Special Report:

What egg farmer surveys tell us about the cost of production during the initial stages of the cage-free transition in the U.S.

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Executive Summary

The production of cage-free eggs in the U.S. has dramatically increased over the last eight years; in March 2015, there were 19 million laying hens (of which 10 million were raised as organic) in cage-free systems, or about 6% of the U.S. flock. In September 2023, there were 126 million cage-free laying hens (19 million organic), which represented 40% of the U.S. flock. Therefore, the Egg Industry Center (EIC) initiated a benchmarking analysis for the cost of producing cage-free white eggs. Organic egg farmers were not surveyed since the various organic production systems have additional requirements that tend to make cost of production much higher than non-organic cage-free systems.

It is the intention of EIC to continue updating these estimates on a regular basis to assist the industry in decision making.

The cost of producing cage-free eggs is higher than conventional eggs in part due to the system's lower production efficiency. This includes:

- 6% more feed to grow pullets
- 22% higher costs of growing pullets for all non-feed items
- 9% fewer eggs produced per hen housed
- 11% higher feed conversion, which requires more feed per dozen eggs produced
- 45% higher costs of non-feed items at the egg laying sites

The difference in cost of production between cage-free and conventional eggs is especially sensitive to feed cost, with the difference increasing when feed cost increases and decreasing as the cost of feed decreases.

Cage-free production is still rather new to many egg farmers. There is potential to improve production inefficiencies that exist such as feed conversion and the number of eggs produced per hen housed as management techniques are learned and implemented.

Introduction

This study is a first attempt to provide benchmark costs of cage-free (CF) white eggs and to compare them with conventionally produced (CC) white eggs. This report outlines the process and methodology used for this study and provides baseline results for 2022 cost of production. The components of the costs with higher variability between survey responses likely indicates areas where there are more opportunities for egg farmers to reduce their costs.

Survey Questionnaire

A survey of U.S. egg farmers was done to estimate the costs associated with producing nest-run white CF and CC eggs. The egg farmer questionnaire was developed to ask as few questions as possible with a goal of maximizing the survey return rate. A drawback of this approach is the lack of capacity to itemize costs in a way that can help egg farmers to better identify the strengths and weaknesses in their individual operations. Despite the limitations of the acquired survey data, this report provides a first step toward a helpful benchmark the costs of CF and CC white egg production.

Anonymous Data Collection

In January of 2023, a two-page survey was sent to more than 100 U.S. egg companies for which the authors have contact information. One person per company was chosen to receive the survey to avoid duplicate entries. Participants were offered a variety of ways to return their surveys, all of which assured their identity was not traceable. As a result, the respondents had anonymity. Data collection focused on the 2022 production cycle information and collection of data ended April 2023.

Analytical Approach

The analysis was conducted in three stages. First, responses with extremely high and extremely low values ("outliers") were eliminated using a robust Tukey outlier analysis (described below). Second, two measures of central location (i.e., the trimmed mean and the median response values) and a measure of response dispersion (range width) were calculated for the remaining responses.

<u>Outliers</u>
Tukey's method (1977) was used to identify outliers, based on its simplicity, and consists of the following steps:

- Numerically sort responses from lowest to highest, and then produce a histogram.
- Find the interquartile range (IQR), which is the difference between the values of the 75^{th} and 25^{th} percentiles.
- Multiply the IQR by 1.5, or 1.5IQR
- Remove low outliers, defined as any value lower than the 25^{th} percentile minus 1.5IQR
- Remove high outliers, defined as any value that is higher than the 75^{th} percentile plus 1.5IQR

<u>Central Location Values</u>
The two measures of central location used for this analysis are the trimmed mean and the median.

- The trimmed mean is estimated by ordering the data, discarding the X% lowest and highest values, and taking the arithmetic mean of the remaining data (Rice, 2006). In the present study, X= 20%, and the trimmed mean is the arithmetic mean after first eliminating outliers, and then eliminating the top 20% and the bottom 20% of the remaining observations.

- The median is defined as the middle value of the ordered observations (from smallest to largest); and when the sample size is even, the median is the average of the two middle values (Rice, 2006). "Clearly, moving the extreme observations does not affect the sample median at all, so the median is quite robust" (Rice, 2006, p. 395). One disadvantage of the median is that it ignores the values outside the center, and such information might be valuable.

Both central location values (trimmed mean, median) may reduce the number of responses used in the analysis. The Tukey method for outlier removal is always applied to the data but does not always remove data points. The trimmed mean only utilizes 60% of remaining values by removing the top and bottom 20% of these. The median only considers the one observation in the middle of the distribution, or the 2 observations in the middle of the distribution in the event of having an even number of observations.

Dispersion

Just as the arithmetic mean is the most common measure of a central location, the most common measure of dispersion of a distribution of numerical values is the standard deviation which measures the dispersion of observations around the arithmetic mean.

Since this report is based on using the median and the trimmed mean instead of the arithmetic mean, the measure of dispersion chosen by the authors is the interquartile range, IQR, defined by the difference between the 25th and the 75th percentile. The 25th (75th) percentile separates the lowest ¼ (¾) of the ordered sample observations from the highest ¾ (¼). In summary, the range of values between the 25th and the 75th percentiles (IQR) indicate the dispersion of sample values around the median. One drawback of using percentiles as the measure of dispersion is that it ignores the information contained in observations other than the one observation of the percentile.

Survey Results

A total of 14 survey responses were received, 14 of which included information about CC eggs for at least 1 region of the country and 11 of them included information about CF eggs. Although it is impossible to know the number of laying hens represented by these responses (due to the anonymity of the respondents), some rough calculations using raw assumptions suggest they represent approximately 91 million layers. The assumptions used for that estimation were derived from the January 2023 edition of the *Egg-Industry* magazine published by WATT Media. This publication shares data about egg company rankings and helped provide the foundational data for the following assumptions:

- Farmers that process more than three million cases in a year would have on average 10.3 million layers,
- Farmers that process less than three million cases would have on average 1.5 million layers.

Feed milling costs:

There was a wide range in costs received for handling, milling and delivery of feed. Therefore, the sum of these values is reported. The aggregated trimmed mean cost was $17.8/ton, and the median was $15.3/ton, with large dispersion seen between companies; for example, the 25th percentile was $12.9/ton and the 75th percentile was $24.2/ton.

Survey results for growing pullets:

The typical age that pullets were moved to the layer houses was reported as 16 weeks for both CC and CF production systems. The dispersion around the median (IQR) was small, 1 week for CC and 0.4 week for CF production (table 1).

Table 1. Survey results for pullet growing section

Variable	Conventional				Cage-free White			
	Count*	Trimmed Mean	Median	IQR	Count	Trimmed Mean	Median	IQR
Age are pullets moved out to the layer facilities (weeks)	15	16.3	16.0	1.0	12	16.0	16.0	0.4
Baby chick cost delivered (including services) ($/pullet)	16	1.07	1.07	0.07	13	1.03	1.08	0.14
Cost of moving pullets to the layer house ($/pullet)	17	0.21	0.18	0.14	12	0.22	0.21	0.10
Other costs: except feed and baby chicks ($/pullet)	15	1.28	1.32	0.33	12	1.88	1.94	0.91

** While 14 surveys were received, some companies reported values for operations in different regions. These regional answers are reflected in the count reported here; however, regional data could not be published because not enough responses were received to be able to estimate costs by region.*

The median value of the baby chick cost (including services) was 107 cents/pullet and 108 cents/pullet for CC and CF production, respectively. The trimmed mean of the baby chick cost (including services) was 107 cents/pullet and 103 cents/pullet for CC vs CF production (CF was 3% lower than CC). The dispersion (IQR) was 7 cents/pullet and 14 cents/pullet for CC and CF systems, respectively.

The median value of the cost of moving pullets was 18 cents/pullet vs 21 cents/pullet for CC and CF production, respectively (i.e., CF median cost was 14% higher for CF). The trimmed mean value of the cost of moving pullets was 21 cents/pullet vs 22 cents/pullet for CC and CF production, respectively (i.e., CF trimmed mean cost was 6% higher than CC). Some of these differences might be explained by the greater difficulty of catching CF birds compared to CC birds. There was a large dispersion in the answers for this variable, about 14 cents for CC and 10 cents for CF systems.

The last variable asked in the pullets' portion of the survey is the sum of all other costs excluding baby chicks and the feed costs, because they are estimated separately. This aggregated number includes labor & benefits (for in-house employees or contractors), housing & equipment, repairs & maintenance, utilities (electric/gas/phone/garbage /water), vaccine or health-related supplies and services, supplies including biosecurity, other services, overhead, miscellaneous including property taxes and insurance, etc. The median value of all other costs (excluding baby chicks and feed) was 132 cents/pullet and 194 cents/pullet for CC and CF production, respectively (CF 47% higher than CC). The trimmed mean value of all other costs (excluding baby chicks and feed) was 128 cents/pullet and 188 cents/pullet for CC and CF production, respectively (CF again 46% higher than CC). There was a very wide dispersion, about 33 cents for CC and 91 cents for CF systems.

<u>Survey results for layer sites:</u>

Table 2 summarizes results for layer sites. The typical age at which layers were culled under 1-cycle (no molt) systems was 92 weeks of age for CC production and 90 for CF production system (table 2). The dispersion was 4 weeks and 9 weeks for CC and CF production, respectively. The typical age of layers culled under 2-cycle (no molt) systems in CC production was 114 weeks of age with a dispersion of 6 weeks.

Table 2. Survey results for egg production sites

Variable		Conventional				Cage-free White			
		Count	Trimmed Mean	Median	IQR	Count	Trimmed Mean	Median	IQR
Age at end of production (weeks)	Under 1-cycle	13	92	92	4	12	91	90	9
	Under 2-cycles	8	113	114	6				
Other costs: except feed and pullets ($/dozen eggs)		17	0.26	0.27	0.05	11	0.38	0.36	0.17

** While 14 surveys were received, some companies reported values for operations in different regions. These regional answers are reflected in the count reported here; however, regional data could not be published because not enough responses were received to be able to estimate costs by region.*

The last variable asked in the layer portion of the survey is the sum of all other costs excluding pullets and feed costs, because they are estimated separately. This aggregated number includes labor & benefits (for in-house employees or contractors), housing & equipment, repairs & maintenance, utilities (electric/gas/phone/garbage /water), vaccine or health-related supplies and services, supplies including biosecurity, other services, overhead, miscellaneous including property taxes and insurance, etc. The median value of all other costs (excluding pullets and feed) was 27 cents/dozen eggs and 36 cents/dozen for CC and CF production, respectively (CF 35% higher than CC). The trimmed mean value of all other cost (excluding pullets and feed) was 26 cents/dozen and 38 cents/dozen for CC and CF production, respectively (CF 45% higher than CC). The dispersion was 5 cents/dozen and 17 cents/dozen for CC and CF production, respectively.

<u>Data variability:</u>

There is substantial variability between the different respondents for some questions. One example is the average non-feed cost for cage-free white egg production was $0.38/dozen but the standard deviation was $0.13/dozen and the IQR was $0.17/dozen. The 95% confidence interval for that the average spans from $0.09/dozen to $0.67/dozen, a range of roughly 3.5 times the IQR. Eliminating the top and bottom 20% to estimate the trimmed mean results in an estimated 95% confidence interval for the trimmed mean between $0.28/dozen and $0.48/dozen which is better (slightly larger than the IQR), even though it is still wide.

<u>Estimated costs:</u>

The cost of growing pullets for CC and CF systems was estimated for different feed prices assuming that growing a white pullet to 16 weeks of age would take 11.7 lbs. of feed per pullet in CC systems and 12.4 lbs. of feed per pullet in CF systems. Most of the difference in the cost of growing pullets is explained by the non-feed costs, but the cost difference between CF and CC increases as feed costs increase simply because growing cage-free pullets uses more feed (table 3). For a middle of the road feed cost of $250/ton the median difference between CC and CF costs of growing pullets was $0.75/bird (18%), and the trimmed mean was $0.66/bird (16%).

Table 3. Cost of growing white type pullets for different layer feed costs

Feed Cost $/ton	Pullets cost ($/pullet)				Pullets cost ($/dozen)			
	Conventional cage		Cage-free		Conventional cage		Cage-free	
	Trimmed Mean	Median	Trimmed Mean	Median	Trimmed Mean	Median	Trimmed Mean	Median
150	3.50	3.51	4.12	4.22	0.10	0.10	0.13	0.14
200	3.81	3.82	4.45	4.55	0.11	0.11	0.14	0.15
250	4.12	4.13	4.79	4.88	0.12	0.12	0.15	0.16
300	4.44	4.45	5.12	5.21	0.13	0.13	0.16	0.17
350	4.75	4.76	5.45	5.55	0.14	0.14	0.17	0.18
400	5.06	5.07	5.78	5.88	0.15	0.15	0.19	0.19

To estimate the cost of production of white eggs, it was assumed that the number of eggs per hen housed up to 90 weeks of age was 412 for CC systems and 375 for CF systems (industry communication). It was assumed 3.23 lbs. of feed per dozen CC eggs and 3.58 lbs. of feed per dozen CF eggs. Similar to what happens with the cost of growing pullets, the difference in cost of egg production is higher with higher feed prices (table 4) because the feed conversion in CF systems is greater than CC systems. For example, at $150/ton feed cost, the estimated median cost of producing cage-free eggs is approximately 15 cents/dozen (25%) higher than conventional, but it is approximately 21 cents/dozen (19%) higher than conventional when the feed reached $400/ton. This difference is slightly different when using the trimmed mean where cost of producing cage-free eggs is approximately 17 cents/dozen (29%) higher than conventional at $150/ton feed cost, but it is approximately 22 cents/dozen (21%) higher than conventional when the feed reached $400/ton.

Table 4. Cost of producing white eggs up to 90 weeks of age for different layer feed costs

Feed Cost $/ton	Feed cost ($/dozen)				Total cost ($/dozen)			
	Conventional cage		Cage-free		Conventional cage		Cage-free	
	Trimmed Mean	Median	Trimmed Mean	Median	Trimmed Mean	Median	Trimmed Mean	Median
150	0.24	0.24	0.27	0.27	0.61	0.61	0.78	0.77
200	0.32	0.32	0.36	0.36	0.70	0.70	0.88	0.87
250	0.40	0.40	0.45	0.45	0.79	0.79	0.98	0.97
300	0.48	0.48	0.54	0.54	0.88	0.88	1.08	1.07
350	0.57	0.57	0.63	0.63	0.97	0.97	1.18	1.17
400	0.65	0.65	0.72	0.72	1.06	1.06	1.28	1.27

Discussion

This is the first attempt of the Egg Industry Center to benchmark cost of production for cage-free systems. The representativeness of these cost of production estimates is somewhat limited by the low number of survey responses and the high variability of reported costs between participating companies.

Two different measures of central location values, namely the trimmed mean and the median, were examined for their utility in summarizing costs of production from survey responses. In general, these two values to characterize a response are similar. The exception noted is in some of the pullet growing responses, such as delivered chick cost and other costs. Given the general similarity, the trimmed mean has been selected for future use.

CF production efficiency is lower than that of CC for all the variables asked, and can be summarized as:

- 6% more feed to grow pullets
- 22% higher costs of growing pullets for all non-feed items
- 9% lower number of eggs produced per hen housed
- 11% higher feed conversion, which requires more feed per dozen eggs produced
- 45% higher costs of non-feed items at the egg laying sites

As a result of overall lower production efficiencies reported in CF systems, the production cost difference between CF and CC eggs increases as feed cost increase, ranging from 17 to 22 cents/dozen for feed cost of $150 to $400 per ton.

CF production is still rather new to many of the commercial egg farmers. There is potential to improve some of the production inefficiencies such as feed conversion and the number of eggs produced per hen housed as management techniques are learned and implemented. Improvement in these areas would help to reduce the gap in the cost of production. Research and outreach of scientific information could play an important role in improving that efficiency. That said, the higher capital costs of building CF facilities, and the additional labor required to operate them, will result in higher costs even if the production efficiencies reach similar levels.

References

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