Understanding Mortality Rates of Laying Hens in Cage-Free Egg Production Systems

In cage-free egg production systems, concerns have been raised over hen mortality rates. High mortality is an obvious indicator of poor welfare, and problems should be addressed without delay. It is important to note, however, that mortality can vary substantially between hen flocks, and that some cage-free systems have healthy flocks that do not suffer substantial death losses. These systems can serve as models for the rest of the industry, since mortality is not inherent to any particular system, but a consequence of how well the system is managed.

It is also important to put the problem into historical perspective. Prior to about 1930, flocks were small. Many diseases, such as coccidiosis, respiratory diseases, and salmonellosis[1,2] became more problematic with the commercialization of chicken production, when flock size increased and there was a growing effort to raise more birds on less land.[3,4] For example, one authoritative text notes that the significance of coccidiosis, "one of the most devastating of poultry diseases," increased as larger groups of birds were kept in confinement.[5] Egg-borne pathogens, such as *Salmonella pullorum*, were disseminated with the advent of large commercial hatcheries.[6,7] During this time period the average mortality rate of chickens jumped from 5-6% to 20%.[8] Although high mortality rates were a significant problem, economic incentives led the industry to seek strategies for mitigating these losses while maintaining large flocks.

For the egg industry, one remedy was to move laying hens into cages. In cages, wire floors separate the chickens from their manure. While this may have helped reduce intestinal disease and parasites,[9] intensive confinement restricts the hens to small, barren cages that offer no opportunity to display important natural behavior, impinging on physical health due to lack of exercise and resulting in a very poor quality of life.[*]

Cages were not introduced solely to improve flock health, however; they also reduced labor requirements and allowed producers to confine many more birds together under one roof,[10] providing producers with further economic advantages.

It is also critical to note that the improved flock health status seen today is not due to any single factor, and is largely due to vaccine development,[11] better hygiene practices such as "all in, all out" policies,[12] disease eradication programs,[13] and genetic selection for disease resistance.[14,15] These factors will continue to be important as egg production systems evolve to respond to animal welfare concerns.

Role of Hen Genetic Strain

A key concept in understanding mortality rates is the interaction between the genetic background of the hen and her environment. Hens must be genetically adapted to their surroundings in order to thrive, and studies and practical experience are beginning to show that a large portion of the mortality in cage-free egg production can be explained by differences in the genetic strain of hen used in the system.

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

Laying hens are bred almost entirely by a limited number of international companies.[16,17] Until recently,[18] since most egg production took place in battery cages, breeding goals were aimed at producing hens who could lay many eggs in cages.[19] However, since cage-free egg production is becoming an international trend (in part a reaction to legislative changes in the EU[20] and California[21]),[†] breeding companies are beginning to select hens on the basis of their performance and survival in cage-free environments.[22]

To illustrate the importance of hen genetic background, we can look to the experience in Denmark, where hens were not moved into cages until 1980. When cages were first introduced in the country, one of the common breeds used was the Danish Skalborg hen. The Skalborg hen was genetically adapted to the floor systems in use at the time, and this was reflected in the mortality rate when the housing environment changed. In breed comparison tests initiated during this time, it was discovered that the mortality rate of the Skalborg hen was five times higher *in cages* compared to floor pens.[23]

In 2005, the *World's Poultry Science Journal* published a study in which the authors reviewed every available study written in English, French, or German that reported hen mortality rates in cage and aviary (multi-tiered cage-free) housing systems from 1980 to 2003. This study eliminated much of the previous bias in the scientific literature by including only studies that used the same hen strain, age, and beak-trim status in both cages and aviaries. Only 14 studies met these criteria, a telling result in itself. When these factors were accounted for in the statistical analysis, the mortality rate did not differ between cages and aviaries. Thus, in previous studies showing a higher mortality rate in aviary systems, the apparent difference was due to factors other than the housing system. One important factor was the choice of hen strain.[24] In some studies that report differences in mortality however, the type of production system is confounded with the strain of hen used in that system.

The difference that genotype makes on mortality rates can be clearly understood by examining studies that have compared different hen strains in the same environment. For example, a 2001 study compared the mortality rates of four hen genetic types: ISA Brown, New Hampshire, White Leghorn, and a cross between New Hampshire and White Leghorn hens. The ISA Brown strain is used for commercial brown egg production. The New Hampshire and White Leghorn strains are pure lines of the respective breeds and have been moderately selected for characteristics important under free range conditions. For the experiment, all four genetic types were reared under identical conditions: indoors in pens until they reached 16 weeks of age and then given free-range access. The mortality rates observed were 19.9% for the ISA Brown hens. For the New Hampshire hens it was 13.8%. For the White Leghorn hens it was 6.7% and, for the cross, it was 3.9%.[25] Since the rearing and housing conditions were identical, the differences resulting from genetics could be observed. Where mortality was high, a primary cause was injurious pecking behavior,[26] a common problem in commercial flocks.

Other studies confirm that brown hens bred for high egg production tend to have higher mortality rates, mainly as a consequence of injurious pecking.[27,28,29] The routine use of these birds in cage-free production has led to the inaccurate conclusion that the higher death rate results from the cage-free system when, in fact, the hen strain or an interaction between the hen strain and the environment is the cause.

[†] A Directive (1999/74/EC) applicable throughout the European Union bans conventional battery cages beginning in 2012. Voters in the state of California approved a 2008 ballot initiative requiring hens have enough room to lay down, stand up, turn around freely, and fully extend their wings. The California law will take effect in 2015.

In some segments of organic production, where brown hybrids have historically dominated, white hybrids are now becoming more popular, primarily because of their more agreeable temperament. A Swedish survey found that, where producers have experienced severe outbreaks of cannibalism, they are shifting from brown to white hybrids.[30] To meet potential consumer demand for cage-free brown eggs, however, it is also possible to breed brown strain hens specifically for cage-free production (see the Stonegate example below).[31]

Injurious pecking behavior is obviously not the only cause of hen mortality. Professor Poul Sørensen of the Danish Institute of Agricultural Science has noted that native and local breeds seem to have better genetic resistance against infection, and are better at defending themselves and escaping from predators.[32] However, even well-adapted hens are less likely to survive if the egg production system is not well managed.

Role of Management

Alternative systems require more skills and experience than cage systems,[33] and are thus more sensitive to poor management.[34] Lapses in management can prevent cage-free flocks from reaching their full welfare potential,[35] contributing to mortality problems.[36] As explained by Michelle Jendral, assistant professor at Nova Scotia Agricultural College, “There is little question that alternative housing systems require considerable management effort, however high productivity, low mortality, and a safe working environment are all achievable, and management skills will continue to develop as experience is gained.”[37]

Currently, differences in management can contribute to inconsistency among cage-free farms, with some performing well and others struggling. Thus, while mortality *can* be high, it is also highly variable between farms.[38,39,40] For example, in a study of free-range units published in the *Veterinary Record*, the estimated losses from culling and death ranged from 1.8-21.4% at the end of the laying cycle. Because a small number of farms suffered heavy losses, however, the distribution was somewhat skewed (the mean mortality was 7.97%, while the median was 6.95%). At least one free-range farm had only 1.8% mortality at 70 weeks,[41] demonstrating that some cage-free producers are adept at minimizing mortality.

An important prerequisite to good management is the attitude of the producer. Scientists have noted that, “[a]ttitudes of those in charge of management and husbandry are likely to be a major determinant of animal welfare.”[42] It has been demonstrated that, in organic production, feather pecking damage is reduced as producers gain experience. Many of these producers are highly motivated, and take extra steps. One study found that farmers who understood the behavioral biology of their chickens, including their origin in a forested environment, have adapted their management, provided enhanced outdoor areas, and paid greater attention to the laying hens’ early rearing experiences. Successful control of feather pecking in this study was dependent on the motivation and devotion of the farmers.[43] In other words, the attitude of the producer matters.

Causes and Prevention

Cannibalism

As previously discussed, one of the most common causes of mortality in cage-free flocks is injurious pecking behavior, including feather pecking and cannibalism. Severe feather pecking can lead to cannibalism.[44] In Sweden, where beak-trimming is not permitted, cannibalism and subsequent injury and infection are associated with hen mortality,[45] and these results have been used to condemn poorly managed cage-free production in the United States.[46] However, beak-trimming is permitted in the United States and is often used to help control cannibalism. Beak-trimmed flocks, especially beak-trimmed brown strains,[47] have lower mortality than they would otherwise.[48,49]

The problem with beak-trimming as a solution is that the procedure is probably painful.[50,51] The welfare of hens is improved when producers are successful at controlling cannibalism using alternative means. The effect of beak-trimming on cannibalism and subsequent mortality is strain-dependent[52] so, given the previously mentioned potential for genetic improvement, the use of strains that do not require beak-trimming is a promising alternative.[53]

In addition to genetic selection for hens who exhibit less injurious pecking, there are many other steps that can be taken to reduce the likelihood of a cannibalism outbreak. Good visibility is required for the performance of cannibalism,[54] so producers often dim the lights in barns to control outbreaks.[55] Since cannibalism is thought to have a hormonal basis, the risk of cannibalism may be reduced by using lighting programs that delay the age at which hens first lay eggs.[56] Early access to perches can decrease cloacal cannibalism by giving potential victims a safe place to avoid hens who would peck them on the floor.[57,58]

Feather pecking is related to foraging behavior[59] and, aside from the nutritional value of feed the ability to seek, investigate, and manipulate potential food items is also of importance.[60] This is one reason that early access to loose litter in which to scratch and peck can sometimes reduce feather pecking,[61] cannibalism,[62] and subsequent mortality.[63] Additional foraging materials such as maize, barley-pea silage, or carrots can dramatically reduce cannibalism and subsequent mortality.[64] Hens who use an outdoor range area (where foraging and exploring opportunities are provided for them) are less likely to feather peck.[65,66] To make outdoor areas more attractive, protective cover[67] such as tall plantings of vegetation, bushes, trees,[68] or artificial structures that provide shelter, shade, and security can be used.[69,70] Finally, it is crucial to select a hen strain that is well suited to the housing environment.[71]

Panic Reactions

Although a relatively infrequent event,[72] large groups of birds confined indoors can pile on top of each other, if they become frightened and rush to escape. One technique cage-free egg producers have used to prevent birds from reacting to strange or unusual sounds is to play music as background noise.[73] Well-insulated barns can also buffer loud, outside noises. Large flocks within a barn can also be subdivided into smaller groups to prevent pile-ups. If birds are exposed to a variety of sights and sounds during their early rearing experience, they become habituated and less likely to show panic reactions as adults.[74]

Disease and Parasites

Disease risk in cage-free systems can be reduced by a variety of means. In barn housing, it is important to provide good ventilation, and to introduce only parasite-free, healthy pullets.[75] Reducing flock size and stocking density can minimize disease risk,[76,77] while overcrowding can lead to higher mortality rates.[78] Providing adequate space is therefore important.

A significant disease concern of poultry is coccidiosis, a protozoan parasite that can inhabit the intestinal tract.[79] In small operations with low stocking densities, limited exposure causes birds to develop immunity without becoming sick.[80] In large-scale commercial production, there are many approaches for controlling coccidiosis, but the primary methods are vaccination[81] and medication delivered in the feed. Nearly all young chickens are given anticoccidial drugs to prevent infection or reduce the infectious load so that birds develop immunity.[82]

For cage-free barn egg production, where hens do not have outdoor access, producers often use raised slatted floors that allow manure to drop through as a method of separating hens from their waste (thus breaking the lifecycle of parasites). This is one method that other segments of the poultry industry (breeding operations, for example) have successfully used for years to prevent intestinal parasites and diseases[83] without the use of cages.

It is important to clean waterers and feeders frequently, and to be sure the height is adjusted appropriately so that droppings do not fall into the water supply. Because wet litter facilitates parasite proliferation, bedding must be managed so it stays dry and friable.[84,85]

For free-range producers, the build up of parasites around the barn can be avoided with the use of mobile housing,[86] pasture rotation, reduced stocking density, and land with good drainage.[87,88] Other methods that are helpful include regularly mowing or grazing to keep vegetation short on pasture, and removing heavily contaminated soil around the barn before introducing a new flock.[89]

Other Outdoor Challenges‡

To protect free-range flocks from nocturnal predators, birds *must* be secured indoors at night without fail. Electric fencing can protect chickens from ground predators such as foxes and dogs.[90,91,92] Perimeter fences can be dug deep in the ground to prevent predators from digging underneath, and an overhang at the top will help prevent animals from climbing over the fence.[93] A well-insulated house is also important to protect birds from extremes in weather conditions.[94]

Case Studies

Where there is a commitment to making meaningful improvements, workable solutions to hen mortality problems have been found. For example, Stonegate supplies eggs for Waitrose, a leading supermarket chain in the United Kingdom. Stonegate has developed its own line of hens, Columbian Blacktails, birds with hardy characteristics that make them more suitable to free-range production. Beak-trimming is not permitted, yet the genetic background of these birds makes them "almost totally free of feather pecking and cannibalism."[95] Stonegate is the United Kingdom's second largest egg producer and packer,[96] demonstrating that welfare improvements can take place on a large scale. The Columbian Blacktails fit the free-range environment—they are genetically adapted to this type of production.

There are many other examples of cage-free egg production operations successfully operating with low mortality rates. For example, in Switzerland, the Research Institute of Organic Agriculture (FiBL) uses a subdivided barn system with rotational access to four outdoor paddocks. One paddock is in use at a time, allowing the other three to recover. Overhead netting protects free-range birds from birds of prey.

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‡ More detailed information on keeping free-range flocks healthy and safe can be found through the Soil Association (www.soilassociation.org) and the National Sustainable Agriculture Information Service (http://attra.ncat.org/).

A mix of brown and white strains, the flock is subdivided into groups of 500 birds. The environment is enriched with perches, dustbaths, nest boxes and plenty of space. The birds are not beak-trimmed, yet they have a mortality rate of less than 2%.[97]

Himmelsfarm (Heaven's Farm) in The Netherlands has three barns with around 32,000 H&N Brown Nick birds. One house was newly retrofitted with a Vencomatic Bolegg Terrace aviary system, holding 17,000 birds. The mortality rate was very low; just 249 birds had died after 51 weeks, amounting to less than 2%.[98]

The Myers farm in Lincolnshire, England, is a free-range farm using Lohmann Tradition birds. After adjustments to the refurbished barn were made, the mortality rate at 48 weeks was less than 1.5% in a flock of over 4,000 birds.[99]

There are also many scientific studies that substantiate commercial experience. For example, in a 1986 study conducted by researchers at the Scottish Farm Buildings Investigation Unit and the North of Scotland College of Agriculture, ISA Brown birds were used in a comparison between battery cages and a perchery system. The cumulative mortality in the perchery was 1.36% from 20-44 weeks while it was 2.47% in the comparison group, in which birds of the same strain were intensively confined in battery cages.[100]

In a 1988 Scottish study of a deep litter egg production system also using ISA Brown hens, mortality of cage-free flocks was 1-3% for beak-trimmed, birds while it was 2-3% in cages. Among birds who were not beak-trimmed mortality rose to 9% in the floor system and 5% in cages.[101]

In a 1996 study, when flocks of white layers were compared in The Netherlands, one researcher found a mean mortality rate of 6.7% in aviaries and 9.2% in battery cages.[102]

A 2009 University of British Columbia study reported mortality rates of beak-trimmed Lohmann White, Lohmann Brown, and H&N White birds. Half of the birds in each strain were confined in battery cages and half were kept in floor pens with a perch and a nest box. Birds reared in floor pens were given access to perches beginning at two weeks of age and were vaccinated against coccidiosis. The mean value for mortality during the laying period was 3.33% for the Lohmann White birds in the floor pens and 10.8% in cages. Similarly, for the Lohmann Brown birds it was 1.67% in the floor pens and 15.8% in cages, and for the H&N White birds mortality figures were 5.71% on the floor and 13.3% in cages, although during the rearing period, mortality was higher for Lohman Brown and H&N White strains on the floor compared to those in cages.[103]

These examples demonstrate that mortality is not inherently higher in cage-free systems. Experienced managers have found ways to make cage-free egg production work well. To expand these results, there is an urgent need to further investigate and perfect the methods used by successful producers.[104]

Conclusion

The egg industry is not static. It continues to evolve and reinvent itself in response to consumer demand. Changing the face of egg production is not only a matter of consumer concern, however, as meeting the welfare needs of the animals is an ethical imperative. The current predominate method of intensively confining hens in small, wire cages causes unacceptably poor welfare.[105] Even if mortality rates could not be corrected in cage-free systems, it might be worse to spend a long life confined to a restrictive, barren cage than a short life in an enriched, cage-free environment that offered a much greater degree of freedom to express natural behavior. However, because hens in well-managed cage-free systems can be both healthy and free to express behavior that is important to them, the choice is simple. The systems with the highest welfare potential are cage-free, and those should be the target of future efforts to improve egg production. The cooperative efforts of producers working together with retailers, scientists, consumers, and advocacy groups could bring about the needed changes. While it may take some time for North American producers to make cage-free systems perform optimally, the longer it takes to make the transition, the longer hens in battery cages will suffer.[§]

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[§] For more information see: "An HSUS Report: A Comparison of the Welfare of Hens in Battery Cages and Alternative Systems" at www.hsus.org/web-files/PDF/farm/hsus-a-comparison-of-the-welfare-of-hens-in-battery-cages-and-alternative-systems.pdf.

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