THE HUMANE LEAGUE Labs

Report E008R01

US EGG PRODUCTION DATA SET

Samara Mendez[1]

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 cage-free hens and the supply of cage-free eggs relative to the overall numbers of hens and table eggs in the United States. The data set is based on reports produced by the United States Department of Agriculture (USDA), which are published weekly or monthly. The data will be updated periodically 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 (both absolute and relative) 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. Data coverage ranges from December 2007 to present. Initial analysis of cage-free trends shows that, as of the most recent version of this report, 26% of all table-egg-laying hens lived in cage-free systems. This figure represents an increase of 23 percentage points over the entire sample period of December 2007 to April 2020.

PUBLISHED August 11, 2019 | **REVISED** May 29, 2020

check for UPDATES

[1] https://orcid.org/0000-0002-8179-744X
The Humane League Labs, Rockville, MD, USA
smendez@thehumaneleague.org

All files related to this project are available in the associated Open Science Framework repository at https://osf.io/z2gxn/.

CONTENTS

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^2 (432 cm^2) 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[1] 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 drove many other food service corporations to make similar commitments. To date, about 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 absolute and relative flock size and egg production in the US starting in August 2016, and relative flock size collected at irregular intervals from 2005 to present. Data are gathered from three United States Department of Agriculture (USDA) reports on cage-free and overall egg production in the US: the weekly *Egg Markets Overview* report [8], the *Monthly USDA Cage-Free Shell Egg* report (hereafter *"Cage-Free Egg"* report) [9], and the monthly *Chickens and Eggs* report [10]. 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 percentage 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 *Cage-Free Egg* report does not distinguish other housing systems such as "free-range" or "pasture" production and the *Egg Markets Overview* report only distinguishes these systems in data collected after 2016, so we do not include them in the report or egg production 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"

[1] 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^2 (748 cm^2) 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^2 (929 cm^2) of floor space in barns without cages [6].

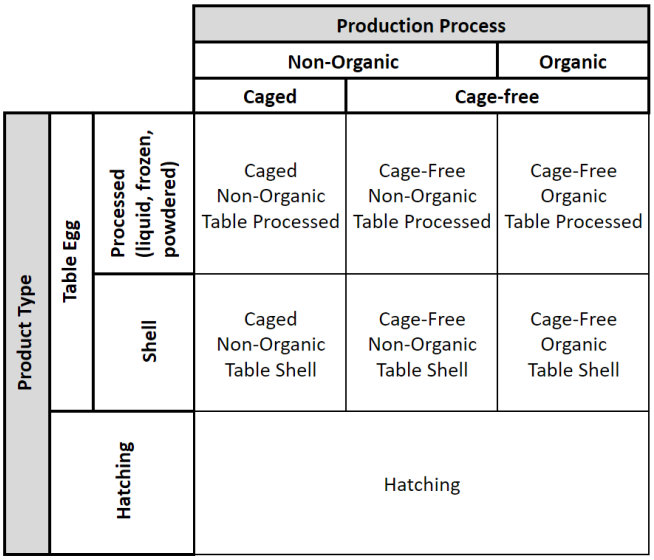

Figure 1 Taxonomy of eggs by product type and production process

eggs. Table eggs can be further divided into "shell" eggs and "processed" eggs. This data set tracks production at the table egg level because neither the *Cage-Free Egg* report nor the *Egg Markets Overview* report disaggregates production data into shell egg and processed egg production;[2] 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 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 [11]) 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 [12]. Aviary and barn systems are two examples of cage-free housing that allow birds to freely roam inside the buildings. In barn systems, birds generally live on one level, while aviary systems have multiple levels for perching [13]. 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 similar to the requirements for cage-free certification, so all certified organic eggs can be classified as cage-free [14]. 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[3] encompass and exceed the requirements of cage-free systems [12; 15; 16]. However, since neither the *Cage-Free Egg* report nor the *Egg Markets Overview* report consistently disaggregates cage-free production data into more production processes than "organic" and "non-organic," we will not detail free-range and

[2] Note that 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 in this report are given at the shell-egg level.

[3] At this time, the USDA does not define or grade eggs marketed as pasture-raised.

pasture-raised production processes in our final data.[4]

METHODOLOGY

In this section, we describe our data collection methodology. We begin with gathering information about how the USDA collects data from egg producers to compile their data products. Next, we describe in detail our methodology for transcribing, cleaning, and analyzing the final data.

Monthly reports

The *Cage-Free Egg* report and the *Chickens and Eggs* report are both produced monthly, published in the first and third weeks of the month, respectively. These reports provide egg production numbers from the previous month, so we timestamp the data with the observed month as stated in the report.[5] These reports are produced by the USDA's Agricultural Marketing Service (AMS) and National Agricultural Statistics Service (NASS), respectively. 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 [17; 18]. 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 [19]. Archived reports referenced in this data set are also available in the directories `data/raw/cage-free-egg-report` and `data/raw/chickens-and-eggs-report` 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 mandatory 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 under the filename `data/raw/Chickens-and-Eggs-report-survey-instrument.pdf`. The AMS collects data for the *Cage-Free Egg* report directly from producers who have volunteered to provide production information. The AMS attempts to contact all US commercial egg producers, but as participation is voluntary, some producers do not respond to the survey. The AMS estimates that the nonresponsive producers manage 5-10% of the US commercial egg laying hens. The authors note that operators of smaller facilities are less likely to respond, and because free-range and pasture housing systems are more likely used at smaller operations, the number of cage-free layer hens may be slightly underestimated in the *Cage-Free Egg* report. The data presented in these reports therefore represents the lower bound of cage-free egg production and flocks sizes in the US. A monthly average of 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,[6] while the *Chickens and Eggs* report constructs monthly egg production from monthly lay rates. 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 percentage of cage-free eggs to total egg production by averaging out some of the variance.

Weekly report

The *Egg Markets Overview* report is produced by the Agricultural Analytics division of the AMS, independently of the *Cage-Free Egg* report, and provides a weekly snapshot of different topics in the US egg market. The report has included the percentage of hens in different housing systems at irregular intervals several times a year since 2016, publishing data that spans back to 2007; coverage of this topic in weekly reports has increased since 2019 to roughly monthly. We time stamp observations from these reports

[4] The authors of these reports have confirmed in personal communications that hens living in free-range and pasture production systems are categorized as cage-free for the sake of the data in their reports.

[5] The AMS collects data for the *Cage-Free Egg* report from participants once per month, although the reports do not indicate a reference date, so it is not clear which day of the month the data represent. We arbitrarily assign the observations to the last day of the observed month.

[6] Personal communication with the authors indicates 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.

with the month-day value stated in the text or table notes. The USDA publishes only the most current version of this report, so we provide the reports that inform this data set in the directory `data/raw/egg-markets-overview`. As with the *Cage-Free Egg* report, egg producer participation in the *Egg Markets Overview* survey is voluntary, and the AMS estimates that producers who manage approximately 90-95% of all US commercial egg layering hens respond to the survey. Flock sizes in this report are adjusted upward by 5-10% to account for producers' non-response.[7] Because the *Egg Markets Overview* data have been adjusted upward while the *Cage-Free Egg* report data have not, the percentage data from the *Egg Markets Overview* report likely provide a more accurate picture of all egg producers in the US. We include both sources of data for completeness, but we use data from the *Egg Markets Overview* report for the analysis below.

Final data set

The final data set is transcribed from portable document format (PDF) files into two comma-separated value (CSV) files for easy use in further analysis. The files named `egg-production.csv` and `cage-free-percentages.csv` are published in the directory `data/final/`, accompanied by a data dictionary, named `data-dictionary.csv`. The data dictionary describes each variable in both files.

Egg production data The file `egg-production.csv` is informed by the *Cage-Free Egg* report and the *Chickens and Eggs* report. We automate data collection from these reports and analyze the data using a script written with the statistical programming language `R` [20]. The automation portion of the code downloads the raw USDA reports, parses production data from the PDF reports, and wrangles the parsed data into the final format. The analysis portion of the code conducts 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 `/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, download locations, variable units, data sources, and new variable construction.

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.[8] 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 date-product type-production process combination.

Cage-free percentages The file used for analysis, `cage-free-percentages.csv`, includes data transcribed from the *Egg Markets Overview* reports and calculations performed on data in the file `egg-production.csv`. We construct this file to analyze basic patterns in the data; namely, 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. The *Egg Markets Overview* report publishes these percentages directly, and we construct similar percentages using the number of cage-free hens reported in the *Cage-Free Egg* report relative to the number of all table layers in the US provided by the *Chickens and Eggs* report. We also use data from these two reports to calculate the monthly percentage of cage-free eggs to relative to total egg production. Complete details are provided in the annotated `R` script `analyze.R`.

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 as reported in the *Egg Markets Overview* reports. From December 2007, when data are first available, to April 2020, the most recent data at the time of this revision, the percentage has increased by 23 points. The industry's expansion of their cage-free flocks accelerated in 2015 and has continued consistently in the subsequent years.

[7] The adjustment factor varies with housing type. Details about this procedure were obtained from AMS staff in personal communication.

[8] Interested users can reconstruct these rates if needed by dividing monthly egg production by monthly average flock size.

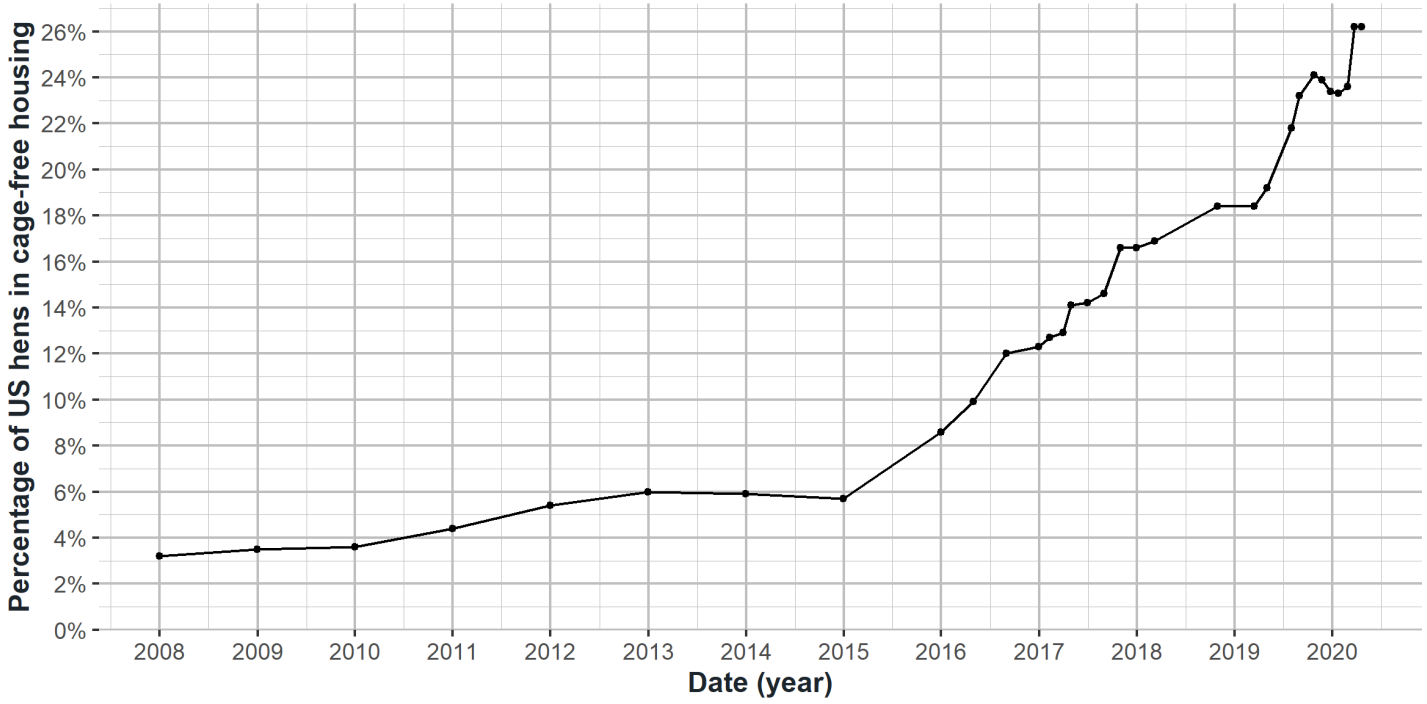

Figure 2 Percentage of hens in cage-free housing from December 2007 to April 2020 [8]. Data are available at https://osf.io/z2gxn/.

Through the creation of this report, we have 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 version of this report. Further, the associated data set and archives will be updated periodically; 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 to other countries. We provide this data set to researchers wishing to conduct independent analysis, and we welcome questions and suggestions to improve future updates.

REVISION HISTORY

February 12, 2020

- Revised "more than 400 food businesses" to "about 400 food businesses."
- Added OSF repository url to caption of Figure 2.
- Non-substantive copy edits and formatting changes.

May 29, 2020

- Updated latest cage-free percentages.
- Restructured and updated the methodology section to include new details about USDA data collection methods.
- Updated Figure 2 to reflect new metholodogy details.
- Non-substantive copy edits.

REFERENCES

[1] American Egg Board. (n.d.). *History of Egg Production*. Retrieved April 29, 2019, from https://www.aeb.org/farmers-and-marketers/history-of-egg-production

[2] *The 88% Campaign*. (2018). The Humane League. https://88percentcampaign.com/files/88-percent-campaign-white-paper.pdf

[3] LAO. (2018, November 6). *Proposition 12*. https://lao.ca.gov/BallotAnalysis/Proposition?number=12&year=2018

[4] Shields, Sara; Shapiro, Paul; & Rowan, Andrew. (2017). A Decade of Progress toward Ending the Intensive Confinement of Farm Animals in the United States. *Animals*, *7*(12), 40. https://doi.org/10.3390/ani7050040

[5] Shell Egg Food Safety (2013, July 1). https://govt.westlaw.com/calregs/Document/I41827B90C03B11E2937A91DEDBAFDA10?viewType=FullText&originationContext=documenttoc&transitionType=CategoryPageItem&contextData=(sc.Default)&bhcp=1&ignorebhwarn=IgnoreWarns

[6] Larkin, Malinda. (2018, December 12). *Another ballot initiative increases housing size for farm animals*. https://www.avma.org/News/JAVMANews/Pages/190101h.aspx

[7] *Chicken Watch*. (n.d.). Retrieved January 26, 2019, from https://www.ChickenWatch.org

[8] USDA. (2018, October 19). *Egg Markets Overview*. USDA AMS Agricultural Analytics Division. http://colonyfoods.com/wp-content/uploads/2018/10/Legacy-Market-News-October-19.pdf

[9] USDA. (n.d.). *Monthly USDA Cage-Free Shell Egg Report*. Agricultural Marketing Service. Retrieved September 25, 2018, from https://usda.library.cornell.edu/concern/publications/rj4304553?locale=en

[10] USDA. (2018, December 21). *Chickens and Eggs*. National Agricultural Statistics Service. https://usda.library.cornell.edu/concern/publications/fb494842n?locale=en

[11] Cal-Maine. (n.d.). *Egg Industry Terms*. Retrieved February 28, 2019, from https://calmainefoods.com/investors/egg-industry-terms/

[12] USDA. (n.d.). *Shell Egg Grading Service FAQs*. Retrieved September 27, 2018, from https://www.ams.usda.gov/publications/qa-shell-eggs

[13] AVMA. (n.d.). *AVMA Issues - A Comparison of Cage and Non-Cage Systems for Housing Laying Hens*. Retrieved February 19, 2019, from https://www.avma.org/KB/Resources/Reference/AnimalWelfare/Pages/AVMA-issues-A-Comparison-of-Cage-and-Non-Cage-Systems-for-Housing-Laying-Hens.aspx

[14] USDA. (2013, July). *Organic Livestock Requirements*. USDA. https://www.ams.usda.gov/publications/content/organic-livestock-requirements

[15] Humane Farm Animal Care. (2018, January 2). *Animal Care Standards: Egg Laying Hens*. Humane Farm Animal Care. https://certifiedhumane.org/how-we-work/our-standards/

[16] American Humane Certified. (2017, June). *Our Standards*. American Humane Farm Program. http://humaneheartland.org/index.php?option=com_content&view=article&id=3&Itemid=106&jsmallfib=1&dir=JSROOT/Animal+Welfare+Full+Standards+%2B+Supplements

[17] USDA. (n.d.). *Livestock, Poultry & Grain Market News Contacts*. Retrieved September 27, 2018, from https://www.ams.usda.gov/market-news/livestock-poultry-grain-contacts

[18] USDA. (n.d.). *National Agricultural Statistics Service Homepage*. Retrieved January 11, 2019, from https://www.nass.usda.gov/

[19] USDA. (2019). *USDA Economics, Statistics and Market Information System*. https://usda.library.cornell.edu/?locale=en

[20] R Core Team. (2019). *R: A Language and Environment for Statistical Computing*. Vienna, Austria. http://www.R-project.org/