

*Report E008R01*

## US EGG PRODUCTION DATA SET


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**EXECUTIVE SUMMARY** Tracking the capability of the egg production industry to supply the food industry with enough cage-free eggs to meet retailers' and restaurants' animal welfare commitments is important to industry groups and farm animal advocacy organizations alike. In this project, we synthesize an analysis-ready data set that tracks the supply of cage-free eggs relative to the overall supply of table eggs in the United States. The data set is based on United States Department of Agriculture (USDA) reports published monthly from September 2016 to present, with auxiliary annual data from December 2007 to December 2015. The data set will be updated monthly as new USDA reports are released. We supplement these data with definitions and a taxonomy of egg products drawn from USDA and industry publications. The data include flock size and egg production of cage-free hens as well as all table egg laying hens in the US, collected to understand the impact of the industry's cage-free transition on hens. Initial analysis of egg production trends shows that, at the time of publication of this report, 20.3% of all table egg layers lived in cage-free systems. This figure represents an increase of 10.2 percentage points between August 2016 to June 2019, with an increase of 17.1 percentage points over the entire sample period of 2007 to June 2019.

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## INTRODUCTION

Egg production in the United States (US) changed greatly over the twentieth century. Prior to the mid-twentieth century, egg-laying hens primarily lived on family farms and roamed outside and in chicken coops for safety and sleeping. Egg farms began to grow in size in the 1940s and 1950s, and farmers transitioned their chicken flocks into indoor barns and cages, ostensibly to keep them safe from predators and diseases [1]. Today the majority of laying hens living in commercial egg production facilities in the US are confined to battery cages with approximately 67 in<sup>2</sup> (432 cm<sup>2</sup>) of space per bird, the minimum required by the national egg producer cooperative United Egg Producers. Cages represent a significant animal welfare concern because they prevent hens from performing their natural behavior and can increase the risk of osteoporosis and body injury from feather pecking and cannibalism [2].

Animal protection groups have focused on campaigning against battery cages for several years, using corporate negotiation, positive and negative publicity campaigns, and legislation to shift the egg production system away from these cages. In 2015, California’s Proposition 2, named “Standards for Confining Farm Animals,” took effect<sup>1</sup> and many major food companies, including Costco and institutional food service providers Sodexo, Aramark, and Compass Group, pledged to source cage-free eggs by dates in the near future. These events spurred many other food service corporations to make similar commitments. To date, over 400 retailers, restaurants, and food service institutions with US operations have made commitments to exclusively source cage-free eggs for their supply chains by 2026 [7].

This report monitors the progress of the egg industry in transitioning their flocks away from battery cages into cage-free systems by tracking the production of cage-free eggs. Understanding productive capabilities is crucial for downstream food companies looking to source cage-free eggs and for animal protection groups seeking to facilitate the transition away from cages. To that end, this data set tracks monthly flock size and egg production numbers in the US starting in August 2016, supplemented by annual flock size data from 2005 to 2015. Data are gathered from three United States Department of Agriculture (USDA) reports on cage-free egg production and overall egg production in the US: the *Monthly Cage-Free Shell Egg* report

<sup>1</sup> Proposition 2 passed in 2008 and was implemented in 2015. The statute prohibited the confinement of farm animals in structures that prevent them from lying down, standing up, fully extending their limbs, and turning around freely [3]. The vague wording of Proposition 2 allowed for “enriched cages” (larger cages with features like perches and scratching areas), and some producers switched from conventional cages to enriched cages as a means of compliance with the new law [4]. In 2013, the California Department of Food and Agriculture updated their statutes to require that all eggs either produced or sold in California be sourced from hens with at least 116 in<sup>2</sup> (748 cm<sup>2</sup>) of floor space in their enclosure [5]. In 2018, Proposition 12, another California ballot initiative entitled “Prevention of Cruelty to Farm Animals Act,” was adopted to further update the standards of confinement for the farm animals producing food sold in California [3]. This bill improved upon the vague language of Proposition 2 and expanded upon the 2013 statutes to require at least 144 in<sup>2</sup> (929 cm<sup>2</sup>) of floor space in barns without cages [6].

		Production Process			
		Non-Organic		Organic	
		Caged	Cage-free		
Product Type	Table Egg	Processed (liquid, frozen, powdered)	Caged Non-Organic Table Processed	Cage-Free Non-Organic Table Processed	Cage-Free Organic Table Processed
		Shell	Caged Non-Organic Table Shell	Cage-Free Non-Organic Table Shell	Cage-Free Organic Table Shell
	Hatching	Hatching			

**Figure 1** Taxonomy of Eggs by Product Type and Production Process

(hereafter “*Cage-Free Egg*” report), the *Chickens and Eggs* report, and the *Egg Markets Overview* report. We supplement the data with clarification of terms and definitions used in the USDA reports and by some industry groups, and we conduct initial analysis of the data by examining the proportion of hens in cage-free housing systems over time.

## BACKGROUND

Modern commercial egg production creates a variety of different egg products using a number of different production processes. The egg products considered in this data set are classified over two dimensions in the USDA reports: production process and product type. Each cell in Figure 1 represents a unique type-process classification. Production process covers two overlapping processes: housing type (“cage-free” or “caged”) and animal management (“organic” or “non-organic”). The USDA reports do not cover other common production processes such as “free-range” or “pasture” housing systems, so we do not include them in the report or data set other than to discuss their relation to cage-free and caged systems. “Product type” encompasses two types of egg products: “table” eggs and “hatching” eggs. Table eggs are further divided into “shell” eggs and “processed” eggs. This data set tracks production at the table egg level because the *Cage-Free Egg* report does not disaggregate production data into shell egg and processed egg production,<sup>2</sup> however, we include these sub-types in the taxonomy for completeness. The terms used here for classification are encountered in the USDA data as well as across egg industry publications, and we clarify these terms in more detail as follows.

Table eggs are all eggs sold to be used as food ingredients. Shell eggs are purchased still in their shells, while processed eggs are broken out of their shells and sold in a variety of processed forms including liquid, frozen, or dried/powdered. Hens who produce table eggs meant for

<sup>2</sup> While the *Cage-Free Egg* report bears the full title “Monthly USDA Cage-Free Shell Egg Report,” the production data are reported at the table egg level. All price data are reported at the shell egg level.

consumption are known as “table egg type layers” (hereafter “table layers”). “Flock size” provides the estimated number of hens living in an operation at a given point in time. A “lay rate” (also called “rate of lay” or “hen-day egg production” in other USDA and industry publications [8]) refers to the number of eggs produced over a given time period by a specific number of hens. The USDA uses different time periods in different reports: for example, the *Chickens and Eggs* report records the lay rate as the number of eggs produced by 100 hens in the reported month, while the *Cage-Free Egg* report gives the more common daily lay rate expressed as a percentage.

Hatching eggs are fertilized eggs used for the reproduction of chicken flocks, either layer hens (both table and hatching) or chickens raised for meat (“broilers”). Hens who produce hatching eggs are called “hatching egg type layers” (hereafter “hatching layers”). The reproductive purpose of hatching layers necessitates that females and males are housed together in aviary or barn systems which, as discussed below, are considered cage-free housing. US hatching layers are distinguished only by breed and their housing systems are not classified in the same manner as table layers. Public data provide no indication of the proportion of hatching eggs that are destined for cage-free systems or otherwise.

Cage-free hen housing systems offer hens more space to move freely through their environment and opportunities to forage, perch, dust-bathe and use a nest area to lay their eggs. The USDA definition of “cage-free” covers a variety of husbandry systems. The system must allow birds to display natural behaviors, and hens must have the following: the ability to move in a way that promotes their welfare, protection from predators, and access to litter. Birds are provided enrichments such as perches, nests, and scratching areas to allow them to perform natural behaviors [9]. Aviary and barn systems are two examples of cage-free housing. Both systems allow birds to freely roam inside the buildings; however, in barn systems, birds generally live on one level, while aviary systems have multiple levels for perching [10]. Cage-free eggs may be produced by either non-organic flocks or “certified organic” flocks. The USDA requirements for organic certification include organic feed requirements as well as housing and welfare requirements. These housing and welfare standards are higher than the requirements for cage-free certification, so all certified organic eggs can be classified as cage-free [11]. Similarly, free-range housing requirements defined by the USDA and pasture-raised housing requirements defined by third-party certifiers like American Humane and Certified Humane<sup>3</sup> encompass and exceed the requirements of cage-free systems [9, 12, 13]. However, since the *Cage-Free Egg* report does not disaggregate cage-free production data into more production processes than “organic” and “non-organic,” we will not detail free-range and pasture-raised production processes in our final data.

## METHODOLOGY

In this section, we describe our data collection methodology, starting with the USDA’s process for compiling the original reports. We gather resources and information about how the USDA collects data from egg producers and reports it in their data products. Next, we describe in detail our methodology for transcribing, cleaning, and analyzing the final data.

The raw monthly data are published in the *Cage-Free Egg* report

<sup>3</sup> At this time, the USDA does not define or grade eggs marketed as pasture-raised.

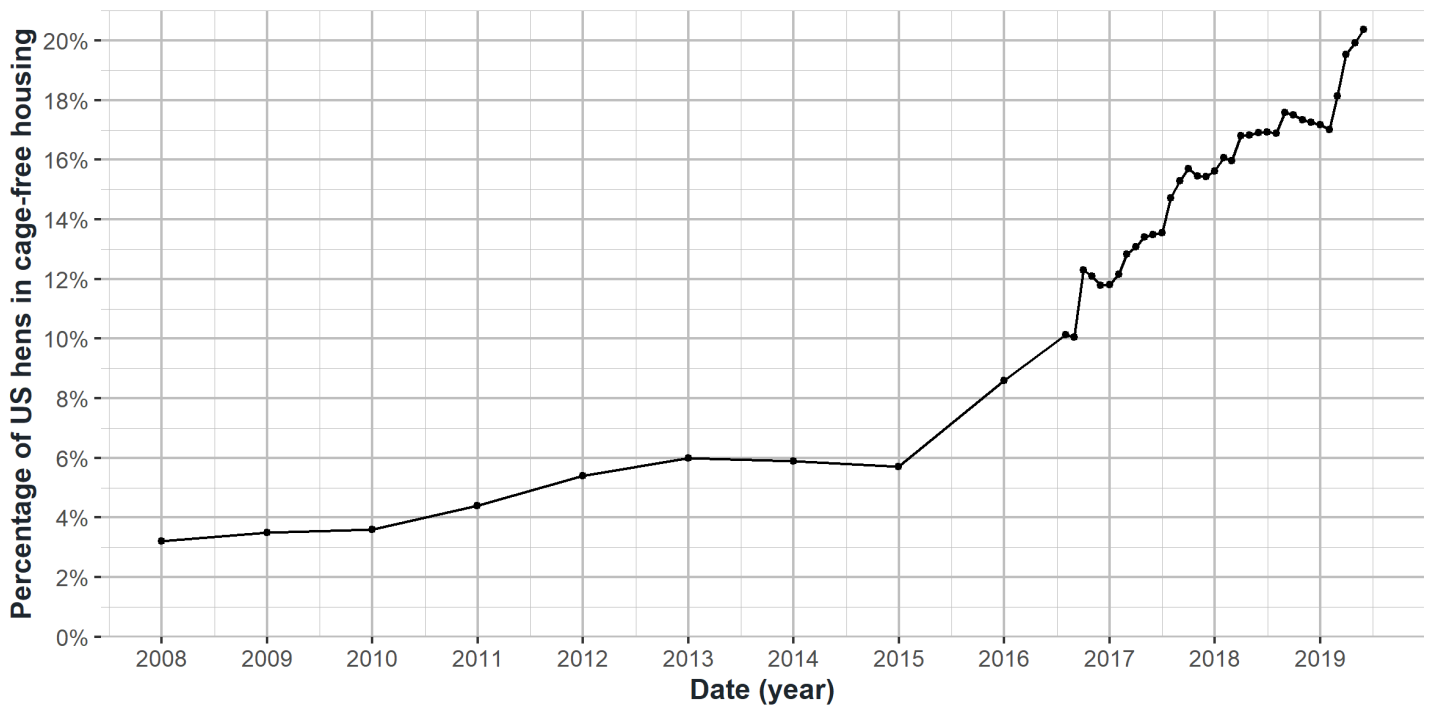
and the *Chickens and Eggs* report in the first and third weeks of the month, respectively. These reports provide egg production numbers from the previous month, and they are produced by the USDA’s Agricultural Marketing Service (AMS) and National Agricultural Statistics Service (NASS), respectively [14, 15]. The *Cage-Free Egg* report is compiled by the Des Moines, Iowa office of the AMS’s Livestock, Poultry, and Grain Market News department, while the *Chickens and Eggs* report is produced by the Livestock Branch of NASS [16, 17]. The first *Cage-Free Egg* report was issued on September 19, 2016 and covers the month of August 2016, while the *Chickens and Eggs* report has been produced since 1933. Archived and current copies of both reports are available on the USDA’s Economics, Statistics and Market Information System website, which provides a search portal for archives of reports produced by five different USDA agencies [18]. Archived reports referenced in this data set are also available in the directory `data/raw/` of the Open Science Framework (OSF) repository at <https://osf.io/z2gxn/>, which will be updated with archived copies of subsequent reports according to their release schedule. All subsequent references to directories and files refer to this OSF repository.

The NASS uses a monthly survey to collect production data directly from egg producers with flocks of at least 30,000 layers for the *Chickens and Eggs* report. This report records data on eggs produced by hens in commercial facilities as opposed to backyard flocks. The survey instrument provided by the NASS is archived in the directory `data/raw/`. The AMS collects data for the *Cage-free Egg* report directly from a group of producers who have volunteered to provide production information. Weekly egg production numbers in the *Cage-Free Egg* report are constructed from the producer-reported number of cage-free hens and daily cage-free lay rates multiplied by seven days,<sup>4</sup> while the *Chickens and Eggs* report constructs monthly egg production from monthly lay rates.<sup>5</sup> To account for time period differences when cleaning and analyzing the data, we convert weekly cage-free egg production to monthly by multiplying the data by the fractional number of weeks in the observed month. These differences in aggregation may affect statistical analysis of constructed variables such as the proportion of cage-free eggs to total egg production by averaging out some of the variance.

The final data set is transcribed from portable document format (PDF) files into comma-separated value (CSV) files for easy use in further analysis. The *Cage-Free Egg* report is composed of three sections: production, wholesale price, and retail price. This report and data set draw on the production data section. We automate the data collection process with a script written with the statistical programming language R [19] to download the raw USDA reports, parse production data from the PDF reports, wrangle the parsed data into the final format, and conduct initial data exploration. The script `make.R`, located in the top level directory of the OSF repository, can be run to execute the entire routine. This routine executes four scripts, located in the directory `/analysis-code/`: `download.R`, `parse.R`, `wrangle.R`, and `analyze.R`. Annotations in the `make.R`, `wrangle.R`, and `analyze.R` files provide details about package dependencies,

<sup>4</sup> Daily cage-free lay rates are based on the monthly lay rates published in the *Chickens and Eggs* report with a downward adjustment to account for the lower productivity of cage-free hens.

<sup>5</sup> The *Chickens and Eggs* report includes a Statistical Methodology section at the end of the report. The methodology behind the *Cage-Free Egg* report is not published in the report itself; details about the methodology were obtained through personal communication with AMS staff members.



**Figure 2** Percentage of Hens in Cage-Free Housing from December 2007 to June 2019

download locations, variable units, and new variable construction. The final data set, published in the directory `data/final/` under the name `egg-production.csv`, is accompanied by the data dictionary, `egg-production-dictionary.csv`. The data dictionary lists a description of each variable and any associated notes.

From the *Cage-Free Egg* report, we transcribe the following: the monthly average of flock size for table layers in cage-free organic and non-organic flocks and the monthly average of each flock’s weekly egg output. As discussed above, we convert egg production to total monthly production. Because the reported egg production numbers are constructed as a function of flock size and lay rates, we omit lay rates to streamline the final data set.<sup>6</sup> From the *Chickens and Eggs* report, we supplement cage-free statistics with the flock size and monthly output of all table and hatching layers. We include the number and output of hatching layers because changes to the overall number of table layers will cause changes in the number of hatching layers required for reproduction. The unit of observation in the final data set is a month-type-process combination.

After compiling the final data set, we analyze basic patterns in the data. In particular, we focus on the relative number of hens living in cage-free systems compared to the whole flock, an important statistic for understanding the transition away from battery cages. We construct the monthly proportion of cage-free hens to all table layers in the US and the monthly proportion of cage-free eggs to total, which are saved in the file `data/final/cagefree-ratios.csv`. Complete details are provided in the annotated R script `analysis.R`. Monthly proportions directly calculated from data in the *Cage-Free Egg* and *Chickens and Eggs* reports (that is, proportions from the period starting in August 2016 to present) are supplemented with annual proportions

<sup>6</sup> Interested users can reconstruct these rates if needed by dividing monthly egg production by monthly average flock size.

of cage-free hens starting in 2007. These data are sourced from the *Egg Markets Overview* report, which is produced by the Agricultural Analytics division of the AMS and provides a weekly snapshot of regularly changing topics in the US egg market [20]. The USDA publishes only the most current version of this report, and previous versions are not archived on any of the USDA’s websites. The specific report that includes the data in this analysis, dated October 19, 2018, is provided in the file `data/raw/Egg-Markets-Overview-2018-10-19`. We time stamp these annual observations with the month-day value of 12-31 based on the table notes in the original report, which state “past year annual numbers reflect flock as of the end of each year” [20].

## RESULTS AND CONCLUSION

Initial exploration of cage-free egg production in the US in Figure 2 shows an increase in the percentage of hens in cage-free housing over time. From December 2007, when data is first available, to the most recent data in June 2019, the percentage has increased by 17.1 points. The industry’s expansion of their cage-free flocks accelerated in 2015 and has continued consistently in the subsequent years.

Through the creation of this report, we have greatly increased our knowledge of the methodology underlying the USDA reporting on cage-free egg production. Any further information obtained or updates to the methodology will be included in future reports. Furthermore, the associated data set and archives will be updated regularly according to the USDA publication release schedule; this report should be regarded as a living document. Future projects using these data may include supply forecasting, demand analysis, and expansion of the data set to other countries. We provide this data set to other researchers wishing to conduct independent analysis, and we welcome questions and suggestions to improve future updates.



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