Laying Hen Housing Research Project

Interim Findings Report

Coalition for Sustainable Egg Supply

Flock One Summary for Environmental, Animal Health and Well-Being, Affordability, Worker Health and Safety, and Food Safety and Quality Research Areas

The Coalition for Sustainable Egg Supply is a multi-stakeholder group collaborating on a commercial-scale study of housing alternatives for egg-laying hens in the U.S. The goal of conducting the Laying Hen Housing Research Project is to understand the sustainability impacts of various laying hen housing, including cage-free aviary, enriched cage and conventional cage systems.

The Coalition's research will result in meaningful science-based data that will help guide future egg production and purchasing decisions.

This research is being conducted on a commercial farm, with all three housing types at the same location. Over the course of three years, and two separate flocks, the research will assess five areas of sustainability: Animal Health and Well-Being, Environment, Food Affordability, Food Safety and Worker Health and Safety. The final analysis will explore interactions and tradeoffs between sustainability areas within each housing system.

Following are topline findings from the first flock of the study, including research on the following elements: Environment, Food Affordability, Animal Health and Well-being, Worker Health and Safety, and Food Safety and Quality. Initial findings begin to offer some insight into the variables to be considered in selecting different hen housing systems.

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Flock One Overview

House Characteristics and Management

	Conv. Cage	Aviary	Enriched
Dimension (L x W x H)	464 x 84 x 20 ft	506 x 70 x 10 ft	506 x 45 x 13 ft
Hen breed		Lohmann White	
No. hens at 19 weeks	193,424	49,842	46,795
Hens per cage	6	-	60
Space per bird, in²	88	100 cage + 73 litter	118
Welfare enrichment elements	N/A	Perch, nest area, litter access	Perch, nest area, scratch pad
Ventilation type	Tunnel	Ceiling/perimeter slot inlets, Cross vent	
Manure handling	Manure belt	Manure belt + litter	Manure belt
Manure removal	every 3-4 days	Belt: every 3-4 days Litter: end of flock	every 3-4 days
Photoperiod (L:D)	16L:8D		

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First Flock Summary

Hen Production Performance (19-78 weeks)

Production Parameter	Conv.	Enriched	Aviary	Ref.*
CUMULATIVE MORTALITY (%)	4.7	5.1	11.6	6.8
AVG. HD EGG PROD (%)	85.9	89.0	88.1	88.2
EGGS PER HEN HOUSED	352	363	340	360
CASE WEIGHT (LB/CASE)	46.4	46.9	46.3	48.6
FEED PER CWT (LB/100bd-day)	22.8	23.6	23.3	22.4
WATER/FEED (LB/LB)	2.07	1.73	1.64	-
FEED CONVERSION (LB/Doz. eggs)	3.18	3.13	3.28	3.14
FC (LB feed/LB egg)	2.02	1.99	2.12	1.94
BODY WEIGHT @ 78 wk (LBS)	3.44	3.42	3.37	3.71

*Lohmann white reference value

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Hen mortality is significantly higher in the aviary system than other systems, followed by the enriched system and then conventional with the lowest.

Egg production by hen is fairly similar across all systems, though their production varies over time within each system. When mortality is taken into account, production is lowest in the aviary system. Because of the higher mortality, the fewer birds remaining in that system cannot produce as many eggs as the other systems.

Production from hens in the enriched system seems to be the most consistent through the 76 weeks studied.

Environment

Ammonia and particulate matter (PM) concentrations are significantly higher in the aviary system than either conventional or enriched:

- Daily mean ammonia (NH3) concentration was below 15 ppm in both conventional and enriched cage houses throughout monitoring period, but exceeded 30 ppm in the aviary house on some days in winter.
- PM concentrations in the aviary house were roughly eight to 10 times those in the conventional and enriched cage houses. PM concentrations in the conventional and enriched houses were by and large similar.

In the aviary system, higher ammonia concentrations are likely a result of the manure being on the floor and not removed until the end of the flock. Hen behavior activity in the litter area of the aviary generates eight to 10 times more dust than enriched or conventional. Ongoing research will assess whether this dust impacts worker or hen health.

Similarly, ammonia and PM emissions from the houses were highest for the aviary house, followed by the conventional house and the enriched house. Methane emissions for all houses were similar and quite small.

Regarding energy use, it is important to consider that this is partial year data only. Also, the research location experienced a mild winter so energy use may have been lower. With those caveats, electricity use was similar across all three systems. The aviary house required supplemental heat (from propane), making it the highest cost system from an energy perspective.

Finally, manure production was similar for different types of housing systems. The manure produced from conventional housing had higher moisture content and higher emission potential than the manure from enriched and aviary systems. The manure contained 25-28 percent of the carbon, 57-63 percent of the nitrogen, 72-80 percent of the phosphorus and 70-90 percent of the potassium from the feed.

Animal Health and Well-Being

Hen mortality was much higher in the aviary system due to conditions associated with egg production, particularly hypocalcemia, and to behavioral issues, with hens either being excessively pecked, or picked out (vent). There was less mortality due to behavioral issues in the enriched system, and none in the conventional system. More birds were culled during the first fifteen days in the enriched system than the other systems due to wings and legs being fractured during placement. Also, it was harder to detect dead birds in the aviary and enriched systems than in the conventional system.

Pullets reared in aviaries had better skeletal integrity than those reared in cages.

Hens in the aviary and enriched systems had a higher incidence of keel bone deviations and/or fractures than hens in the conventional system.

Hens in conventional cages had the highest incidence of foot problems, mainly hyperkeratosis. When hens in the aviary had foot problems they were more severe than those in conventional or enriched cages.

The research findings also showed that conventional and enriched cage hens had cleaner feathers but worse feather cover than aviary hens. Hens with large areas of feather loss lost more body heat than better-feathered hens. Patterns of feather loss suggested that hens in conventional and enriched systems lost feathers due mainly to abrasion against the cage, while those in the aviary system lost feathers due to aggressive pecking from other birds.

During the daytime, about 10-17 percent of hens used the perches in the enriched system and the perches in the litter area of the aviary system.

In the aviary system, mid-afternoon was the peak time for dust-bathing, with up to 22 percent of hens seen dust-bathing in the open litter area. In enriched cages approximately 30 percent of hens dust-bathed, but mostly on the wire floor of the cage.

Feather lipid levels were lowest in the aviary system, indicating that hens can dust-bathe effectively in this system. However, they were also lower in enriched than conventional, indicating that the pad in the enriched system was somewhat effective for dust-bathing.

The foraging/dusting pad in the enriched system was used during the performance of various behaviors and became very dirty. In the aviary, the open litter area was also well used, with up to 90 percent of the area occupied.

Food Affordability

Operating and Capital Costs per Dozen Eggs

	Conventional	Aviary	Enriched
Feed costs	$0.395	$0.408	$0.394
Prod. labor costs	$0.017	$0.057	$0.047
Pullet cost	$0.146	$0.196	$0.147
Capital cost* (Capital outlay X 10% return)	$0.042	$0.138	$0.104
Sum of major cost components	$0.600	$0.799	$0.692

Preliminary data

Costs per dozen eggs are highest for eggs produced in the aviary system, followed by those from enriched housing and then conventional housing. Operating costs—feed, pullet and operating labor costs – were highest in the aviary system, while the other two houses were lower, and similar to each other.

Feed comprises the largest share of operating costs and these findings suggest it was even a higher share during this period of investigation. While the price of corn and soybeans have been historically high, we are not likely to see those prices go back down to where they were before 2007, so feed cost differentials will remain particularly important.

Capital costs are much higher for aviary and enriched systems than conventional because of the cost of the barns. No pronounced operating cost differences were found between conventional and enriched housing systems.

Worker Health and Safety

Airborne particulate matter inside hen houses, depending on its size, can make its way into workers' airways, with smaller particles being deposited deep into the lungs. Endotoxins (bacterial toxins), can promote airway irritation and inflammation, as well as decreased lung function.

To measure the impact of air quality on worker health, a total of 123 worker day data samples, with 41 samples from each of the three housing systems, were collected from workers who were randomly assigned to each house, ensuring equal coverage of each house. Each of those workers wore a personal exposure monitor while in the hen houses, sampling for total suspended particles (TSP, also called inhalable) of all sizes and smaller particles up to 2.5 microns in size (PM2.5) through each of three seasons; summer, winter and spring.

Inhalable particle and PM2.5 concentrations, as well as endotoxins (bacterial toxins), were significantly higher in the aviary system when compared to those in the conventional and enriched systems, which were not statistically different from each other. It is believed that these levels are highest in the aviary system due to litter (dustbathing material and manure) left on the floor.

Across the three seasons tested, spring, summer and winter, the aviary system had higher inhalable concentrations, PM2.5 concentrations, inhalable endotoxins and PM2.5 endotoxins.

Employees participated in respiratory analyses, measuring lung function and exhaled nitric oxide.

Lung function and exhaled nitric oxide, both tests of possible airway inflammation were measured, along with self-reported occurrence of respiratory symptoms. Changes in lung function and exhaled nitric oxide were similar in the three systems. Average mask use was higher for those workers in aviary housing, which may have protected them from greater respiratory consequences.

Worker ergonomics were also considered, with tasks classified into three categories indicating their level of ergonomic risk due to body position during the task. Researchers also looked for three main ergonomic stressors, including force, repetition and posture.

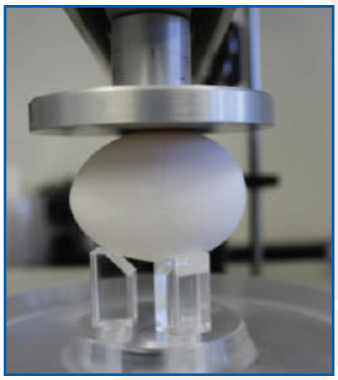
In the ergonomic review, a number of tasks stood out as possible risks. Loading and unloading of cages in the conventional and enriched colony systems during population and de-population require extreme body positions, including squatting for an extended time. There was also significant twisting while "herding" the birds and standing on small diameter railings in these two systems.

Gathering eggs that had been laid on the floor in aviary systems was also noted as an issue, as it warranted extreme body positions, including squatting for an extended period of time. Further, extreme arm positions over the shoulder and reaching to the side, as well as rapid and extreme hand and wrist positions were noted. Crawling and lying on the floor to collect floor eggs also exposes the employee to potential respiratory hazards, especially if no respiratory protection is worn, as well as to potential infection hazards to the hands and the knees.

Food Safety and Quality

Egg quality was assessed across multiple parameters. It was determined that initial egg quality is not impacted by hen housing type.

Eggs from the three systems were further assessed using the same measures at four, six and 12 weeks of cold storage to determine if housing system impacted the rate of egg quality decline. Findings showed the hen housing system did not impact egg quality over time. Current egg quality standards, written for conventional egg production, should adequately define egg quality for commercial cage-free aviary and enriched colony cages.



Shell strength and other variables were measured to determine egg quality.

Researchers also looked at the effect of housing type on hens' immune systems and Salmonella vaccination effectiveness. An effective immune response can result in a better resistance to invasion and colonization of Salmonella into tissues including ovary and eggs. The humoral and mucosal antibody levels of each flock were measured through ELISA Measurement to determine immune status. Antibody response observed in serum samples and crop lavage extracts, as detected by ELISA readers, did not detect evidence of differences in hens between housing systems; however, significant seasonal differences were noted.

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