Mislaid Egg Management in Cage-Free Hen Houses

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Cage-Free Production and Mislaid Eggs on the Floor

Poultry production (meat and eggs) provides an affordable and efficient protein for people's diets. Currently the United States is the world's largest broiler producer (41 billion pounds in 2017) and the world's second-largest egg producer (105 billion table eggs in 2017). However, the U.S. egg industry is facing several animal-welfare challenges regarding housing systems for laying hens. The primary fast-food chains and big-box grocers (e.g., McDonalds and Walmart) have pledged to source only cage-free eggs by the year 2025. If the pledges are fulfilled, the market share of cage-free eggs will increase from 24.5% in December 2020 to 72% by 2025. Seven states also have passed regulations to source only cage-free or free-range eggs by 2025 or earlier.

Cage-free production is not without its own challenges. The percentage of *floor eggs*—eggs mislaid on the floor (Figure 1)—can be as high as 10% on cage-free egg farms. Any *mislaid eggs*—eggs that are laid outside of nesting boxes—increase labor costs because they must be collected manually by farm workers every day. Furthermore, floor eggs are at higher risk of contamination by bacteria (e.g., *Salmonella* spp.) from litter and manure, which may cause food safety concerns. *Salmonella* outbreaks are a potential concern within the egg industry and an increased number of mislaid eggs could exacerbate the problem. In addressing the issue, producers should consider several factors that impact mislaid eggs, including breed, environment, nest training, and management practices.

Figure 1. Mislaid eggs on the bedding floor of cage-free hen houses (Chai, 2021).

Floor Eggs Management With Light Control

Lighting management has been used to reduce the number of floor eggs in cage-free production environments. A commercial cage-free layer farm in Iowa shared their successful experience in reducing floor eggs with lighting control. The light intensity beneath the aviary system (5 lx) was typically lower than the open floor areas (20 lx), which caused the hens to mostly lay eggs beneath the aviary system. Figure 2a was taken before installing lights beneath the aviary system, while Figure 2b shows that lights were installed beneath the aviary system (light intensity was about 20–50 lx). The total number of floor eggs was reduced by up to 80% beneath the aviary system after light installation (where light intensity was increased from 5 lx to 20–50 lx). However, mislaid eggs were found in some other places, such as in the middle of the open floor. Therefore, other methods may help in further reducing the number of eggs laid on the floor.

Figure 2. Effect of lighting management on mislaid floor eggs: (a) floor eggs were observed beneath the aviary system because of low light intensity, (b) floor eggs were reduced greatly after installing more lights, and (c), a more detailed view of lights installed beneath the aviary system. Farms can adjust the number and distance of lights based on their own circumstances regarding floor eggs, while considering the increase in costs from the lighting equipment and electricity use (Chai, 2021).

Floor Egg Collection With Robots

There are two primary robotic applications for floor-egg management. The first application uses robots to physically collect floor eggs, and the second application uses robots to alter floor-laying behaviors. Lab-scale studies on robotic egg collection have been conducted in several different countries. In the Netherlands, researchers at Wageningen University designed PoultryBot (Figure 3), which is 1.1 m long, 0.55 m wide, and 0.45 m tall. In laboratory tests using 300 floor eggs, the robot successfully collected 46% of eggs. In the United States, studies have tested—and improved—an egg-collecting robot and developed software used to identify floor eggs. University of Georgia poultry science researchers, in collaboration with Georgia Tech engineers, evaluated the robot Spoutnic (by Tibot, a French company), and improved the robot's capabilities in egg detection, target approach, and egg collection. The floor-egg retrieval success rate reported for Spoutnic is over 80% in laboratory or experimental cage-free housing tests. Mississippi researchers developed a vision-based floor-egg detecting software to work with robots to improve the accuracy of identifying floor eggs (Figure 4).

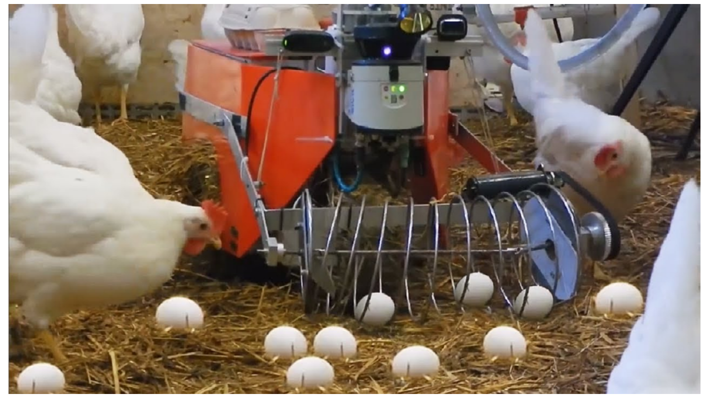

Figure 3. PoultryBot, a robot developed for floor-egg collection (Vroegindeweij et al., 2018).

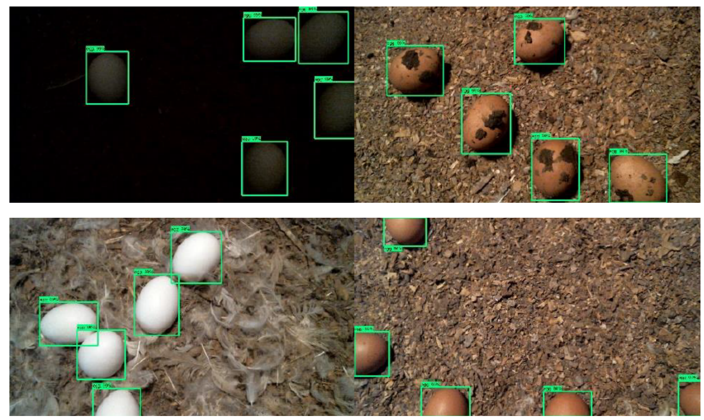

Figure 4. Floor-egg detection using vision-based software (Li et al., 2020).

UGA poultry science researchers tested the Spoutnic robot in commercial broiler breeder houses in Georgia (Figure 5). The number of floor eggs was reduced significantly. However, numerous eggs were laid on the raised slats between nesting boxes instead of on the floor. The increasing number of eggs laid on the floor or on raised slats reflect issues with the nesting boxes. There may have been too few available nesting boxes in the house, or the design or environment of the nesting boxes didn't appeal to the hens. Nests should be easily accessible for layers, and an insufficient number of nest boxes will compel hens to lay floor eggs. Nesting materials should not negatively contribute to egg flora. They should be hygienic in design, bird-friendly, and provide a measure of comfort. Hens are more likely to use boxes that provide a sense of seclusion.

Figure 5. Robotic application for reducing floor eggs in broiler breeder houses from an ongoing study by UGA poultry science researchers.

While robots are now commercially available, incorporating robotics into poultry houses requires forethought and an understanding of poultry housing systems, production situations, bird behavior, and the impact on bird welfare. The ideal timing for the introduction of robots into a flock is still under investigation—and may depend on the goal or use of the robots—for example, when is best time to introduce robots specifically to manage floor eggs. Research should be conducted in commercial houses to explore the effect of robot introduction time (e.g., at the beginning of the flock, at the peak of egg production, and at the peak of mislaid eggs) for different housing conditions (e.g., bedding, lighting, environmental conditions, birds' age, etc.).

Mislaid Egg Management Tips

Methods with potential for managing mislaid or floor eggs in cage-free layer houses can be summarized as follows:

1. **House-lighting time management:** In cage-free aviary systems, lighting management is used to help control floor-access time. Hens tend to move back to the aviary system (e.g., perches or platforms) after the lights are turned off (using dimmable light control) for an 8-hr dark period. According to observations in commercial cage-free layer houses, most floor eggs are laid at first light. Delaying floor access time in the morning may help reduce floor eggs by keeping the birds near the nests for the first few hours of light. Other reasons for a high percentage of floor eggs that require further study include competition for preferred nesting places and what effect the depth and type of bedding material on the floor has on egg-laying behaviors.

2. **Light intensity and distribution:** Make sure to provide sufficient light intensity evenly across the litter floor. Damaged or blown bulbs result in shadows around the house and can lead to increased floor eggs in these darker areas. Increasing the light intensity under the aviary system has been tested to be effective at reducing over 80% of floor eggs.

3. **Bedding depth:** As stated in the United Egg Producers (UEP) guide for cage-free production (2017), all cage-free houses are required to provide a minimum of 15% of the total space for litter. Scratch areas covered with litter help reduce the risk of feather pecking and cannibalism, and minimize flightiness, for hens living in large flocks. However, deep litter attracts birds to lay eggs on the litter itself. According to research conducted at Iowa State University, reducing litter depth discourages hens from laying eggs on floor of commercial cage-free houses.

4. **Nesting space:** Nesting behavior is a key priority and important welfare indicator for egg production, so providing hens with safe and secure locations to lay eggs is critical. In cage-free commercial production systems, it is common to utilize automatic egg-collection nests, with a rubber (plastic) nest floor mat or artificial turf. Hens show a preference for solid nest floors over wire nest floors. UEP concluded that a good nesting design in cage-free systems facilitates egg collection, minimizes the risk of cloacal cannibalism, and assists food safety and sanitation. UEP's guidelines for nesting space include: (a) providing a minimum of 9 sq ft of nest space per 100 hens, (b) providing a suitable nest floor substrate that encourages nesting behavior, (c) avoiding nests with wire floors or plastic-coated wire floors alone, (d) providing loose litter material in nests (e.g., fresh straw) to help train pullets to use the nests, and (e) inspecting and cleaning nests as necessary to ensure that manure does not accumulate. Four to six hens usually can share a nesting box in cage-free facility.

Mislaid or floor egg management is important for broiler breeder production as well as cage-free henhouses. Since cage-free layer housing is different from broiler breeder housing systems, producers should follow methods established specifically for breeder housing operations.

Summary

Researchers have been investigating the issue of mislaid eggs in cage-free housing and the possibility of reducing the incidence of floor eggs through management of lighting, litter and bedding, nesting space, and the use of robotics. Egg-production housing systems can vary between egg farms and selecting appropriate methods to reduce floor eggs will depend on specific production situations on a given farm. Additional studies are needed to address bird behaviors and food safety issues associated with mislaid eggs.

For more information, or to ask questions about this study, contact Lilong Chai, lchai@uga.edu, or Casey Ritz, critz@uga.edu.

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