

What We Do and Don't Know Related to Cage Free Egg Production Research
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During the early 2000s the pressure was on the U.S. egg industry to increase cage space and to transition from conventional cage systems to housing that accommodates the natural behaviors of laying hens (Ochs et al. 2019). By 2016, state ballot or citizen initiatives coupled with corporate social responsibility commitments set targeted dates or goals for the transition of caged laying hen housing to cage-free (Trejo-Pech and Thompson, 2020).

Today the U.S. egg industry is transitioning to cage free egg production. USDA has reported nearly 111.1 m hens are being raised in cage-free (including barn and certified organic) environments (USDA-AMS, Feb 2022). With this transition comes numerous challenges to egg producers including the variety of labeling, certification, and third-party animal welfare audit programs, ever-changing customer demands, the financial challenges of transitioning to new housing, profitability, design, and technology selection, selecting hen genetics, worker safety and training, egg quality and safety, etc. Moreover, the demand to provide validated scientific evidence to answer questions or address problems posed by cage free production is growing faster than public scientists can often deliver.

During a recent discussion between the United Egg Producers (UEP) Scientific Animal Welfare Committee (SAC) and UEP members, we generated a short list of research questions and needs. Many of these questions are related to animal welfare requirements levied on the industry and the growing diversity of cage-free housing designs. The list below represents the top-of-mind issues both SAC scientists and producers identified during the discussion. The list is not comprehensive nor representative of all egg producers or scientists, but rather a snapshot of areas currently identified as problematic, in need of resolution, or further research.

1. Nest quality/design: Because there are many newer and customized cage-free housing designs, setting requirements for nest design and space allowance is challenging. We also know there are differences in time of lay and nest occupancy between brown and white strains of hens (Villanueva et al. 2017) too. Some research has focused on the hen's laying experience but mostly in furnished cages (Engel et al. 2019; Hunniford and Widowski, 2019). Identifying and validating outcomes-based measures to assess whether a nest design and the provision of floor space is working well together could be helpful to egg producers and auditors of hen welfare.

2. Depopulation methods: Recent developments in the U.S. concerning HPAI infections found in wild and domestic bird cause us to revisit the contentious issue of the rapid depopulation of flocks. Recent studies on ventilation shutdown with added heat and gas (Eberle-Krish et al. 2018) have been accepted only as a method of last resort (AVMA, 2019). Studies have been conducted in Europe using high density foam technology (see review McKeegan 2018) that is currently under test by the swine industry in the U.S. There is tremendous public scrutiny and pressure to make depopulation methods more humane. It is important to note that depopulation is not the same as euthanasia (defined as a humane death). Routine depopulation of a layer house becomes confounded with the methods of rapid killing used to contain an infectious disease. End of lay culling is a term suggested as a replacement for end of lay euthanasia.

3. Lighting: Innovative technologies in lighting may include characteristics such as spectrum, timing, energy efficiency, bulb type, and shape. It is an important part of housing design. New innovative lighting, like pulsed LED lighting, is rapidly emerging yet there is little independent published data to clearly understand its mechanisms and effects to birds' physiology and sleep pattern. Also, important is how lighting connects to egg quality/safety issues (England and Ruhnke 2020), for example, lighting strategies that may deter floor eggs. And how lighting type and placements could encourage birds to evenly use resources across the house, discourage bad behaviors, and facilitate worker tasks like bird observation in the house.

5. Impacts of midnight feeding of birds. Many guidelines set criteria for prescribed continuous light and dark periods for the welfare of hens. However, during periods of hot weather a "midnight feeding period" of 30 – 60 minutes may be provided to hens and interrupts the continuity of the dark period. There is some published data indicating midnight feeding can impact hen welfare in cage free and enriched cage conditions (van Straaveren et al. 2018; Decina et al. 2019). As climate warms there is likely to be more not less hot weather events.

6. Nest training and pullet raising. Doors have been used under the system or on the aviary structure to restrict hen access to litter to prevent laying floor eggs. Some guidelines prohibit the use of doors. Are there successful strategies for nest training that don't require hens to be locked up for periods of time each day? There are indications that pullet training strategies such as pen enrichment can reduce floor laying (Bari et al. 2020). Pullet raising strategies for successful cage free living. More research focus should be placed on identifying best strategies that prepare chicks and pullets for cage free environments that will definitively improve the welfare of layers throughout their lay period.

7. Balancing food safety, health, and other aspects of cage free production with expectations set for bird welfare. There is a need to periodically update systematic assessment of these tradeoffs to help U.S. producers find that spot where the balance can be struck for system sustainability. For example, a recent meta-analysis (Schuck-Paim et al 2021) found mortality rates in cage free systems to be declining as egg producers become more experienced at managing cage free systems. And Canada has published a life cycle analysis as their producers transition out of conventional cage systems (Turner et al. 2022). Banks of aggregated systematic data collected from commercial cage free producers is one of many ways to study these tradeoffs.

8. Matching genetics to housing design: There is still much to learn about strains of hens and their adaptability to differ cage free system designs. We also know producers may be balancing hen strain adaptability to cage free with a customer's specification for egg quality attributes. This could create a conflict between selecting strains best suited to cage free housing with customer standards for egg quality attributes. Information is available on egg storage and/or impact of housing system on egg quality (Jones et al. 2018; Zotte et al. 2021) however more work on hen strain adaptability to cage free conditions, including egg quality attributes, benefits producers and informs customers of the impacts of their egg quality specs on hen welfare.

9. Identification and validation of animal outcomes-based measures that would effectively replace engineering, management, or resource-based measures. Using animal-based outcomes could provide greater flexibility in how producers meet, and problem solve hen welfare requirements under a range of housing, management, and production conditions.

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