998). External factors and causation of dustbathing in domestic hens. *Behavioural Processes*, *43,* 219-228.

Duncan, I.J.H. (2001). The pros and cons of cages. *World's Poultry Science Journal*, 57, 381-390.

Duncan, I.J.H. (2010). *Battery cages and why they reduce hen welfare* [PowerPoint slides]. Presentation hosted by the Poultry Industry of Canada. Guelph, ON.

Duncan, I.J.H. (2011, May 12). "*Is there a future for battery cages in Canada?* [PowerPoint slides]. Presentation hosted by the Animal Welfare Foundation of Canada. Abbotsford, BC. Retrieved from: http://www.youtube.com/watch?v=LVD73WiAy9k&feature=relmfu

Duncan, I.J.H. & Rollin, B. (2012). In WSPA (ed.) *What's On Your Plate? The Hidden Costs of Industrial Animal Agriculture in Canada*. (pp135-160). Toronto, ON: WSPA-Canada.

Egg Farmers of Canada. (2011). Annual Report. P. 19. Retrieved from: http://www.eggs.ca/resources/MediaRoom/Publications/EFC_Annual_Report_2011_ENG-Web-Final.pdf

Ellen, E.D., Visscher, J., van Arendonk, J.A.M., & Bijma, P. (2008). Survival of laying hens: genetic parameters for direct and associative effects in three purebred layer lines. *Poultry Science*, *87,* 233-239.

European Food Safety Authority (EFSA). (2005). Scientific report on the welfare aspects of various systems for keeping laying hens. EFSA-Q-2003-92, *Annex to the EFSA Journal*. *197,* 1-23. Retrieved from: www.efsa.europa.eu/EFSA/Scientific_Opinion/lh_scirep_final1.pdf

EFSA. (2007). Report of the Task Force on Zoonoses Data Collection on the Analysis of the baseline study on the prevalence of Salmonella in holdings of laying hen flocks of *Gallus gallus. The EFSA Journal 97*. Retrieved from: http://www.efsa.europa.eu/en/efsajournal/pub/97r.htm

Fiks-van Niekerk, T.G.C.M. (2001). Organic farming: a small but growing concept. In *Proceedings, 6th European Symposium on Poultry Welfare*. Zollikofen, Switzerland. 6 pp.

Fleming R.H., McCormack, H.A,, McTeir L, & Whitehead, C.C. (2006). Relationships between genetic, environmental and nutritional factors influencing osteoporosis in laying hens. *British Poultry Science*. *47*(6), 742-55.

Fleming, R.H., Whitehead, C.C., Alvey, D., Gregory, N.G. & Wilkins, L.J. (1994). Bone structure and breaking strength in laying hens housed in different husbandry systems. *British Poultry Science*, *35*, 651-662.

Follensbee, M.E., Duncan, I.J.H., & Widowski, T.M. (1992). Quantifying nesting motivation of domestic hens. *Journal of Animal Science*, *70* (Suppl.1), 164.

Graml, C., Waiblinger, S., & Niebuhr, K. (2008). Validation of tests for on-farm assessment of the hen-human relationship in non-cage systems. *Applied Animal Behaviour Science*, *111*, 301-310.

Green, L.E., Lewis, K., Kimpton, A., & Nicol, C.J. (2000). Cross-sectional study of the prevalence of feather pecking in laying hens in alternative systems and its associations with management and disease. *The Veterinary Record*, *147,* 233-238.

Gregory, N.G., L.J. Wilkins, S. D. Eleperuma, A. J. Ballantyne & Overfield, N.D. (1990). Broken bones in domestic fowls: Effects of husbandry system and stunning method in end-of-lay hens. *British Poultry Science*, *31,* 59-69.

Gregory, N.G., & Wilkins, L.J. (1991). Broken bones in hens. *The Veterinary Record*, *129*(25-26), 559.

Groot Koerkamp, P.W.G., Metz, J.H.M., Uenk, G.H., Phillips, V.R., Holden, M.R., & Sneath, R.W. (1998). Concentrations and emissions of ammonia in livestock buildings in northern Europe. *Journal of Agricultural Engineering Research*, *70*, 79-95.

Gunnarsson, S., Keeling, L.J., & Svedberg, J. (1999). Effect of rearing factors on the prevalence of floor eggs, cloacal cannibalism and feather pecking in commercial flocks of loose housed laying hens. *British Poultry Science*, *40,* 12-18.

Gunnarsson, S., Yngvesson, J., Keeling, L.J., & Forkman, B. (2000). Rearing without early access to perches impairs the spatial skills of laying hens. *Applied Animal Behaviour Science*, *67,* 217-228.

Gustafsson, G., & von Wachenfelt, E. (2006). Airborne dust control measures for floor housing system for laying hens. *Agricultural Engineering International: The CIGR Journal, VIII,* 1-13.

Hansen, I., Braastad, B.O., Storbraten, J. & Tofastrud, M. (1993). Differences in fearfulness indicated by tonic immobility between laying hens in aviaries and in cages. *Animal Welfare*, *2,* 105-12.

Harris/Decima. (2009). *VHS – Battery Cages*. This study was commissioned by VHS and conducted by Harris/Decima between December 3 -13 2009.

Harris/Decima. (2010). *WSPA – Humane Treatment of Animals*. This study was commissioned by the WSPA and conducted by Harris/Decima between October 26 - November 7, 2010.

Hartini, S., Choct, M., Hinch, G., Kocher, A., & Nolan, J.V. (2002). Effects of light intensity during rearing and beak trimming and dietary fiber sources on mortality, egg production, and performance of ISA brown laying hens. *Journal of Applied Poultry Research*, *11,* 104-110.

Hocking, P.M., Channing, C.E., Robertson, G.W., Edmond, A., & Jones, R.B. (2004). Between breed genetic variation for welfare-related behavioural traits in domestic fowl. *Applied Animal Behaviour Science*, *89,* 85-105.

Huber-Eicher, B. & Wechsler, B. (1997). Feather pecking in domestic chicks: its relation to dustbathing and foraging. *Animal Behaviour, 54,* 757-768.

Huber-Eicher, B., & Audigé, L. (1999). Analysis of risk factors for the occurrence of feather pecking in laying hen growers. *British Poultry Science*, *40*(5), 599-604.

Huber-Eicher, B., & Sebö, F. (2001). Reducing feather pecking when raising laying hen chicks in aviary systems. *Applied Animal Behaviour Science*, *73,* 59-68.

Hughes, B.O., & Duncan, I.J.H. (1972). The influence of strain and environmental factors upon feather pecking and cannibalism in fowls. *British Poultry Science, 13*, 525-547.

Hughes, B.O., Wilson, S., Appleby, M.C., & Smith, S.F. (1993). Comparison of bone volume and strength as measures of skeletal integrity in caged laying hens with access to perches. *Research in Veterinary Science, 54*(2), 202-206.

Humane Society of the United States [HSUS]. (2010). An HSUS Report: Welfare Issues with Furnished Cages for Egg-Laying Hens. Retrieved from: www.humanesociety.org/assets/pdfs/farm/welfare_issues_furnished_cages.pdf

Jendral, M.J. (2008). Assessing the Welfare of Laying Hens Housed in Conventional, Modified and Commercially-Available Furnished Colony Cages. A thesis submitted to the Faculty of Graduate Studies and Research in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Animal Science. Department of Agricultural, Food and Nutritional Science. Edmonton, AB.

Johnsen, P.F., Vestergaard, K.S., & Nørgaard-Nielsen, G. (1998). Influence of early rearing conditions of the development of feather pecking and cannibalism in domestic fowl. *Applied Animal Behaviour Science, 60,* 25-41.

Kaufmann-Bart, M., & Hoop, R.K. (2009). Diseases in chicks and laying hens during the first 12 years after battery cages were banned. *The Veterinary Record,164,* 203-207.

Keeling, L.J., & Duncan, I.J.H. (1989). Inter-individual distances and orientation in laying hens housed in groups of three in two different sized enclosures. *Applied Animal Behaviour Science, 24,* 325-342.

Knierim, U., Staack, M., Gruber, B., Keppler, C., Zaludik, K., & Niebuhr, K. (2008). Risk factors for feather pecking in organic laying hens –starting points for prevention in the housing environment. *16th IFOAM Organic World Congress,* Modena, Italy, June 16-20.

Knowles, T.G., D.M. Broom, N.G. Gregory & Wilkins, L.J. (1993). Effect of bone strength on the frequency of broken bones in hens. *Research in Veterinary Science, 54,* 15-19.

Knowles, T.G. & Wilkins, L.J. (1998). The problem of broken bones during the handling of laying hens – a review. *Poultry Science, 77*,1798–1802. Retrieved from: http://ps.fass.org/content/77/12/1798.full.pdf

Lambton, S.L., Knowles, T.G., Yorke, C., & Nicol, C.J. (2010). The risk factors affecting the development of gentle and severe feather pecking in loose housed laying hens. *Applied Animal Behaviour Science,123*(1), 32-42.

Lay, D.C., Fulton, R.M., Hester, P.Y., Karcher, D.M., Kjaer, J.B., Mench, J.A.,…Porter, R.E. Martrenchar, A., Huonnic, D., & Cotte, J.P. (2003). Influence of environmental enrichment on injurious pecking and perching behaviour in young turkeys. *British Poultry Science*, *42*, 161-170. 2011). Emerging Issues: Social Sustainability of Egg Production Symposium. Hen welfare in different housing systems. *Poultry Science*, *90*, 278-294. Retrieved from: http://ps.fass.org/content/90/1/278.full.pdf+html

LayWel. (2004). Welfare implications of changes in production systems for laying hens. Work Packages #4: Behaviour. “Litter substrates as enrichment components.” Retrieved from: www.laywel.eu/

LayWel. (2006). Welfare implications of changes in production systems for laying hens. www.laywel.eu/web/pdf/deliverable%2071%20welfare%20assessment.pdf

LayWel. (2006). Deliverable 2.3: Description of housing systems for laying hens. Retrieved from: http://www.laywel.eu/web/pdf/deliverable%2023.pdf pp10.

Lindberg, A.C. (1997). Leg and wing movements by hens in enriched modified cage systems. *British Poultry Science*, *38,* S10-11.

Lindberg, A.C., & C.J. Nicol. (1997). Dustbathing in modified battery cages: Is sham dustbathing an adequate substitute? *Applied Animal Behaviour Science*, *55*(1), 113-128. Retrieved from: http://www.sciencedirect.com/science/article/pii/S0168159197000300

Lusk, J. (2010). The Effect of Proposition 2 on the Demand for Eggs in California. *Journal of Agricultural and Food Industrial Organization*, *8* (1). Article 3.

Leyendecker, M., Hamann, H., Hartun, J., Kamphues, J., Neumann, U., Sürie, C., & Distl, O. (2005). Keeping laying hens in furnished cages and an aviary housing system enhances their bone stability. *British Poultry Science*, *46,* 536-544.

Mahboub, H.D.H., Müller, J., & von Borell, E. (2004). Outdoor use, tonic immobility, heterophil/lymphocyte ratio and feather condition in free-range laying hens of different genotype. *British Poultry Science*, *45*(6), 738-744.

Martrenchar, A., Huonnic, D., & Cotte, J.P. (2003). Influence of environmental enrichment on injurious pecking and perching behaviour in youg turkeys. *British Poultry Science, 42,* 161-170.

Matlow, M. (2011). Profile: Hope Eco Farm. World Society for the Protection of Animals-Canada. Retrieved from: http://www.choosecagefree.ca/news/hope_eco_farm.html

Meijsser, F.M., & Hughes, B.O. (1989). Comparative analysis of pre-laying behaviour in battery cages and in three alternative systems. *British Poultry Science*, *30*, 747-760.

Mennerat, A. Nilsen, F. , Ebert, D. & Skorping, A. (2010). Intensive Farming; Evolutionary Implications for Parasites and Pathogens. *Evolutionary Biology*, *37*, 59-67, Retrieved from: http://www.sfu.ca/cstudies/science/resources/1320967498.pdf

Moinard, C., Rutherford, K.M.D., Haskell, M.J., McCorquodale, C., Jones, R.B., & Green, P.R. (2005). Effects of obstructed take-off and landing perches on the flight accuracy of laying hens. *Applied Animal Behaviour Science*, *93*, 81-95.

Newberry, R.C. (2003). Cannibalism. In Perry, G.C. (ed.), *Welfare of the Laying Hen, Poultry Science Symposium Series*, *27,* 239-258. Wallingford, U.K.: CABI Publishing.

Newberry, R.C., Estevez, I., & Keeling, L. (2001). Group size and perching behaviour in young domestic fowl. *Applied Animal Behaviour Science*, *73,* 117-129.

Nicol, C.J. (1987). Effect of cage height and area on the behaviour of hens housed in battery cages. *British Poultry Science*, *28*, 327-335.

Nicol, C.J., Lindberg, A.C., Phillips, A.J., Pope, S.J., Wilkins, L.J., & Green, L.E. (2001). Influence of prior exposure to wood shavings on feather pecking, dustbathing and foraging in adult laying hens. *Applied Animal Behaviour Science*, *73*, 141-155.

Nicol, C.J., Pötzsch, C., Lewis, K., & Green, L.E. (2003). Matched concurrent case-control study of risk factors for feather pecking in hens on free-range commercial farms in the U.K. *British Poultry Science*, *44*, 515-523.

Nicol, C.J., Brown, S.N., Glen, E., Pope, S.J., Short, F.J., Warriss, P.D.,…Wilkins, L.J. (2006). Effects of stocking density, flock size and management on the welfare of laying hens in single-tier aviaries. *British Poultry Science*, *47*(2), 35-146.

Nierenberg, D. & Garcés, L. (2005). Industrial Animal Agriculture: the next global health crisis? London, U.K.: WSPA-International.

Nimmermark, S., Lund, V., Gustafsson, G. & Eduard, W. (2009). Ammonia, dust and bacteria in welfare-oriented systems for laying hens. *Annals of Agricultural and Environmental Medicine, 16*, 103-113.

Nørgaard-Nielsen, G., Vestergaard, K., & Simonsen, H.B. (1993). Effects of rearing experience and stimulus enrichment on feather damage in laying hens. *Applied Animal Behaviour Science*, *38,* 345-352.

Norwood, F. B. (2010, July). Presentation for the ADSA-PSA-AMPA-CSAS-WSASAS-ASAS Joint Annual Meeting; July 11-15, 2010; Denver, CO. Retrieved from: http://asp.okstate.edu/baileynorwood/survey4/files/ADSAblahblahblah%20Presentation%20All.pdf

Olsson, I.A.S. & Keeling, L.J. (2000). Night-time roosting in laying hens and the effect of thwarting access to perches. *Applied Animal Behaviour Science*, *68*(3), 243-256.

Olsson, I.A.S., & Keeling, L.J. (2002). The push-door for measuring motivation in hens: Laying hens are motivated to perch at night. *Animal Welfare*, *11*(1), 11-19.

Olsson, I.A.S., & Keeling, L.J. (2005). Why in earth? Dustbathing behaviour in jungle and domestic fowl reviewed from a Tinbergian and animal welfare perspective. *Applied Animal Behaviour Science*, *93*(3-4), 259-282.

Organic Agriculture Centre of Canada (OACC). (2009). Reducing the Risk of Feather Pecking for Laying Hens in Organic Egg Production. Animal Welfare on Organic Farms Fact Sheet Series.

Pickel, T., Scholz, B., & Schrader, L. (2010). Perch material and diameter affects particular perching behaviours in laying hens. *Applied Animal Behaviour Science*, *127,* 37-42.

Pickel, T., Schrader, L., & Scholz, B. (2011). Pressure load on keel bone and foot pads in perching laying hens in relation to perch design. *Poultry Science*, *90*, 715-724.

Pip, E. (2012). Pathogens and Public Health. In WSPA (ed) *What's On Your Plate? The Hidden Costs of Industrial Animal Agriculture in Canada*. (pp. 59-69). Toronto, ON: WSPA-Canada.

Pötzsch, C.J., Lewis, K., Nicol, C.J., & Green, L.E. (2001). A cross-sectional study of the prevalence of vent pecking in laying hens in alternative systems and its associations with feather pecking, management and disease. *Applied Animal Behaviour Science*, *74,* 259-272.

Rodenburg, T.B. , Frank A.M. Tuyttens, Bart Sonck, Koen De Reu, Lieve Herman & Johan Zoons. (2005). Welfare, Health, and Hygiene of Laying Hens Housed in Furnished Cages and in Alternative Systems. *Journal of Applied Animal Welfare Science*, *8*(3), 211-226.

Rodenburg, T.B., Komen, H., Ellen, E.D., Uitdehaag, K.A., & van Arendonk, J.A.M. (2008). Selection method and early-life history affect behavioural development, feather pecking and cannibalism in laying hens: A review. *Applied Animal Behaviour Science*, *110,* 217-228.

Rodenburg, T.B., Tuyttens, F.A.M., de Reu, K., Herman, L., Zoons, J., & Sonck, B. (2008). Welfare assessment of laying hens in furnished cages and non-cage systems: an on-farm comparison. *Animal Welfare*, *17*, 363-373. Retrieved from: www.ingentaconnect.com/content/ufaw/aw/2008/00000017/00000004/art00005

Rodenburg, T.B., Uitdehaag, K.A., Ellen, E.D., & Komen, J. (2009). The effects of selection on low mortality and brooding by a mother hen on open-field response, feather pecking and cannibalism in laying hens. *Animal Welfare*, *18*, 427-432.

Rogers, L. (1995). *The Development of Brain and Behaviour in the Chicken*. Wallingford, U.K.: CAB International, pp. 95-110.

Savory, C.J., Wood-Gush, D.G.M., & Duncan, I.J.H. (1978). Feeding behaviour in a population of domestic fowl in the wild. *Applied Animal Ethology*, *4,* 13-27.

Schrader, L., & Müller, B. (2009). Night-time roosting in the domestic fowl: The height matters. *Applied Animal Behaviour Science*, *121*, 179-183.

Scott, G.B., & Parker, C.A.L. (1994). The ability of laying hens to negotiate between horizontal perches. *Applied Animal Behaviour Science*, *42*,121-127.

Scott, G.B., Lambe, N.R., & Hitchcock, D. (1997). Ability of laying hens to negotiate horizontal perches at different heights, separated by different angles. *British Poultry Science*, *38*, 48-54.

Shields, S.J. (2004). Dustbathing by broiler chickens: characteristics, substrate preference, and implications for welfare. Ph.D. Dissertation, University of California, Davis, pp.10-12.

Shini, A., Stewart, G.D., Shini, S., & Bryden, W.L. (2008). Free range housing systems: performance from three consecutive laying cycles. Poster presentation, XXII World's Poultry Congress. June 29 – July 4, Brisbane, Australia. As cited in Compassion In World Farming (CIWF). Hen welfare in alternative systems. January 2012.

Špinka, M. & Wemelsfelder, F. (2011). Environmental Challenge and Animal Agency. In M. Appleby, J. Mench, A. Olsson & B. Hughes (Eds), *Animal Welfare: 2nd Edition*. (pp. 27-43). Wallingford: U.K.: CABI Publishing.

Steenfeldt, S., Kjaer, J.B., & Engberg, R.M. (2007). Effect of feeding silages or carrots as supplements to laying hens on production performance, nutrient digestibility, gut structure, gut microflora and feather pecking behaviour. *British Poultry Science*, *48*(4), 454-468.

Struelens, E., Tuyttens, F., Duchateau, L., Cox, M., Vranken, E., De Baere K., …Sonck B. (2004). Perch height preference of laying hens in furnished cages: influence of cage height. Proc. 38th International Congress of the ISAE. Helsinki, Finland. August 3-7.

Struelens, E., Tuyttens, F.A., Duchateau, L., Leroy, T., Cox, M., Vranken, E.,… Sonck, B. (2008). Perching behaviour and perch height preference of laying hens in furnished cages varying in height. *British Poultry Sci*ence, *49*(4), 381-389.

Struelens, E., & Tuyttens, F.A.M. (2009). Effects of perch design on behaviour and health of laying hens. *Animal Welfare*, *18*, 533-538.

Struelens, E., Tuyttens, F.A.M., Ampe, B., O¨Dberg, F., Sonck, B., & Duchateau, L. (2009). Perch width preferences of laying hens. *British Poultry Science*, *50*(4), 418-23.

Tanaka T., & Hurnik, J.F. (1992). Comparison of behaviour and performance of laying hens housed in battery cages and an aviary. *Poultry Science, 71*, 235-243.

Tauson, R., & Abrahamsson, P. (1996). Foot and keel bone disorders in laying hens: effects of artificial perch material and hybrid. *Acta Agriculturae Scandinavica Section A, Animal Science*, *46*(4), 239-246.

Technomic Information Services. (2007). Future Food Trends. Issue No. 3. p 2.

United Egg Producers (UEP). (2010) Animal Husbandry Guidelines for U.S. Egg Laying Flocks. 2010 Edition. Retrieved from: http://www.uepcertified.com/pdf/2010-uep-animal-welfare-guidelines.pdf. p. 27.

United States Center for Disease Control. (2011, July). Trends in Foodborne Illness, 1996-2010. Retrieved from: http://www.cdc.gov/foodborneburden/trends-in-foodborne-illness.html

United States Department of Agriculture. (2012, February). Chickens and Eggs. 2011 Summary. p 6. Retrieved from: http://usda01.library.cornell.edu/usda/current/ChickEgg/ChickEgg-02-28-2012.pdf

Van Liere, D.W., & Bokma, S. (1987). Short-term feather maintenance as a function of dust-bathing in laying hens. *Applied Animal Behaviour Science*, *18*(2), 197-204.

Wechsler, B., & Huber-Eicher, B. (1998). The effect of foraging material and perch height on feather pecking and feather damage in laying hens. *Applied Animal Behaviour Science*, 58(1): 131-141. Retrieved from: www.journals.elsevierhealth.com/periodicals/applan/article/S0168-1591(97)00137-8/abstract

Weise, Elizabeth. (2010, August 9). Egg Farmers: Good Managing Can Help Control Salmonella. USA Today. Retrieved from: http://www.usatoday.com/yourlife/food/safety/2010-09-03-egg-farms-salmonella_N.htm

Whitehead, C.C. (2000). Geneotype and nutrition interactions in relation to bone strength in laying hens. *Lohmann Information,* No. 23, 15-19. Retrieved from: http://www.lohmann-information.com/content/l_i_23_article_3.pdf

Whitehead, C.C. & Fleming, R.H. (2000). Osteoporosis in cage layers. *Poultry Science*, *79*, 1033-1041.

Whitehead, CC, Fleming, R.H, Julian, R.J, & Sørensen, P. (2003). Skeletal problems associated with selection for increased production. In: W.M. Muir & S.E. Aggrey (Eds.), *Poultry Genetics, Breeding and Biotechnology* (pp. 29-52). Wallingford, U.K.: CABI Publishing.

Widowski, T.M., & Duncan, I.J.H. (2000). Working for a dustbath: are hens increasing pleasure rather than reducing suffering. *Applied Animal Behaviour Science*, *68*, 39-53.

Wigley, P. (In press). Salmonella in poultry and pig production. Reader in Foodborne Zoonoses, National Centre for Zoonosis Research, Institute for Infection and Global Health, University of Liverpool.

Wilkins, L.J., Brown, S.N., Zimmerman, P.H., Leeb, C., & Nicol, C.J. (2004). Investigation of palpation as a method for determining the prevalence of keel and furculum damage in laying hens. *The Veterinary Record*, *155*(18), 547-549.

Wilson, S., Hughes, B.O., Appleby, M.C., & Smith, S.F. (1993). Effects of perches on trabecular bone volume in laying hens. *Research in Veterinary Science*, *54*(2), 207-211.

Wood-Gush, D.G.M. & Gilbert, A.B. (1969). Observations on the laying behaviour of hens in battery cages. *British Poultry Sci*ence, *10*, 29-36.

World Health Organization. (2004). Avian Influenza, Factsheet No 277.

Yue, S. & Duncan, I.J.H. (2003). Frustrated nesting behaviour: relation to extra-cuticular shell calcium and bone strength in White Leghorn hens. *British Poultry Science*, *44*, 175-181.

Zimmerman, P.H., Koene, P. & van Hooff, J.A.R.A.M. (2000).Thwarting of behaviour in different contexts and the gackel-call in laying hens. *Applied Animal Behaviour Science*, *69*, 255-264.

Appendix

Hen Housing Standards in the United States[i],[ii]

	Enforceability/ Verification	Minimum floor space per adult hen	Nest boxes	Perches	Dustbaths/ Scratch Area	Access to outdoors	Beak Trimming
United Egg Producers Certified (UEP) – Battery Cages	Inspected by third party auditors	White hens: 67 in^2 (432 cm^2) Brown hens: 76 in^2 (490 cm^2)	No	No	No	No	Accepted practice includes: 1. Infrared beak treatment at 1 day old. 2. Blade trimming no later than 10 days old. Ideally genetic stock should be used that do not require beak trimming.
American Humane Certified – Enriched Cage	Inspected by third party auditors	116.3 in^2 (750 cm^2) 17.7 in (45 cm) available height.	Yes No specific size requirements for nesting areas currently defined.	Yes Size: 5.9 in (15 cm) per hen. 9.4 in (24 cm) of height above the perch.	Yes	No	Accepted practice includes: 1. Infrared beak treatment at 1 day old. 2. Blade trimming no later than 10 days old. Ideally genetic stock should be used that do not require beak trimming.
US Proposed Legislation – Enriched Cage[iii]	No	White hens: 124 in^2 (800 cm^2) Brown hens: 144 in^2 (929 cm^2)[iv]	Yes No specific size requirements for nesting areas currently defined.	Yes No specific size requirements for perching areas currently defined.	Yes	No	Accepted Regulations on specific practices are not currently defined.
United Egg Producers Certified (EUP) – Cage-Free[v]	Inspected by third party auditors	Litter Floors: 216 in^2 (1,394 cm^2) Perching area over dropping pit/belt: White hens: 144 in^2 (929 cm^2) Brown hens: 173 in^2 (1,116 cm^2) Aviary: 144 in^2 (929 cm^2)	Yes Size: 1,296 in^2 (8,361 cm^2) per 100 hens	Yes Size: 6 in (15.24 cm) per hen. 20% elevated to 16 in (40.64 cm) above adjacent floor and 12 in (30.48 cm) away from adjacent perches and walls. Height should not exceed 39.6 in (100.6 cm) from adjacent floor. 55% of flock must have access to perch at one time in a multi-tier operation.	Yes 15% of usable floor space covered in litter, including floor areas in tiered/aviary systems. Amount of litter is not currently defined.	Optional	Accepted practice includes: 1. Infrared beak treatment at 1 day old. 2. Blade trimming no later than 10 days old. Ideally genetic stock should be used that do not require beak trimming.

	Enforceability/ Verification	Minimum floor space per adult hen	Nest boxes	Perches	Dustbaths/ Scratch Area	Access to outdoors	Beak Trimming
American Humane Certified – Cage-Free	Inspected by third party auditors	Indoors: Litter Floors: 180 in^2 (1,161 cm^2) Perching area over dropping pit/belt or Aviary: White hens: 144 in^2 (929 cm^2) Brown hens: 173 in^2 (1,116 cm^2) 17.7 in (45 cm) between tiers Free-Range: 6,273 in^2 (40,469 cm^2)	Yes One nest box per every 5-7 hens or 1,296 in^2 (8,361 cm^2) per 100 hens for colony nests. 2-4 in (5.08-10.16 cm) of substrate in nest box areas.	Yes Size: 6 in (15.24 cm) per hen. 20% elevated to 16 in (40.64 cm) above adjacent floor and 12 in (30.48 cm) away from adjacent perches and walls. Height should not exceed 39.4 in (100 cm) from adjacent floor.	Yes 15% of usable floor space covered in litter. Amount of litter is not currently defined.	Optional[vi]	Accepted practice includes: 1. Infrared beak treatment at 1 day old. 2. Blade trimming no later than 10 days old. Ideally genetic stock should be used that do not require beak trimming.
US Dept. of Agriculture (USDA) Certified Organic	Inspected by USDA accredited third party auditors	Indoors: With 6 in (15.24 cm) perch space per hen: 173 in^2 (1,116 cm^2) With perch space for 20% of hens: 216 in^2 (1,394 cm^2) Outdoor: 288 in^2 (1,858 cm^2)	Poultry houses must allow all birds to engage in natural behavior; however, no specific requirements for nesting currently defined.	Yes Size: 6 in (15.24 cm) per hen. 55% of flock must have access to perch at one time in a multi-tier operation.	Yes 30% of usable floor space covered in litter. Amount of litter is not currently defined.	Yes Year-round access to outdoors that is suitable for species, stage of life, the climate and environment is required.[vii]	Accepted practice includes: No later than 10 days old. Methods must minimize pain and stress. Physical alterations should only be performed to improve the health or welfare of the hen and/or to protect the flock.

i Approximately 80% of eggs produced in the United States are certified by the United Egg Producers (UEP). The remaining 20% either meet the standards of an alternative certifier or do not comply with any mandatory regulations. The U.S. government has voluntary guidelines for battery cages, cage-free and free-range systems; however, it does not require independent verification.

ii Additional U.S. certifiers include Certified Humane, Animal Welfare Approved and Food Alliance Certified.

iii The Egg Inspection Act Amendments of 2012 (H.R. 3798/S. 3239) is pending legislation agreed upon by the United Egg Producers and the Human Society of the United States, and further supported by WSPA. The legislation would require all battery cages in the United State to be minimally replaced with enriched cages (also known as 'furnished cages'), all egg-laying hens to be able to express natural behaviors and all eggs cartons to be clearly labeled as to the eggs' method of production - e.g. "eggs from caged hens", "eggs from cage-free hens". Source: Egg Inspection Act Amendments of 2012, H.R. 3798, 112th Cong., 2d Sess. (2012).

iv Ibid

v UEP Certified defines cage-free as all floor, aviaries and systems with outdoor access. Source: United Egg Producers (UEP). (2010) *Animal Husbandry Guidelines for U.S. Egg Laying Flocks*. 2010 Edition. Retrieved from: http://www.uepcertified.com/pdf/2010-uep-animal-welfare-guidelines.pdf

vi American Humane Certified producers also operating as USDA Certified Organic should defer to the USDA standards when standards differ between the two certifiers. Source: American Humane Association. (2012) American Humane Certified Animal Welfare Standards for Laying Hens-Cage-Free, Aviary, and Free-Range. 2012 Revised Edition. Retrieved from: http://humaneheartland.org/index.php?option=com_content&view=article&id=3&Itemid=106&jsmallfib=1&dir=JSROOT/Animal+Welfare+Standards+Checklists

vii Temporary Confinement is allowed for nest box training, a documented occurrence of an outbreak of disease in the region of migratory pathways, and/or when the healthy, safety or well-being of the hen is jeopardized. When temporary confinement is necessary, conditions must be documented through historical data, literature, educational materials and/or prior experience by the producer. Sources: United States Department of Agriculture (USDA) National Organic Standards Board. (2009) National Organic Standards Board Livestock Committee Proposed Recommendations for Animal Welfare. 2009 Edition. Retrieved from: http://www.ams.usda.gov/AMSv1.0/getfile?dDocName=STELPRDC5081490,

Hen Housing Standards in the Canada

	Enforceability/ Verification	Minimum floor space per adult hen	Nest boxes	Perches	Dustbaths/ Scratch Area	Access to outdoors	Beak Trimming
Recommended Code of Practice – Battery Cages[i]	Voluntary guidelines. Not audited by independent third party.	White hens: 67 in^2 (432 cm^2) Brown hens: 75 in^2 (483 cm^2)	No	No	No	No	Should ideally take place prior to 14 days of age. Not recommended after 8 weeks. Farmers encouraged to use layer strains which do not require beak trimming.
Egg Farmers of Canada (EFC) Policy on Enriched Cages[ii]	Standards required to be recognized as an "Enriched Housing System" & receive EFC certificate. Not audited by independent third party.	93 in^2 (600 cm^2), not including nest box.	Yes. A nest box is required.	Yes. Perches are required.	Optional	No	
Recommended Code of Practice – Free-run[iii]	Voluntary guidelines. Not audited by independent third party.	White hens: 264 in^2 (1,700 cm^2) on litter floors 132 in^2 (850 cm^2) on wire/slat floors Brown hens: 292 in^2 (1,900 cm^2) on litter floors 147 in^2 (950 cm^2) on wire/slat floors *Doesn't apply to aviaries.*	Potentially. Recommends 20 individual nests for every 100 hens.	Potentially. Recommends an adequate number and length of perches be provided to avoid aggression among chickens.	No recommendations but may be provided.	No	Should ideally take place prior to 14 days of age. Not recommended after 8 weeks. Farmers encouraged to use layer strains which do not require beak trimming.
Recommended Code of Practice – Free-range[iv]	Voluntary guidelines. Not audited by independent third party.	No space recommendations for outdoor environment.	Potentially. Recommends 20 individual nests for every 100 hens.	Potentially. Recommends an adequate number and length of perches be provided to avoid aggression among chickens.	No recommendations however outdoor environments typically provide dustbathing opportunities.	Yes, when weather permits and all birds should have easy access to shelter.	Should ideally take place prior to 14 days of age. Not recommended after 8 weeks. Farmers encouraged to use layer strains which do not require beak trimming.

	Enforceability/ Verification	Minimum floor space per adult hen	Nest boxes	Perches	Dustbaths/ Scratch Area	Access to outdoors	Beak Trimming
Canada Organic ***(Certified Organic)***[v]	Mandatory requirements. Annually audited by independent third party.	Indoors: 264 in^2 (1,700 cm^2) Outdoors: 388 in^2 (2,500 cm^2) Equivalent to 6 hens/m^2 (Indoors), 4 hens/m^2 (Outdoors) as stated in the standards.	Yes. Require that hens have access to an adequate number of nests according to 'best management practices'. The guidelines recommend 1 nest box for every 4-8 hens, or communal nests with minimum of 120 cm^2/hen.[vi]	Yes. Hens must have 18 cm of perch space/hen.	Yes. Litter must be provided and houses with slatted floors must have 30% minimum of solid floor area with sufficient litter available for dustbaths, scratching and foraging. Guidelines recommend the provision of dustbathing facilities.	Yes, hens must have free access to pasture, open-air runs or other exercise areas, subject to weather and other conditions, for at least one third of their life.[vii]	Prohibited unless deemed necessary to control problem behaviour. Use of pain control recommended but not required.[viii]
BC SPCA – ***(Certified SPCA)***[ix]	Mandatory requirements. Annually and randomly audited by independent third party.	Indoors: 295 in^2 (1,904 cm^2)/hen (white or brown) on litter floors 172 in^2 (1,111 cm^2)/hen on partially slatted floors Outdoors: 6,273 in^2 (40,469 cm^2) is recommended.	Yes. Requires one nest box for every 5 hens or if communal nests are provided, at least 1 m^2 must be provided for every 120 hens, with suitable substrate to promote nesting behaviour.	Yes. Requires at least 15 cm of perch space per bird. Some perches must be raised at least 30 cm above floor.	Requires the provision of dustbathing and scratch areas. 30-50% of total floor area must be covered in substrate that is well-drained and well-maintained.	Yes. Free-range hens must have access to outdoors for at least 6 hrs/day for at least 180 days/year, when weather permits. Outdoor range must provide appropriate foraging opportunities and shade and shelter.[x]	Prohibited unless all other efforts to control cannibalism have been unsuccessful. Farmers encouraged to use layer strains which do not require beak trimming & are best adapted to cage-free housing.

i Canadian Agri-Food Research Council (CARC). (2003). *Recommended Code of Practice for the Care and Handling of Pullets, Layers and Spent Fowl*. Ottawa, ON: CARC. Retrieved from: www.nfacc.ca/pdfs/codes/Poultry%20Layers%20Code%20of%20Practice.pdf

ii In 2011, the Egg Farmers of Canada (EFC) adopted the EU requirements for usable space per hen in enriched cages as an Interim Policy until the Codes of Practice are updated. Nest boxes and perches are required but scratch pads and dust baths are optional in order to be recognized as an Enriched Housing System and to receive a certificate from EFC. Sources: Egg Farmers of Canada – *Animal Care Fact Sheet* and Alberta Egg Producers. 2011 Annual Report: www.eggs.ab.ca/_literature_124679/AEP_2011. p 15.

iii CARC. (2003). p. 8-9.

iv CARC. (2003). p. 8-10.

v Canadian General Standards Board. (2006). *Organic Production Systems. General Principles and Management Standards: Livestock Production*. CAN/CGSB-32.310-2006. Amended October 2008.

vi Canadian Organic Growers. (2010). *A Guide to Understanding the Canadian Organic Standards. General Principles and Management Standards*. v. 6 January. p. 49.

vii Outside areas must be covered with vegetation to provide protection from predators. Source: Canadian General Standards Board (2006). p. 19. Birds should be provided with outdoor access when their feather cover and outdoor conditions enable them to adequately thermoregulate. Source: Animal Welfare Task Force. (2009). *Animal Welfare on Organic Farms. Guidance for Organic Poultry Production*. January. p. 8.

viii Beak trimming is only allowed when necessary to control problem behaviour that has negative impact on welfare of other animals. Farmers must document measures taken to eliminate behaviour. Source: Canadian General Standards Board. (2006). p. 15.

ix BC SPCA. (2009). *SPCA Certified: Standards for the raising and handling of laying hens*.

x Free-range hens must have outdoor access at least 6 hrs/day unless daylight period is less. SPCA Certified free-run systems are not required to have outdoor access.



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