Egg Industry Center

2022 Impact Report

THE EGG INDUSTRY CENTER

CONTRIBUTING TO A SUSTAINABLE EGG SUPPLY

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FROM THE EIC DIRECTOR

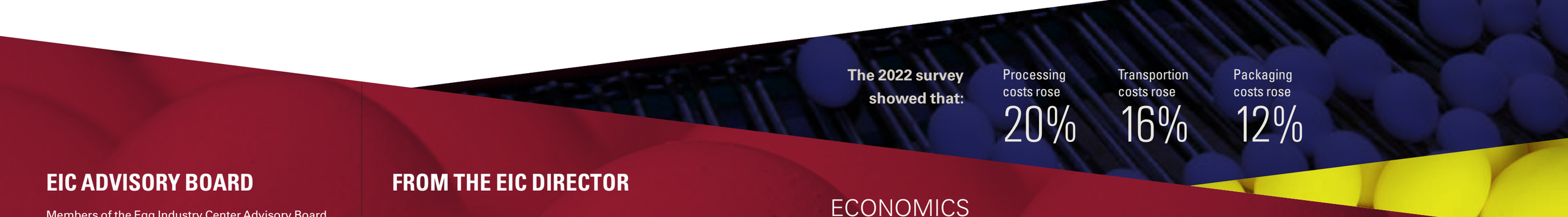
The purpose of the Egg Industry Center's 2022 Impact Report is to highlight some of our sponsored applied research. To date the EIC has funded 14 different partners in the USA and Canada to investigate and explore challenges facing the industry. Solutions are needed to solve some tough challenges in the areas of egg production and management, layer and pullet health and welfare, and environmental impact. Our partners are rapidly bouncing back from COVID-induced delays, and we've funded a new round of projects.

In addition to EIC-sponsored research, we have completed an updated Life Cycle Assessment (LCA) for the US egg industry. This LCA is currently under International Standards Organization (ISO) review as I write this. Last year we reported on this strategic sustainability effort; our next phase is to develop consumer, science, and policy messages in cooperation with our collaborators at the American Egg Board, the United Egg Producers, and the US Roundtable for Sustainable Poultry and Eggs. The information learned in the LCA will directly impact efforts to build out the new Framework for Sustainability effort that the US-RSPE is promoting.

Our Board is in the midst of a fund-raising campaign to facilitate continued funding of the above areas of research. The past year has made it clear that a dollar doesn't go as far as it used to. The goal is to double our annual funding so that EIC can invest at least $500k per year in this critical research. Thank you to all that have contributed to this campaign. If you have not donated then please consider doing so.

We look forward to continuing to serve our industry partners, with science-based research and education, and timely market analysis. Please keep in touch! I hope to see you at our next Egg Industry Issues Forum in the fall of 2022 — our first face-to-face meeting since 2019.

RICHARD GATES
Director, Egg Industry Center
Iowa Egg Council Endowed Professor, Iowa State University



ECONOMICS

Turbulent market year drives up cost to process, package, transport eggs

A 2022 STUDY

of how much egg farmers spend on post-production revealed that in 2021 the costs of processing, packaging, and transporting eggs climbed roughly 20%, probably as a result of a turbulent market year, with pandemic-related market disruptions and marked labor shortages.

The study by the Egg Industry Center helps egg farmers compare industry costs with their own operational costs for processing (washing and weighing), putting eggs in cartons, and transporting eggs to market. This processing, cartoning, and transporting report is referred to as the PCT study.

"Using 2021 data provided by egg farmers, we estimated that for the most common egg type reported by U.S. producers (eggs processed on the farm where they are produced), PCT costs averaged about 47 cents for every dozen eggs produced," said Maro Ibarburu, EIC associate scientist and business analyst.

The survey showed three different points of cost increase across the industry: processing costs, which rose 20%; the costs of transporting eggs to warehouses, which increased by 16%; and packaging costs, which rose by 12%. Overall, the largest difference between the new analysis and past studies occurred in the processing cost versus packaging or transport costs.

Responses received for the 2022 survey represented approximately 74 million layers, or about 23% of the U.S. laying hen inventory and 33% of the laying hens dedicated to shell egg production.

One challenge for the study was low survey responses, so there was no estimate for eggs trucked from a farm to a processing facility. "The off-line dataset we developed had two very different clusters of costs," Ibarburu said. "The costs were too far apart without enough data points to draw a reliable conclusion."

EIC initially assessed PCT costs in 2019, updated the study in 2021 using 2020 data, and then completed the most recent study with 2021 data. Ibarburu pointed out that costs changed during the pandemic.

"Whether looking at transportation, energy, labor, supplies, etc., all these things affect an egg processor's total costs," said Ibarburu. "For example, transportation costs for refrigerated trucks reported by the United States Department of Agriculture went up nearly 20% during the same timeframe as the PCT study."

Derreck Nassar, president and CEO of the United States Egg Marketers Inc., summarized the importance of the study for the industry. "The Egg Industry Center's PCT report plays a vital role in benchmarking post-production costs of eggs for the supply chain. This ultimately primes egg farmers and stakeholders alike to be more efficient and competitive while resulting in more value for consumers."

The PCT study is available at eggindustrycenter.org

Building a better cage-free house, or maybe a better cage-free hen line

Dr. Prafulla Regmi at the University of Georgia is studying how laying hens interact with their cage-free housing environment and the impact this relationship has on egg production and hen welfare.

Not every cage-free housing system is designed to accommodate the behavior of laying hens, and not every hen line is suitable for a cage-free lifestyle. When these mismatches occur, it can jeopardize a hen's ability to thrive physically and socially, impacting production and welfare.

As the U.S. egg industry expands cage-free production, these housing systems are continuously evolving, often without an understanding of how hens use the space provided. Commercial aviary systems are typically designed with a vertical and horizontal extension of resources—feeders, perches, drinkers, and nesting areas. Hens are expected to navigate these more open environments without compromising their welfare or egg production. However, studies have found that improper use of resources in a cage-free housing system can result in poor health outcomes for the hen, including keel bone fractures and footpad dermatitis, as well as production challenges such as mislaid eggs.

Dr. Prafulla Regmi at the University of Georgia is studying how laying hens interact with their cage-free housing environment and the impact this relationship has on egg production and hen welfare. This new research, which is funded by the Egg Industry Center, uses radio frequency identification (RFID) technology to track the movement patterns of hens in an aviary system.

The study also seeks a better understanding of the role of genetics in birds' navigation and use of resources within the aviary system and subsequent relation to production and welfare outcomes. Previous research has found that nesting behavior and floor eggs have a moderate to high genetic heritability.

"The interaction of hens with their housing environment can provide important data needed to link and devise a novel strategy to enrich resource use, production performance, and welfare in the aviary system. Such data is also particularly important for breeding companies to assist in their selection programs for birds raised in cage-free housing system as well as to develop management tools to optimize production and well-being," said Regmi.

Regmi is an assistant professor in the Department of Poultry Science at Georgia. His research examines how housing systems and genetic strains influence the performance and welfare of laying hens. In this study he will collaborate with Dr. Sammy Aggrey, professor of poultry science at Georgia with expertise in the genetics and genomics of gut health, stressors, and other traits of importance to the poultry industry; and Dr. Kenneth Anderson, professor in the Prestage Department of Poultry Science at North Carolina State University, whose research focuses on laying hen management in different housing systems.

Hens in the study will be housed in double-tiered aviary systems featuring a floor/litter area and a community nest area on the first tier, as well as perch, nest, feeder, and drinker space. Half of the hens will be fitted with a passive RFID tag encased into a leg band so they can be tracked—via traveling wave form antennas installed within the aviary room—throughout the production period for their daily activity and to monitor their egg laying habits, in the nest box or not. The activity patterns of hens will be correlated with egg production and quality, percentage of mislaid eggs, hen welfare and bone properties, and genomic analysis based on blood samples.

Results from the study could lead to improved cage-free housing designs that encourage nest laying of eggs and discourage group behavior, such as floor eggs and overcrowding, that hinder performance and welfare. The genetic markers developed in the study can be used in marker assisted selection for the traits-of-interest either in established lines or in the development of new genetic lines suitable for cage-free egg production.

Dr. Amy Murillo, an entomologist at the University of California, Riverside, is studying how plant-based essential oils applied to affected areas of laying hens could work as alternatives to traditional pesticides in controlling northern foul mite.

Study is first to field-test essential oil treatment against northern fowl mite

Laying hens infested with the northern fowl mite (NFM) have been shown to produce fewer eggs and have reduced egg weights and feed conversion efficiency. Infected hens also exhibit numerous physiological signs of stress, including lower body weight and skin lesions from increased preening behavior. Cage-free facilities allow mite infestations to spread differently than before so the industry needs solutions to help all types of flocks, including organic.

Dr. Amy Murillo, an entomologist at the University of California, Riverside, is studying how plant-based essential oils applied to affected areas of laying hens could work as alternatives to traditional pesticides in controlling NFM, the most common ectoparasite in North America. Essential oils have proven effective at killing mites in the laboratory, but no studies have been conducted to date that field-test the efficacy of essential oils on NFM in poultry.

Murillo is an assistant professor in the Department of Entomology at UC Riverside who studies ectoparasites and develops practical control methods that can reduce economic damage and protect animal well-being. She is collaborating with Dr. Caleb Hubbard, postdoctoral scholar at UC Riverside.

In a study funded by the Egg Industry Center, the team mixed thyme essential oil, which is certified organic, with a small amount of olive oil and deionized water into a hand sprayer. NFM-infected birds in the study were removed from individual cages and sprayed in the vent area with either a high concentration of thyme essential oil in the mixture, a low concentration, or no thyme essential oil in the mixture. All birds were treated twice, one week apart.

"We found that the lower concentration of thyme essential oil, which caused mite mortality in previous lab studies, was not sufficient for treatment on-bird. The higher concentration worked well and caused a significant reduction in northern fowl mite populations on-bird. Some birds had no mites recorded post-treatment," Murillo said.

"We are really excited that we found a dose that works, and we actually saw mite populations decrease on birds in the field," she said.

The team will continue to monitor the health, welfare, and production factors of hens treated with the thyme essential oil. There were no negative welfare effects observed for birds treated during testing to determine the most effective dosage.

Further study is needed to refine the application methods and possibly test the thyme essential oil treatment in a cage-free setting. The team is also investigating the chemical properties associated with the thyme essential oil, which could help them determine the best way to apply the treatment.

"We don't know how these essential oils are killing the mites. It's possible there are certain compounds associated with essential oils that are responsible for killing arthropods. It's worth exploring because then those compounds could be refined, and it would make it a more efficient product to use," Murillo said.

While the EIC-funded study is testing essential oils against only NFM, Murillo hopes they would be just as effective on other ectoparasites associated with chickens.

"We hope at the end of this study that we can provide useful feedback for producers. Traditional insecticides are just not working as well anymore, they are expensive, or producers may not want to use them for organic reasons," she said.

Reducing floor eggs and automating their collection in cage-free houses

Cage-free housing offers hens larger living quarters with enhanced resources compared to conventional cage systems. Enabling hens to roam freely, however, leads to eggs laid on the floor. Gathering floor eggs requires more labor and increases the risk of bacterial contamination and shell damage if the eggs are not collected in a timely manner.

Dr. Yang Zhao, an agricultural engineer and animal scientist at the University of Tennessee, wanted to find a way to automatically reduce and collect floor eggs in cage-free houses. Previous studies have found that floor eggs represent approximately 0.2% to 0.5% of daily egg production with partial-day litter access; the number can be greater in houses providing full-day litter access to laying hens.

In a study funded by the Egg Industry Center, Zhao and colleagues introduced a robotic vehicle that roamed a research laboratory pen slowly at specific intervals during the major egg-laying period. It took the hens a couple of days to get acclimated to the robot. After the acclimation period, the birds behaved normally and kept a distance from the robot. After seven days, the birds often remained in proximity to the robot. At the end of two weeks, birds sometimes rode the robot as it roamed the pen. The robot reduced floor eggs notably during the first two weeks but had limited effect overall.

"The good news is the poultry didn't show notable aversion when interacting with the robot as compared to humans. This means the robot didn't induce more stress to poultry. On the other hand, when birds get familiar with the robot, it would be difficult to create a clearance area needed for egg collection," Zhao said. He suggested a robot equipped with additional features, such as sounds or lights, might keep the hens at a distance.

The study also tested a computer vision system with artificial intelligence algorithms to identify floor eggs in a simulated cage-free lighting environment. This system was then incorporated into a robotic arm attached to a stationary surface for automatic egg collection. The automated vision-based egg collection system successfully identified and picked up white and brown eggs from litter with a 92% to 94% success rate.

"We are excited about the high accuracy of floor egg detection via the vision-based deep learning algorithms. In future research, it would be interesting to integrate the vision-based egg detection system and the ground robot for automatic egg collection," Zhao said.

But until the industry has a robot to collect floor eggs, it is best to train birds to lay in the systems. "It's hard to correct floor-laying behavior once it's developed," Zhao said.

Collaborating with Zhao on this research were Dr. Joseph Purswell, research leader and agricultural engineer at the U.S. Department of Agriculture's Agricultural Research Service, Poultry Research Unit; Dr. Wei Zhai, associate professor of poultry science at Mississippi State University; Dr. Hongwei Xin, dean and director of University of Tennessee AgResearch; and Dr. Jenny Du, professor of electrical and computer engineering at Mississippi State University.

Further details related to this study are published in *PLOS ONE*, *Sensors*, and *Transactions of the ASABE*.

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Science, collaboration are keys to a sustainable future

"Our job is to be at the table to ensure we are engaging the proper scientists to assist in maintaining and improving our operations in a logical and defensible manner."

DR. RICHARD S. GATES, EIC DIRECTOR

Considering the challenges facing the U.S. egg industry on its journey toward a sustainable future, it's easy to become overwhelmed trying to identify which hurdle to clear first.

When headlines warn of another outbreak of highly pathogenic avian influenza, forcing the depopulation of farms to prevent further spread, how can producers protect their laying hens and ensure their own livelihoods?

As more customers and state regulations demand eggs from cage-free operations, how do producers move from conventional cage housing systems in a way that is affordable and safe for their flocks, with the least impact on the environment? And what role can the egg industry play in reducing emissions and improving manure management on farms?

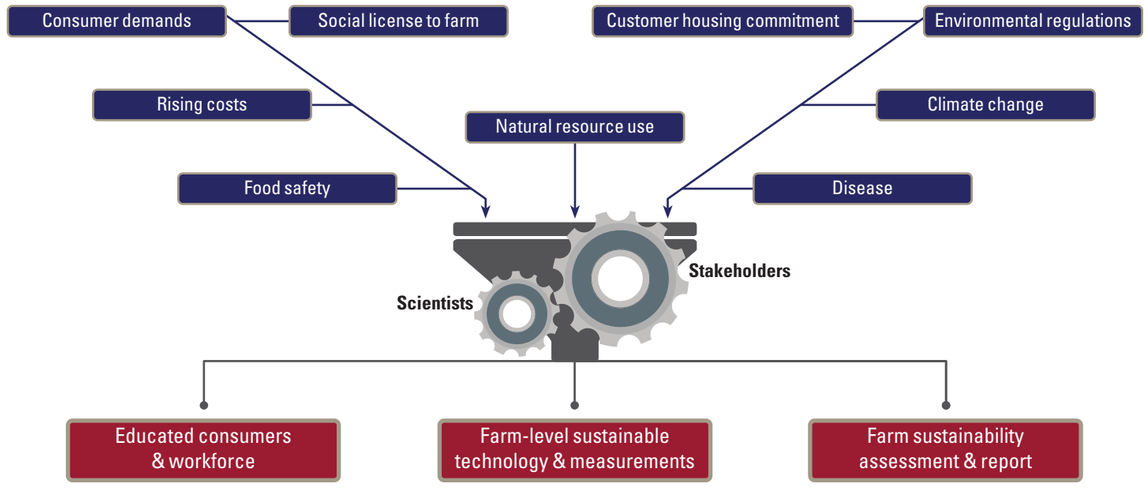
Regardless of how the questions are prioritized, the egg industry must look for answers derived from a collaborative, science-based approach in order to lay out a roadmap for sustainability.

Partners with the egg industry

Over the past decade, the Egg Industry Center has embraced a diverse pool of researchers by funding critical work at 14 universities across North America to secure scientifically based solutions for the egg industry. During this time, EIC also published a life cycle assessment (LCA), a study examining the industry's environmental impacts, based on production practices in 1960 and 2010. Given the significant changes in the egg industry since then, EIC is once again collaborating with the United Egg Producers (UEP) and the American Egg Board (AEB) to provide an updated LCA, which is expected to be released soon.

As the industry continues to examine sustainability challenges, several areas of focus have been identified that need new knowledge and technology solutions generated through scientific study. By examining previous research, surveying egg producers and allied partners, and having conversations with key stakeholders such as UEP, AEB, and the U.S. Roundtable for Sustainable Poultry & Eggs (US-RSPE), these are some of the key challenges identified as needing science-based solutions:

PROJECT APPROACH TO A SUSTAINABLE US EGG INDUSTRY



- **Feed formulation.** Comprising about 70% of key environmental impact contributions in food animal production, including eggs, practices related to breeder, pullet, and layer feed sources and formulations are a key opportunity for continued improvements in sustainability. This is an active area of research and rapidly gaining appreciation in the egg industry. While least-cost formulations will undoubtedly continue to prevail, the trade-offs with other aspects of sustainability (environment, social) will also drive adoption of novel feeds.

- **Manure management.** Manure generated by egg farms and the practices for its utilization have a significant effect on the egg industry, the environment, and the community. New methods are needed to turn hen manure into renewable energy and high-value fertilizer to enhance the profitability of egg production and further reduce its environmental impacts.

- **Hen health and welfare.** The transition to cage-free housing creates unique challenges for the health and welfare of the flock as well as the ability to monitor hens' health and safety. Technologies are needed for real-time assessment of health and to control airborne transmission of pathogens. There is also a growing demand for automating some aspects of the hen welfare certification, using, for example, animal-based outcomes assessments.

- **Disease and emission control.** There is no national assessment of emissions from cage-free laying facilities. Development of emissions standards would help farmers make decisions on where to locate new cage-free layer farms, how to manage environmental impacts, and how to prevent airborne infectious diseases.

- **Sustainability assessment tool.** The pending LCA findings can inform the creation of an on-farm sustainability assessment tool to support farm-level decision-making in achieving carbon neutrality, sustainability, and environmental justice. While national, regional, and company-wide life cycle assessments are a key first step, on-farm assessments are necessary to help egg farmers make decisions regarding their own operations' sustainability.

"EIC is working closely with our partners, including US-RSPE, of which we are a member, to ensure science will be front and center in the development of an on-farm assessment tool that we can all support for the egg industry," said Dr. Richard Gates, EIC director.

To help fund science-based solutions that increase sustainability, EIC is pursuing a $10 million grant from the USDA's Agricultural and Food Research Initiative's Sustainable Agricultural Systems (SAS) program. Leaders on this EIC project are experts in poultry science, veterinary medicine, engineering, animal welfare, renewable energy, economics, system modeling, life cycle assessment, and sustainability analysis. The project team is backed by a stakeholder advisory board that includes leaders of egg organizations, egg farmers, environmental NGOs, and sustainability executives of supply-chain companies.

"Our job is to be at the table to ensure we are engaging the proper scientists to assist in maintaining and improving our operations in a logical and defensible manner," Gates said of EIC's role. "We can help with the methodology itself, to make sure assessments are done properly. And by actively participating, we can learn about problems that individual producers are having with implementing their unique sustainability strategies and help find solutions."

In addition to a focus on research to advance sustainable egg production, EIC's SAS project includes plans for educational modules on sustainability basics for egg farmers, employees, and their customers, as well as elementary, secondary school, collegiate, and adult education.

The Egg Industry Center

Funding critical research at 14 universities across North America to secure scientifically based solutions for the entire egg industry.

Without our donor's and partner's faith in the EIC mission, and their matching financial generosity, EIC could not help the industry the way we do. Thank you EIC supporters!

To learn how you can help advance the work of the Egg Industry Center, please contact EIC today.

Egg Industry Center

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