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National Animal Health Monitoring System

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Layers 2013

Part III: Trends in Health and Management Practices on Table-Egg Farms in the United States, 1999–2013

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Items of Note

In 2010, the Food and Drug Administration (FDA) implemented an egg safety rule to control *Salmonella* Enteritidis on U.S. farms producing eggs for human consumption.[1] The FDA used information from the NAHMS Layers '99 study while assessing the need for and economic impact of the egg safety rule. As practices have changed substantially since 1999, it was determined that updated information on practices would be useful to industry and government agencies. Therefore, NAHMS conducted a study in summer 2013 to describe management practices on table-egg farms and, in particular, practices relevant to *Salmonella* Enteritidis. The 1999 study sample was selected from the National Agricultural Statistics Service list of table-egg operations with 30,000 or more hens. The 2013 study sample was selected from the FDA list of registered table-egg premises with 3,000 or more laying hens; a subset of farms with 30,000 or more hens was used for comparison to the 1999 study.

The capacity of layer houses increased from 1999 to 2013. In 1999, 60.5 percent of layer houses had a capacity of 30,000 or more birds compared with 82.0 percent in 2013.

Cage-free housing increased substantially from 1999 to 2013; in 1999, only 0.08 percent of farms (0.6 percent of houses) had at least one cage-free house compared with 18.7 percent of farms (11.8 percent of houses) in 2013. However, a higher percentage of pullets were cage-reared in 2013 than in 1999 (93.0 and 78.7 percent, respectively). Cage-free farms tend to be smaller and therefore account for fewer birds.

A lower percentage of farms routinely molted their flocks in 2013 than in 1999 (57.0 and 82.6 percent, respectively). For farms that molted their flocks in 2013, the most common procedure was to feed an alternative diet rather than to restrict or withhold feed.

A lower percentage of farms had problems with cannibalism in 2013 than in 1999 (24.8 and 53.2 percent, respectively). The percentage of farms with respiratory problems and other diseases stayed about the same from 1999 to 2013.

Sixty-week and total mortalities decreased from 1999 to 2013. In 1999, 40.8 percent of farms had a 60-week mortality of 7 percent or higher compared with only 16.0 percent of farms in 2013.

The percentage of farms that gathered all eggs by hand decreased from 28.6 percent in 1999 to less than 1 percent in 2013. The percentage of eggs gathered by hand decreased from 10.6 percent in 1999 to 0.4 percent in 2013.

[1] Code of Federal Regulations, Title 21, Volume 2, Part 118 Production, storage, and transportation of shell eggs.

The percentage of farms that processed eggs on-farm increased from 18.8 percent in 1999 to 40.7 percent in 2013. For farms that processed eggs off-farm, the percentage of farms that stored eggs on-farm at less than 50°F increased from 21.2 percent in 1999 to 92.7 percent in 2013. The FDA egg safety rule requires eggs to be stored at 45°F or less, beginning 36 hours after they are layed.

The percentage of farms that cleaned and disinfected plastic flats used for storing or transporting shell eggs processed off-farm increased from 1999 to 2013. Similarly, the percentage of farms that cleaned racks or pallets before reusing them increased from 1999 to 2013.

The percentage of farms that required employees and crews to use footbaths or change their clothes/coveralls before entering bird areas and that prohibited employees from owning poultry increased from 1999 to 2013.

The percentage of farms with gated entrances and signs posted to restrict or limit vehicle access increased from 1999 to 2013. A higher percentage of farms required business visitors to park in a restricted area away from layer houses in 2013 compared with 1999. The percentage of farms that allowed business and nonbusiness visitors into the layer houses without signing in decreased from 1999 to 2013.

Mice caused the greatest ongoing rodent problem in both study years, although a higher percentage of farms reported problems with mice or rats in 1999 than in 2013. About one-third of houses had a rodent index of 26 or greater in 1999, which is considered high. No farms had a rodent index of 26 or greater in 2013. This finding may be due, in part, to differences in study design. In 1999, rodent index was calculated based on traps set in layer houses for 1 week; in 2013, the typical rodex index was reported for the previous year. The use of traps and sticky tape for rodent control increased and the use of cats decreased from 1999 to 2013. A rodent index of 0–10 is considered low; 11–25 is considered moderate; and a index of 26 more is considred high.

The average number of days layer houses were usually empty between flocks (down time) did not change substantially from 1999 to 2013 (25.1 and 19.4 days, respectively). However, the percentage of farms with a down time of less than 4 days decreased from 1999 to 2013 (11.3 and 2.5 percent, respectively). The percentages of farms with cleaning and disinfecting procedures for feeders, hoppers, water tanks, and houses were similar in both study years.

The percentage of farms that received pullets monitored for *Salmonella* Enteritidis increased from 69.6 percent in 1999 to 95.9 percent in 2013. Vaccinating pullets against *Salmonella* was rarely performed in 1999 (5.4 percent of farms, accounting for 14.6 percent of layers), whereas in 2013 nearly all farms placed pullets that had been

vaccinated against *Salmonella* (98.7 percent of farms, accounting for 99.5 percent of layers).

The percentage of farms that routinely tested layer houses for *Salmonella* Enteritidis increased from 58.0 percent in 1999 to 98.7 percent in 2013. A higher percentage of farms in 2013 than in 1999 (81.5 and 56.1 percent, respectively) participated in an egg (*Salmonella* Enteritidis) quality assurance program.

The prevalence of *Salmonella* Enteritidis in layer houses was measured differently in 1999 and 2013. In 1999, a one-time sampling of layer houses was performed by data collectors and samples were cultured for *Salmonella* Enteritidis. In 2013, producers reported the number of flocks that had been tested for *Salmonella* Enteritidis and the number that tested positive over a 1-year period. In 1999, 7.1 percent of layer houses tested positive for *Salmonella* Enteritidis. In 2013, 1.2 percent of flocks tested positive. These results suggest a reduction in the prevalence of *Salmonella* Enteritidis from 1999 to 2013, even though the methodology differed.

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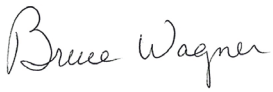
Acknowledgments

The Layers 2013 study was a cooperative effort among animal- and human-health officials, university researchers, poultry industry leaders, and producers. We would like to thank our reviewers for providing valuable expertise and guidance through their comments. All participants are to be commended, particularly the poultry producers whose voluntary efforts made the Layers 2013 study possible.



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Feedback

Feedback, comments, and suggestions regarding Layers 2013 study reports are welcomed. You may submit feedback via online survey at: http://www.aphis.usda.gov/nahms (Click on “FEEDBACK on NAHMS reports.”)

Introduction

The National Animal Health Monitoring System (NAHMS) is a nonregulatory program of the U.S. Department of Agriculture's (USDA) Animal and Plant Health Inspection Service. NAHMS is designed to help meet the Nation's animal-health information needs.

Layers '99 was NAHMS' first national study of U.S. poultry and provided baseline health and management information for the table-egg industry. Layers '99 estimated the prevalence and associated risk factors of *Salmonella* Enteritidis in U.S. layer flocks.

Poultry 2004 was NAHMS' second study of the U.S. poultry industry. This study provided information on bird health and movement, and on biosecurity practices used in backyard flocks, gamefowl breeder flocks, and live-poultry markets.

The 2007 Small Enterprise Chicken study was NAHMS' third study of the U.S. poultry industry. This study focused on biosecurity practices and bird movement on operations with 1,000 to 19,999 chickens.

Poultry 2010 was NAHMS' fourth study of the U.S. poultry industry. This study addressed four topics: 1) structure of commercial poultry industries, 2) farm-level practices of primary breeder and multiplier flocks, 3) prevalence of and risk factors associated with clostridial dermatitis on turkey grower farms, and 4) management of urban chicken flocks in Miami, Denver, Los Angeles, and New York City.

Layers 2013 is NAHMS' fifth study of the U.S. poultry industry. This study updates baseline health and management information for the table-egg industry, estimates the prevalence of *Salmonella* Enteritidis in U.S. layer flocks, and describes management practices relevant to *Salmonella* Enteritidis.

Layers 2013 "Part III: Trends in Health and Management Practices on Table-Egg Farms in the United States, 1999–2013," is the third in a series of reports containing information from the Layers 2013 study. Containing information generated from the NAHMS Layers '99 and 2013 studies, Part III focuses on changes in health, management, and *Salmonella* Enteritidis control practices from 1999 to 2013 on farms with 30,000 or more hens.

Information on the methods used in the study can be found at the end of this report.

Further information on NAHMS studies and reports is available online at: http://www.aphis.usda.gov/nahms

Terms Used in This Report

Flock: A group of birds of similar age (may vary several weeks from the median age of the flock) considered as a production unit. A flock usually fills only one layer house, but it may take up more or less than one house.

Last completed flock: The most recent flock in which the production cycle was complete and the flock was removed from farm.

Layer: A female chicken that produces eggs.

Molt: The period when birds are taken out of production (usually around 65 weeks of age) until they return to their approximate 18-week weight. After a rest period, birds are returned to production for another laying cycle.

Population estimates: Data from survey respondents are weighted to reflect the probability of selection during sampling and account for survey nonresponse. Estimates in this report are provided with a measure of precision called the standard error. A 95-percent confidence interval can be created with bounds equal to the estimate, plus or minus two standard errors. If the only error is sampling error, the confidence intervals created in this manner will contain the true population mean 95 out of 100 times. An estimate of 7.5 with a standard error of 1.0 results in limits of 5.5 to 9.5 (two times the standard error above and below the estimate). An estimate of 3.4 gives a standard error of 0.3 and results in limits of 2.8 and 4.0. Alternatively, the 90-percent confidence interval would be created by multiplying the standard error by 1.65 instead of 2. Most estimates in this report are rounded to the nearest tenth. If rounded to 0, the standard error was reported (0.0). If there were no reports of the event, no standard error was reported (—).

Prebiotic: Nondigestible feed ingredients that can increase the health-promoting attributes of bacteria already in the colon.

Probiotic: Product that contains live microbes intended to confer a health benefit on the host.

Pullet: A female chicken less than 20 weeks of age. A pullet placed in the laying house is called a layer.

Rodent index: A measurement standardized to the number of mice caught per 12 traps per 7 days: number of rodents x 12/number of days x 12/number of traps. A rodent index of 0 to 10 is considered low;11 to 25 is considered moderate; and a index of 26 or more is considred high.

Section I: Population Estimates

A. Poultry Houses

Note: All estimates in this report are for farms with 30,000 or more laying hens.

A higher percentage of farms had six or more layer houses in 2013 than in 1999.

A.1. Percentage of farms by number of layer houses on-farm, and by study:

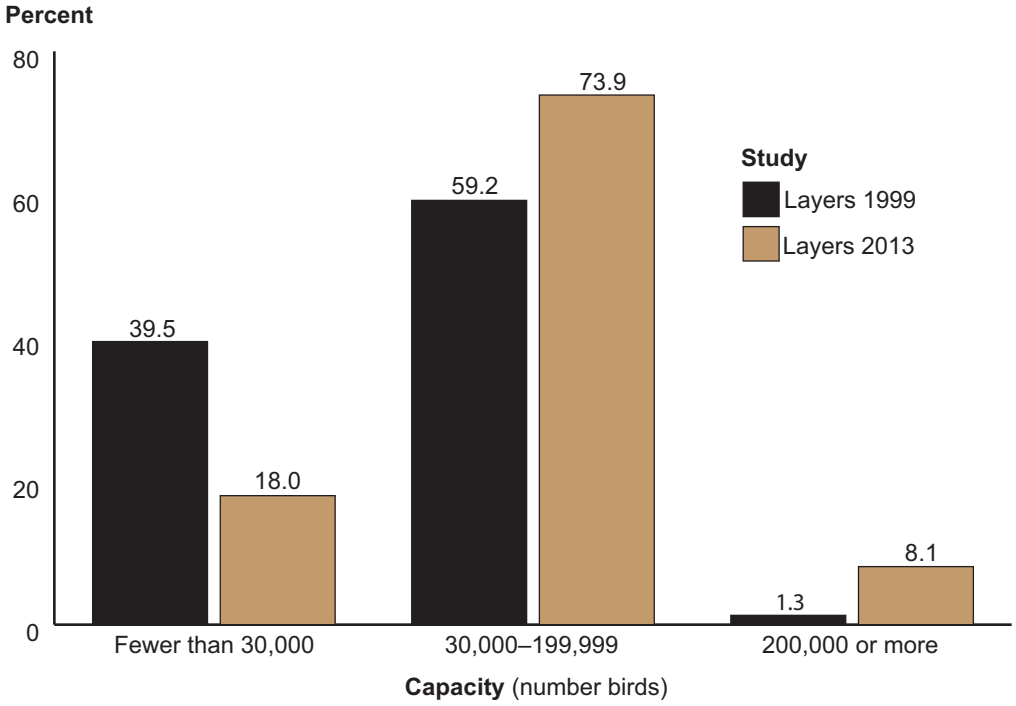
	Percent Farms			
	Study			
	Layers 1999		Layers 2013	
Number layer houses	Percent	Std. error	Percent	Std. error
1	34.5	(7.0)	24.3	(3.8)
2	24.5	(3.8)	25.0	(4.5)
3–5	24.5	(3.9)	18.4	(1.8)
6 or more	16.5	(2.4)	32.3	(3.0)
Total	100.0		100.0	

The maximum capacity of layer houses increased from 1999 to 2013: in 1999, 60.5 percent of layer houses had a capacity of 30,000 or more birds compared with 82.0 percent of houses in 2013. Similarly, in 1999 69.0 percent of farms had any layer houses with a maximum capacity of 30,000 or more birds compared with 94.5 percent of farms in 2013.

A.2. Percentage of farms and percentage of layer houses by maximum capacity of houses (number of birds), and by study:

	Percent			
	Study			
	Layers 1999		Layers 2013	
Maximum capacity (number birds)	**Percent**	**Std. error**	**Percent**	**Std. error**
Farms				
Fewer than 30,000	40.2	(5.5)	21.8	(3.6)
30,000–199,999	67.3	(5.5)	84.3	(2.0)
200,000 or more	1.7	(1.1)	10.2	(1.4)
Houses				
Fewer than 30,000	39.5	(4.4)	18.0	(3.0)
30,000–199,999	59.2	(4.1)	73.9	(3.2)
200,000 or more	1.3	(0.8)	8.1	(1.6)
Total	100.0		100.0	

Percentage of layer houses by maximum capacity of houses (number of birds), and by study



The percentage of layer houses 20 years old or older increased from 38.7 percent in 1999 to 54.3 percent in 2013.

A.3. Percentage of layer houses by age of house and by study:

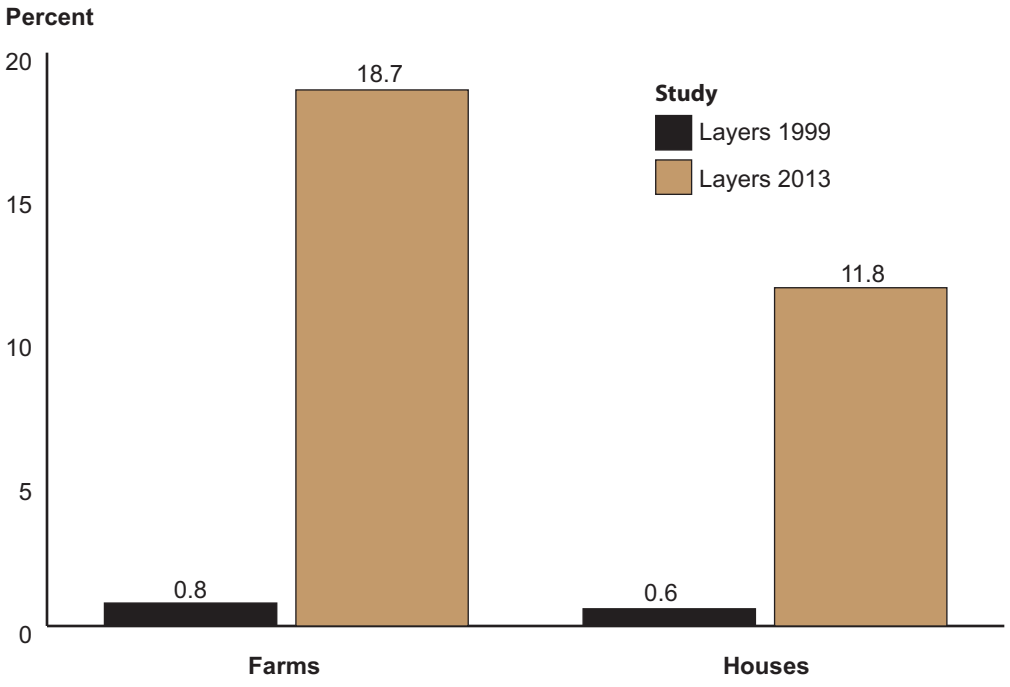
	Percent Layer Houses			
	Study			
	Layers 1999		Layers 2013	
Age of house (yr)	**Percent**	**Std. error**	**Percent**	**Std. error**
Less than 5	9.7	(1.9)	6.7	(1.1)
5–9	13.5	(3.4)	10.6	(1.6)
10–19	38.1	(4.3)	28.4	(2.7)
20 or more	38.7	(4.1)	54.3	(3.6)
Total	100.0		100.0	

A substantial increase in the use of cage-free housing occurred from 1999 to 2013. In 1999, 0.8 percent of farms (0.6 percent of houses) had at least one cage-free house compared with 18.7 percent of farms (11.8 percent of houses) in 2013.

A.4. Percentage of farms in which any houses were cage-free and percentage of houses that were cage-free, by study:

Study							
Layers 1999				Layers 2013			
Pct. farms	**Std. error**	**Pct. houses**	**Std. error**	**Pct. farms**	**Std. error**	**Pct. houses**	**Std. error**
0.8	(0.3)	0.6	(0.2)	18.7	(2.3)	11.8	(1.8)

Percentage of farms in which any houses were cage-free and percentage of houses that were cage-free, by study



B. Pullets

In 1999 and 2013, a relatively low percentage of farms raised pullets on-farm.

B.1. Percentage of farms in which any pullets were raised on-farm, by study:

Percent Farms			
Study			
Layers 1999		Layers 2013	
Percent	Std. error	Percent	Std. error
11.5	(2.8)	6.9	(0.8)

The percentage of farms that obtained pullets from three or more different source-farms decreased from 19.8 percent in 1999 to 5.3 percent in 2013.

B.2. Percentage of farms by number of different source-farms used to make up the most recently placed layer flock, and by study:

	Percent Farms			
	Study			
	Layers 1999		Layers 2013	
Number	Percent	Std. error	Percent	Std. error
1	61.8	(3.4)	74.8	(3.4)
2	18.4	(2.5)	20.0	(3.3)
3	6.2	(2.1)	4.5	(0.8)
4 or more	13.6	(3.0)	0.8	(0.4)
Total	100.0		100.0	

*Pullets raised on the same site as layers were counted as one source-farm.

The percentage of farms by source of pullets was similar in 1999 and 2013.

B.3. Percentage of farms by source-farm used to populate the most recently placed layer flock, and by study:

	Percent Farms			
	Study			
	Layers 1999		Layers 2013	
Source	**Percent**	**Std. error**	**Percent**	**Std. error**
A different company	28.5	(3.2)	17.9	(3.7)
A different farm, same company	72.6	(2.7)	78.8	(3.6)
Raised on this farm	6.6	(0.9)	5.4	(1.0)

A higher percentage of pullets were cage-reared in 2013 than in 1999 (93.0 and 78.7 percent, respectively).

B.4. Percentage of farms and percentage of pullets by rearing type of the most recently placed layer flock, and by study:

	Percent			
	Study			
	Layers 1999		Layers 2013	
Rearing type	**Percent**	**Std. error**	**Percent**	**Std. error**
Farms				
All cage-reared	71.3	(3.2)	76.8	(2.5)
All floor-reared	23.0	(3.2)	20.7	(2.4)
Both cage- and floor-reared	5.7	(1.1)	2.5	(0.8)
Total	100.0		100.0	
Pullets*				
Cage-reared	78.7	(3.2)	93.0	(1.7)
Floor-reared	21.3	(3.2)	7.0	(1.7)
Total	100.0		100.0	

*Weighted by farm maximum hen capacity.

A higher percentage of farms used prebiotic/probiotic products in 2013 than in 1999, although the difference may be related, in part, to the difference between the two studies in how the question was worded.

B.5. Percentage of farms in which the pullets making up the most recently placed layer flock were given a prebiotic or probiotic product, by study:

Percent Farms			
Study			
Layers 1999[1]		Layers 2013[2]	
Percent	Std. error	Percent	Std. error
10.3	(2.9)	43.7	(3.8)

[1]In 1999, this question read, “Competitive exclusion product used to reduce *Salmonella* Enteritidis in the pullets.”

[2]In 2013, this question read, “Prebiotic” or “probiotic”; 13.5 percent of respondents did not know.

C. Layer Management

Drinking water sources for layers were similar in 1999 and 2013.

C.1. Percentage of farms by primary source of drinking water for layers, and by study:

	Percent Farms			
	Study			
	Layers 1999		Layers 2013	
Water source	**Percent**	**Std. error**	**Percent**	**Std. error**
Municipal	6.1	(1.4)	9.8	(1.4)
Well <300 ft deep	66.0	(4.3)	89.0	(1.4)
Well ≥300 ft deep	26.8	(4.2)		
Surface (e.g., pond)	NA		0.0	(—)
Other	1.1	(0.5)	1.3	(0.7)
Total	100.0		100.0	

The percentage of farms that chlorinated nonmunicipal drinking water increased from 15.0 percent 1999 to 35.9 percent in 2013.

C.2. For farms in which the primary source of drinking water for layers was **not** from a municipal source, percentage of farms that chlorinated drinking water, by study:

Percent Farms			
Study			
Layers 1999		Layers 2013*	
Percent	**Std. error**	**Percent**	**Std. error**
15.0	(3.5)	35.9	(5.1)

*Chlorinated on farm.

A higher percentage of farms used nipple drinkers and a lower percentage used cup drinkers in 2013 than in 1999. No farms used troughs for layers' drinking water in 2013 compared with 11.5 percent in 1999. Nipple drinkers provide relatively sanitary conditions and less leakage into the environment.

C.3. Percentage of farms, and percentage of laying hens on those farms, by type of water delivery system used in layer houses, and by study:

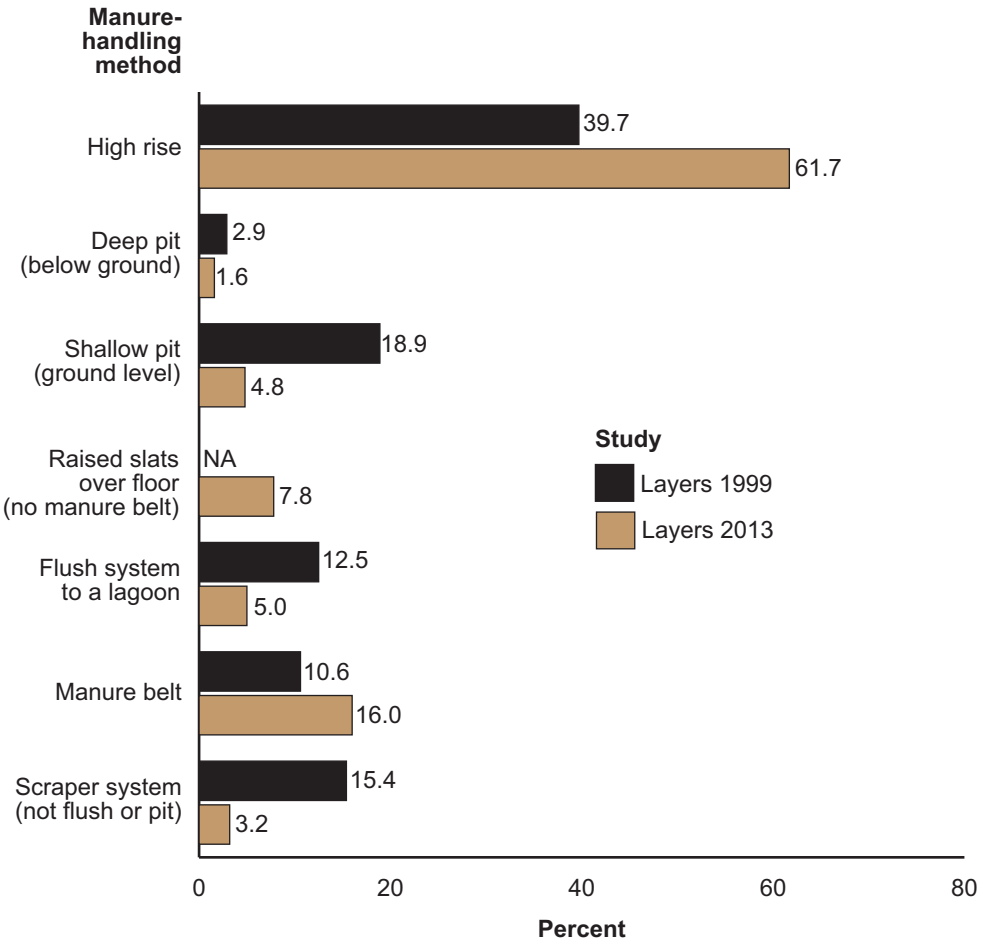
	Percent Farms			
	Study			
	Layers 1999		Layers 2013	
Delivery system	**Percent**	**Std. error**	**Percent**	**Std. error**
Nipple drinker	61.7	(5.8)	91.8	(1.8)
Cup drinker	39.6	(5.1)	8.8	(1.8)
Bell drinker	NA		1.6	(0.5)
Troughs	11.5	(3.9)	0.0	(—)
Other	NA		0.2	(0.0)

From 1999 to 2013, the percentage of farms that used high-rise housing as their primary method of handling manure increased, while the percentage of farms that primarily used shallow pits, flush systems, and scraper systems decreased. The percentage of laying hens living in the various systems did not change substantially.

C.4. Percentage of farms by primary manure handling method, and by study:

	Percent Farms							
	Study							
	Layers 1999				Layers 2013			
Manure handling method	**Pct. farms**	**Std. error**	**Pct. hens**	**Std. error**	**Pct. farms**	**Std. error**	**Pct. hens**	**Std. error**
High rise	39.7	(4.4)	47.0	(7.4)	61.7	(2.4)	48.6	(5.4)
Deep pit (below ground)	2.9	(1.0)	4.8	(3.5)	1.6	(0.7)	2.4	(1.3)
Shallow pit (ground level)	18.9	(4.4)	3.9	(1.3)	4.8	(0.8)	5.4	(2.3)
Raised slats over floor (no manure belt)	NA		NA		7.8	(1.2)	1.0	(0.2)
Flush system to a lagoon	12.5	(2.5)	7.7	(2.0)	5.0	(1.0)	5.0	(1.3)
Manure belt	10.6	(2.7)	27.7	(7.3)	16.0	(2.5)	36.7	(5.8)
Scraper system (not flush or pit)	15.4	(2.6)	8.9	(2.0)	3.2	(0.7)	0.9	(0.3)
Total	100.0		100.0		100.0		100.0	

Percentage of farms by primary manure-handling method, and by study



The percentage of farms that routinely molted their flocks decreased from 1999 to 2013 (82.6 and 57.0 percent, respectively). For farms that did molt their flock in 2013, the highest percentage fed an alternative diet, rather than restricting or withholding feed.

C.5. Percentage of farms by routine molting method used, and by study:

	Percent Farms			
	Study			
	Layers 1999		Layers 2013	
Molting method	**Percent**	**Std. error**	**Percent**	**Std. error**
Do not usually molt	17.4	(4.2)	43.0	(3.8)
Withhold or restrict feed set number of days	14.0	(3.3)	5.2	(1.5)
Withhold or restrict feed to certain weight	68.6	(4.6)		
Feed alternative diet	NA		50.9	(3.8)
Other	0.0	(—)	0.9	(0.5)
Total	100.0		100.0	

The percentage of farms that composted dead birds increased from 1999 to 2013. Conversely, the percentage of farms that disposed of dead birds in a covered deep pit decreased from 1999 to 2013.

C.6. Percentage of farms by method of dead-bird (daily mortality) disposal, and by study:

	Percent Farms			
	Study			
	Layers 1999[1]		Layers 2013[2]	
Disposal method	**Percent**	**Std. error**	**Percent**	**Std. error**
Composting	15.0	(3.5)	33.5	(4.0)
Incineration	9.0	(2.9)	13.4	(1.7)
Covered deep pit[3]	32.0	(5.8)	6.9	(1.5)
Rendering	32.0	(4.9)	26.5	(1.8)
Landfill	NA		14.9	(3.7)
Other	16.1	(3.6)	4.7	(3.3)
Total			100.0	

[1]Last completed flock—allowed to select more than one method.
[2]Primary method.
[3]In 2013 this question read, “Burial/covered deep pit.”

D. Morbidity and Mortality

The percentage of farms that had problems with cannibalism decreased from 53.2 percent in 1999 to 24.8 percent in 2013. The percentages of farms that had problems with respiratory disease and other diseases were similar in 1999 and 2013.

D.1. Percentage of farms in which the last completed flock had a problem (minor, moderate, or severe) with the following diseases/conditions, by study:

	Percent Farms			
	Study			
	Layers 1999		Layers 2013	
Disease/condition	**Percent**	**Std. error**	**Percent**	**Std. error**
Cannibalism[1]	53.2	(5.2)	24.8	(2.3)
Respiratory disease[2]	21.1	(3.7)	21.5	(2.2)
Other disease	58.3	(5.6)	49.6	(3.9)

[1]In 1999 this question read, “prolapse (blow out) and cannibalism.”

[2]In 1999 this category combined responses for Newcastle disease, infectious bronchitis, laryngotracheitis, infectious coryza, *Mycoplasma gallisepticum*, and respiratory disease (no specific diagnosis).

The 60-week mortality and total mortality for hens placed in the last completed flock decreased from 1999 to 2013.

D.2. Percentage of hens placed in the last completed flock that died at or before 60 weeks of age and percentage of hens that died in total, by study:

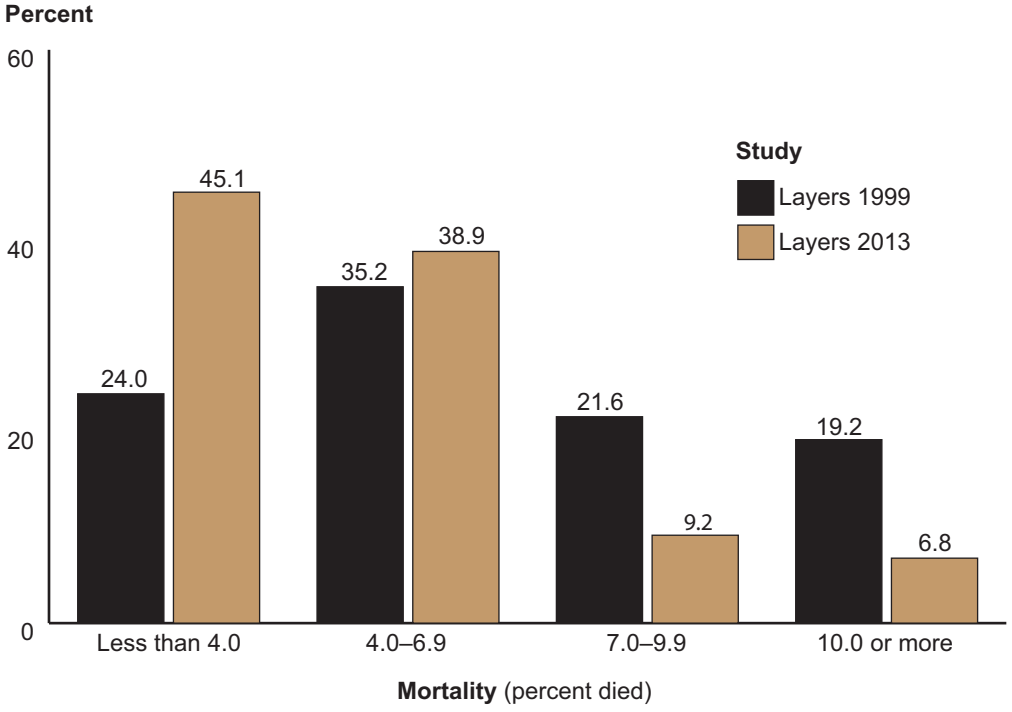
	Percent Hens			
	Study			
	Layers 1999		Layers 2013	
Mortality	**Percent**	**Std. error**	**Percent**	**Std. error**
At or before 60 weeks	6.5	(0.3)	5.2	(0.3)
Total	14.6	(0.7)	10.4	(0.5)

Over 40 percent of farms had a 60-week mortality of 7 percent or higher in 1999, compared with only 16.0 percent of farms in 2013.

D.3. Percentage of farms by 60-week mortality for the last completed flock, and by study:

	Percent Farms			
	Study			
	Layers 1999		Layers 2013	
Mortality (percent died)	**Percent**	**Std. error**	**Percent**	**Std. error**
Less than 4.0	24.0	(3.1)	45.1	(4.2)
4.0–6.9	35.2	(3.6)	38.9	(4.2)
7.0–9.9	21.6	(2.9)	9.2	(1.7)
10.0 or more	19.2	(3.7)	6.8	(1.4)
Total	100.0		100.0	

Percentage of farms by 60-week mortality for the last completed flock, and by study



E. Egg Handling

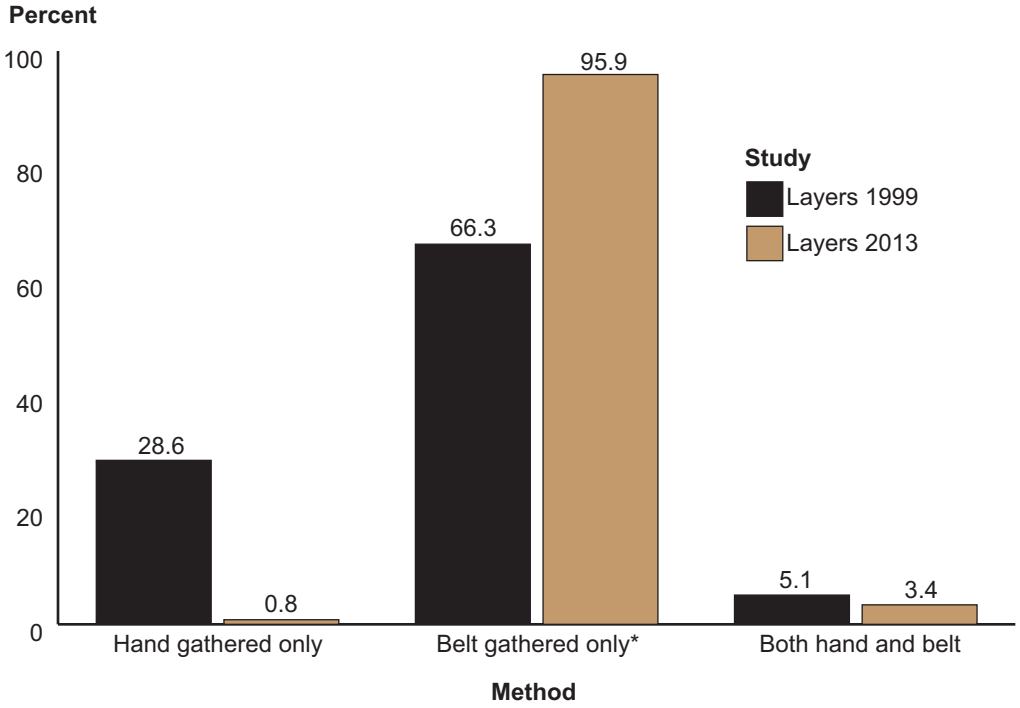
The percentage of farms that gathered all eggs by hand decreased from 28.6 percent in 1999 to less than 1 percent in 2013.

E.1. Percentage of farms by method of gathering eggs, and by study:

	Percent Farms			
	Study			
	Layers 1999		Layers 2013	
Egg-gathering method	Percent	Std. error	Percent	Std. error
Hand only	28.6	(4.5)	0.8	(0.4)
Belt only*	66.3	(4.6)	95.9*	(1.1)
Both hand and belt	5.1	(1.9)	3.4	(1.0)
Total	100.0		100.0	

* 2013 included belt with either hand or automated packing.

Percentage of farms by method of gathering eggs, and by study



*2013 included belt with either hand or automated packing.

The percentage of eggs gathered by hand decreased from 10.6 percent in 1999 to 0.4 percent in 2013.

E.2. Percentage of eggs by method of gathering eggs, and by study:

	Percent Eggs			
	Study			
	Layers 1999		Layers 2013	
Egg-gathering method	**Percent**	**Std. error**	**Percent**	**Std. error**
Hand	10.6	(2.1)	0.4	(0.2)
Belt*	89.4	(2.1)	99.6*	(0.2)
Total	100.0		100.0	

*2013 question included either hand packing or automated packing.

The percentage of farms that processed eggs on-farm increased from 18.8 percent in 1999 to 40.7 percent in 2013.

E.3. Percentage of farms by primary location for shell egg processing (washing, grading, and packing into cartons), and by study:

	Percent Farms*			
	Study			
	Layers 1999		Layers 2013*	
Primary location for processing	**Percent**	**Std. error**	**Percent**	**Std. error**
On-farm	18.8	(3.2)	40.7	(2.3)
Off-farm	81.2	(3.2)	59.3	(2.3)
Total	100.0		100.0	

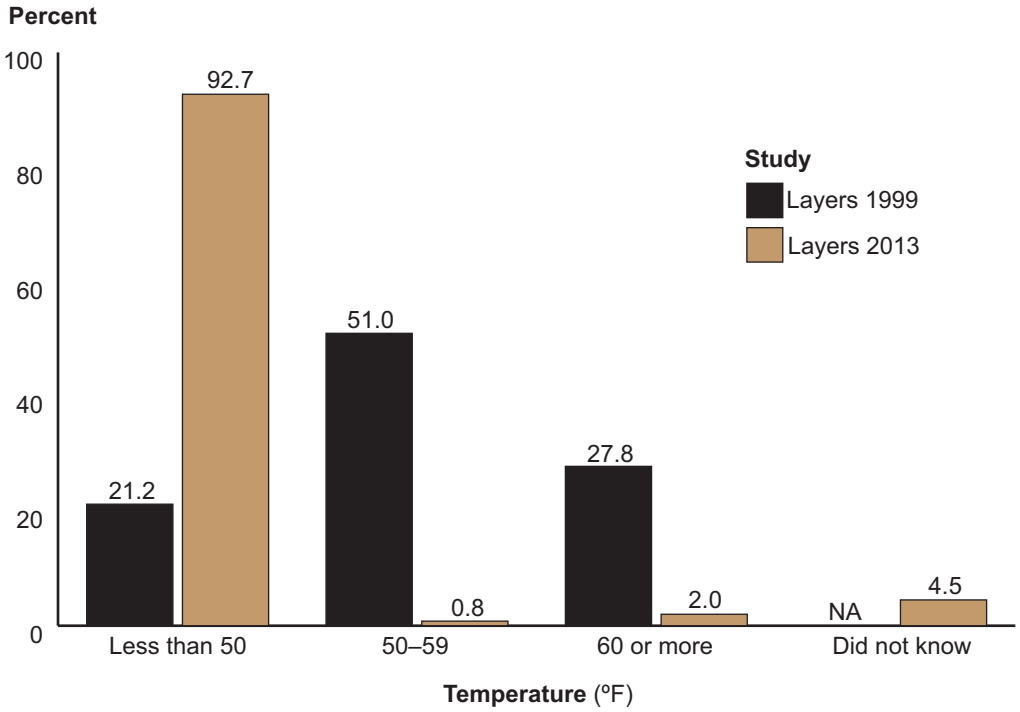
*This table does not include farms that sent all of their eggs for breaking (in 2013, 16 percent of farms).

The percentages of farms by the average number of days between egg pickups and by the distance to a processing plant were similar in 1999 and 2013. The percentage of farms that stored eggs on-farm at less than 50°F increased from 21.2 percent in 1999 to 92.7 percent in 2013. The FDA egg safety rule requires that eggs held 36 hours or longer be stored at 45°F or less, beginning 36 hours after they are layed.

E.4. For farms that processed eggs off-farm, percentage of farms by on-farm egg management, and by study:

	Percent Farms			
	Study			
	Layers 1999		Layers 2013	
Egg management	**Percent**	**Std. error**	**Percent**	**Std. error**
Average number of days between egg pickups				
0–2	48.5	(7.4)	45.0	(7.0)
3–5	45.1	(7.5)	47.3	(7.3)
6–9	6.2	(2.7)	7.7	(3.2)
10 or more	0.2	(0.1)	0.0	(—)
Total	100.0		100.0	
Usual temperature for egg storage on-farm (°F)				
Less than 50	21.2	(5.2)	92.7	(1.8)
50–59	51.0	(8.2)	0.8	(0.6)
60 or more	27.8	(5.7)	2.0	(1.2)
Did not know	NA		4.5	(1.6)
Total	100.0		100.0	
Usual percentage humidity for egg storage on-farm				
Less than 50	2.6	(1.3)	2.2	(1.3)
50–74	29.4	(5.5)	19.2	(3.2)
75 or higher	29.2	(5.8)	29.0	(7.8)
Did not know	38.8	(6.6)	49.6	(8.0)
Total	100.0		100.0	
Distance (miles) to processing plant where the majority of eggs were processed				
Less than 5	12.0	(3.1)	10.1	(1.7)
5–9	10.9	(2.5)	10.6	(2.1)
10 or more	77.1	(4.5)	73.0	(3.0)
Did not know	NA		6.3	(1.8)
Total	100.0		100.0	

For farms that processed eggs off-farm, percentage of farms by usual temperature for on-farm egg storage, and by study



The percentages of farms that used cleaned and disinfected reusable plastic flats and that cleaned racks or pallets before reusing them increased from 1999 to 2013.

E.5. For farms that processed eggs off-farm, percentage of farms by management of egg flats, racks, and pallets, and by study:

	Percent Farms			
	Study			
	Layers 1999		Layers 2013	
Management	**Percent**	**Std. error**	**Percent**	**Std. error**
Type of flats primarily used for storage and transport of shell eggs processed off-farm				
Disposable fiber	18.5	(8.1)	1.8	(1.2)
Reusable plastic, cleaned and disinfected	71.6	(8.0)	97.1	(1.3)
Reusable plastic, not cleaned and disinfected	9.9	(2.5)	1.2	(0.6)
Total	100.0		100.0	
Egg racks or pallets returned to the same farm				
	29.2	(8.8)	41.4	(4.8)
Before reusing at the farm, racks or pallets were…				
Cleaned	35.4	(6.2)	70.1	(3.6)
Disinfected	24.8	(6.9)	42.6	(7.4)

F. Employee and Visitor Biosecurity

The percentages of farms that prohibited employees or crews from owning poultry, and required employees or crews to use footbaths or change their clothes/coveralls increased from 1999 to 2013.

F.1. Percentage of farms in which the following precautions were required for employees and company or contract crews who worked in the layer houses, by study:

	Percent Farms			
	Study			
	Layers 1999		Layers 2013	
Precaution required	**Percent**	**Std. error**	**Percent**	**Std. error**
Employees				
Different personnel for different houses[1]	19.2	(5.1)	26.6	(2.8)
Shower	3.9	(1.4)	8.6	(3.3)
Hand sanitizer	NA		51.9	(4.0)
Footbaths	24.5	(5.4)	79.3	(4.5)
Change boots or use shoe covers	NA		35.3	(4.0)
Change clothes/coveralls	17.6	(3.7)	34.5	(3.9)
Not be around other poultry for at least 24 hr (e.g., other farms, markets, slaughter plants) before coming on this farm	85.2	(3.2)	85.9	(4.2)
Cannot own their own poultry or birds	75.7	(4.5)	94.2	(3.5)

Table continued.

F.1. (cont'd.) Percentage of farms in which the following precautions were required for employees and company or contract crews who worked in the layer houses, by study:

	Percent Farms			
	Study			
	Layers 1999		Layers 1999	
Precaution required	**Percent**	**Std. error**	**Percent**	**Std. error**
Crews				
Different personnel for different houses[1]	17.2	(5.3)	25.0	(2.7)
Shower	4.8	(1.7)	14.4	(4.0)
Hand sanitizer	NA		48.3	(3.8)
Footbaths	24.6	(6.4)	87.5	(2.9)
Change boots or use shoe covers	NA		64.4	(4.5)
Change clothes/coveralls	32.0	(5.6)	66.7	(3.5)
Not be around other poultry for at least 24 hr (e.g., other farms, markets, slaughter plants) before coming on this farm[2]	74.0	(6.6)	74.4	(4.2)
Cannot own their own poultry or birds[3]	55.2	(6.5)	78.3	(3.8)

[1]Layers 2013—for farms with more than one house.

[2]In 2013, 12.3 percent of producers did not know if this precaution was required.

[3]In 2013, 17.9 percent of producers did not know if this precaution was required.

The percentage of farms with gated entrances and signs posted to restrict or limit vehicle access increased from 1999 to 2013.

F.2. Percentage of farms by barriers used to restrict or limit visitor or vehicle access to the farm, and by study:

	Percent Farms			
	Study			
	Layers 1999		Layers 2013	
Barrier	**Percent**	**Std. error**	**Percent**	**Std. error**
Gated entrance	16.5	(2.3)	27.1	(1.9)
Fencing that limits vehicle access*	26.7	(4.3)	29.8	(2.0)
Signs posted (e.g., no trespassing)	72.9	(4.1)	99.0	(0.4)
Other	7.0	(1.6)	10.5	(1.7)

*In 1999 this question read, “fencing surrounding the farm.”

A higher percentage of farms in 2013 than in 1999 required business visitors to park in a restricted area away from the layer housing:

F.3. Percentage of farms by vehicle biosecurity requirements for business and nonbusiness visitors to the farm, and by study:

	Percent Farms			
	Study			
	Layers 1999		Layers 2013	
Requirements for vehicles	**Percent**	**Std. error**	**Percent**	**Std. error**
Business visitors				
Have vehicle tires cleaned or disinfected upon entering*	15.9	(4.0)	13.1	(1.7)
Park in a restricted area away from layer housing	27.2	(4.4)	52.4	(3.9)
Use a vehicle that has not been on another poultry farm that day	61.6	(6.4)	42.1	(4.1)
Use other vehicle biosecurity measures	NA		9.6	(1.8)
Nonbusiness visitors				
Have vehicle tires cleaned or disinfected upon entering*	7.6	(3.7)	6.5	(1.5)
Park in a restricted area away from layer housing	30.3	(8.1)	49.4	(4.2)
Use a vehicle that has not been on another poultry farm that day	62.9	(8.9)	39.7	(4.5)
Use other vehicle biosecurity measures	NA		4.1	(1.1)

*In 1999 this question read “cleaned and disinfected.”

The percentage of farms that allowed business and nonbusiness visitors into the layer houses without signing in decreased from 1999 to 2013.

F.4. Percentage of farms by biosecurity policy for business and nonbusiness visitors inside the layer houses, and by study:

	Percent Farms			
	Study			
	Layers 1999		Layers 2013	
Policy	**Percent**	**Std. error**	**Percent**	**Std. error**
Business visitors				
Visitors NOT allowed inside the layer houses	22.9	(6.8)	8.7	(1.5)
Visitors allowed in layer houses but required to sign in	37.4	(6.7)	84.9	(2.9)
Visitors allowed in layer houses and NOT required to sign in	39.7	(6.0)	6.4	(2.5)
Total	100.0		100.0	
Nonbusiness visitors				
Visitors NOT allowed inside the layer houses	68.1	(5.7)	62.3	(4.0)
Visitors allowed in layer houses but required to sign in	11.7	(4.3)	31.8	(4.6)
Visitors allowed in layer houses and NOT required to sign in	20.2	(3.9)	5.9	(2.5)
Total	100.0		100.0	

The percentage of farms that required footbaths for visitors increased from 1999 to 2013.

F.5. For farms in which business or nonbusiness visitors entered the layer houses, percentage of farms by biosecurity requirements for visitors, and by study:

	Percent Farms					
	Study					
	Layers 1999		Layers 2013 (business visitors)		Layers 2013 (nonbusiness visitors)	
Requirement for visitors	Pct.	Std. error	Pct.	Std. error	Pct.	Std. error
Shower	2.9	(1.5)	2.9	(1.0)	1.5	(1.3)
Footbaths	34.0	(6.6)	84.3	(3.6)	79.2	(6.6)
Change boots or use shoe covers[1]	76.1	(4.8)	86.2	(3.2)	66.6	(9.4)
Change clothes/ coveralls[2]	64.5	(5.9)	83.8	(3.4)	62.9	(9.3)

[1]In 1999 this question read, “Clean boots.”
[2]In 1999 this question read, “Clean coveralls.”

G. Animals

The percentage of farms located less than 1 mile of a premises with poultry nearly doubled from 1999 to 2013. This finding may reflect the growing popularity of backyard poultry.

G.1. Percentage of farms by distance to the nearest premises with poultry,* and by study:

	Percent Farms			
	Study			
	Layers 1999		Layers 2013	
Distance (miles)	**Percent**	**Std. error**	**Percent**	**Std. error**
Less than 1	25.7	(4.6)	50.7	(3.5)
1–2	38.6	(6.3)	28.0	(3.3)
More than 2	35.8	(5.9)	21.3	(2.0)
Total	100.0		100.0	

*Including backyard flocks, chickens, ducks, geese, turkeys, etc.

The percentage of farms in which wild birds had access to feed decreased from 1999 to 2013. Access to feed by other types of animals did not change substantially, when considering standard errors.

G.2. Percentage of farms in which the following animals had access to feed (e.g., feed in tanks, bins, feed lines) before it was fed to layers, by study:

	Percent Farms			
	Study			
	Layers 1999*		Layers 2013	
Animal	**Percent**	**Std. error**	**Percent**	**Std. error**
Rodents	21.4	(4.3)	11.1	(1.7)
Wild birds	7.6	(2.1)	1.1	(1.0)
Flies	31.4	(4.9)	18.8	(3.6)
Darkling beetles	NA		16.1	(3.6)
Cats	5.0	(2.0)	1.1	(1.0)
Dogs	1.6	(0.9)	1.1	(1.0)

*In 1999 this question read, “Feed in tanks, bins, lines, hoppers, etc.”

H. Rodent and Fly Control

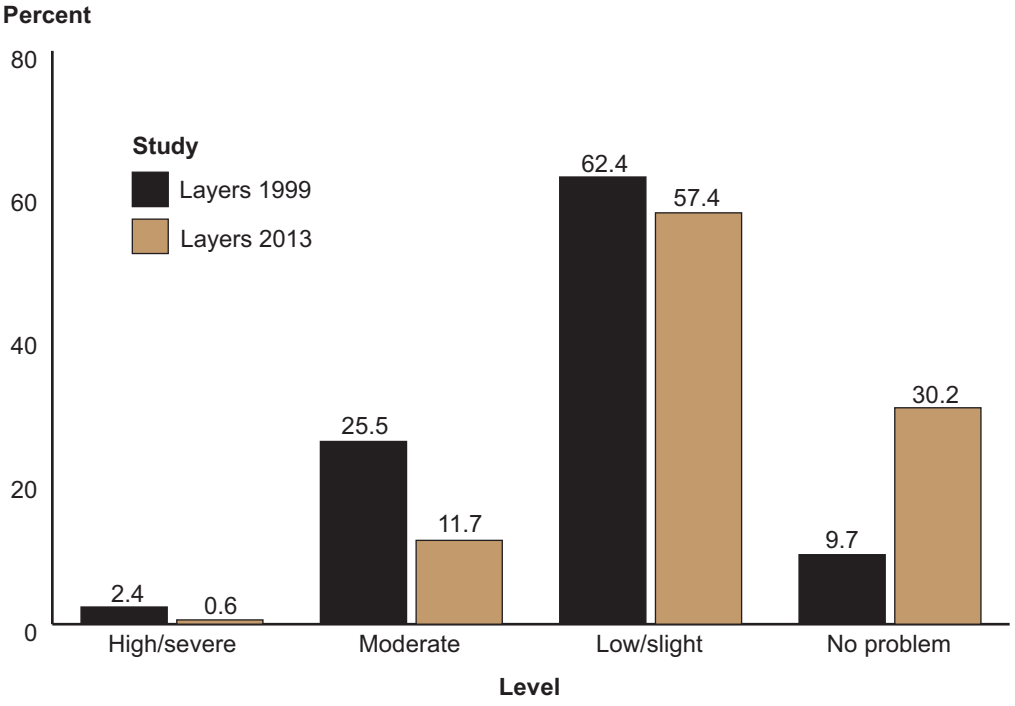
The percentages of farms that had any problems with mice or rats decreased from 1999 to 2013. This difference may be due in part to the differences in study design. In 1999, rodent severity was measured as a one-time data collector observation whereas in 2013 it was producer reported for the previous year in general.

H.1. Percentage of farms by level of ongoing problem* caused by mice, rats, and other rodents, and by study:

		Percent Farms			
		Study			
		Layers 1999		Layers 2013	
Rodent	Level	Pct.	Std. error	Pct.	Std. error
Mice	High/severe	2.4	(1.7)	0.6	(0.5)
	Moderate	25.5	(4.5)	11.7	(4.3)
	Low/slight	62.4	(5.3)	57.4	(3.5)
	No problem	9.7	(3.5)	30.2	(4.0)
	Total	100.0		100.0	
Rats	High/severe	1.6	(0.6)	0.0	(—)
	Moderate	6.9	(2.1)	1.2	(0.5)
	Low/slight	43.7	(5.8)	27.2	(4.4)
	No problem	47.8	(6.1)	71.6	(4.4)
	Total	100.0		100.0	
Other rodents	High/severe	0.0	(—)	0.0	(—)
	Moderate	0.8	(0.3)	0.0	(—)
	Low/slight	1.2	(0.4)	1.3	(0.5)
	No problem	98.0	(0.5)	98.7	(0.5)
	Total	100.0		100.0	

*In 1999 this was a one-time observation by the data collector; in 2013 the level of ongoing problems during the previous 12 months was reported by the producer.

Percentage of farms by level of ongoing problem* caused by mice, and by study



*In 1999 this was a one-time observation by the data collector; in 2013 the level of ongoing problem during the previous 12 months was reported by the producer.

Mice caused the greatest ongoing rodent problem in both study years.

H.2. Percentage of farms by rodent that caused the greatest ongoing problem in the layer house(s) during the previous 12 months, and by study:

	Percent Farms			
	Study			
	Layers 1999		Layers 2013	
Rodent	**Percent**	**Std. error**	**Percent**	**Std. error**
Mice	84.0	(3.6)	66.0	(4.0)
Rats	15.4	(3.6)	7.2	(1.2)
Other rodents	0.6	(0.3)	0.0	(—)
No problem with rodents	NA		26.8	(3.9)
Total	100.0		100.0	

About one-third of houses had a rodent index of 26 or greater in 1999. No farms had a rodent index of 26 or greater in 2013. This difference may be due in part to differences in study design. In 1999, rodent index was calculated based on traps set in the layer houses for 1 week, whereas in 2013 the rodex index was producer reported for the previous year in general.

H.3. Percentage of houses/farms by rodent index and by study:

	Percent Farms			
	Study			
	Layers 1999[1]		Layers 2013[2]	
Rodent index (number mice)	**Percent houses**	**Std. error**	**Percent farms**	**Std. error**
0–10 (low)	49.5	(5.9)	85.4	(4.4)
11–25 (moderate)	19.0	(3.0)	14.6	(4.4)
26 or more (high)	31.5	(6.4)	0.0	(—)
Total	100.0		100.0	

[1]Percent houses measured over a 1-week period by the data collector.
[2]Producer reported typical rodent index during the previous 12 months for farms that monitored rodent index.

The percentage of farms that used traps and sticky tape to control rodents increased

from 46.0 percent in 1999 to 87.1 percent in 2013. In 1999, 25.6 percent of farms used cats to control rodents compared with just 9.1 percent in 2013.

H.4. Percentage of farms by rodent control methods used in the layer houses during the previous 12 months, and by study:

	Percent Farms			
	Study			
	Layers 1999		Layers 2013	
Rodent control method	**Percent**	**Std. error**	**Percent**	**Std. error**
Chemicals or bait including those used by a pest control operator	92.7	(2.3)	92.6	(1.2)
Traps or sticky tape	46.0	(6.5)	87.1	(2.1)
Cats	25.6	(4.3)	9.1	(3.8)
Professional pest control operator	NA		28.7	(3.2)
Other	1.2	(0.4)	0.8	(0.3)

The percentages of farms that used larvacide (spot treatment) and biological predators to control flies increased from 1999 to 2013.

H.5. Percentage of farms by fly control methods used in the layer houses during the previous 12 months (other than manure removal), and by study:

	Percent Farms			
	Study			
	Layers 1999		Layers 2013	
Fly control method	Percent	Std. error	Percent	Std. error
Residual spray (long acting)	58.2	(5.5)	59.4	(4.1)
Space spray/fogger	39.0	(6.2)	49.6	(4.3)
Baits/traps*	72.1	(4.4)	77.8	(4.1)
Larvicide (spot treatment)	20.6	(5.2)	39.3	(4.0)
Larvicide in feed	36.5	(5.3)	36.7	(4.6)
Biological predators	13.8	(3.5)	31.4	(4.6)
Other	7.1	(1.9)	3.1	(1.5)

*In 1999 the question read, “Baits.”

I. Down-Time Procedures

For farms with cages, nearly all farms in both study years removed layers that had escaped from their cages.

I.1. Percentage of farms that, at the end of production, removed layers that had escaped from their cages (e.g., down in the pit or on top of cages), by study:

	Percent Farms			
	Study			
	Layers 1999		Layers 2013	
Removed escaped layers?	Percent	Std. error	Percent	Std. error
Yes	98.6	(0.4)	82.9	(2.3)
No	0.8	(0.4)	2.2	(0.8)
NA (no cages)	0.6	(0.2)	14.9	(2.2)
Total	100.0		100.0	

The average down time did not change substantially from 1999 to 2013 (25.1 and 19.4 days, respectively).

I.2. Average number of days layer houses were usually empty between flocks, by study:

Average Number of Days			
Study			
Layers 1999		Layers 2013	
Average	Std. error	Average	Std. error
25.1	(3.8)	19.4	(2.4)

The percentage of farms with a down time of less than 4 days decreased from 1999 to 2013 (11.3 and 2.5 percent, respectively).

I.3. Percentage of farms by number of days layer houses were usually empty between flocks, and by study:

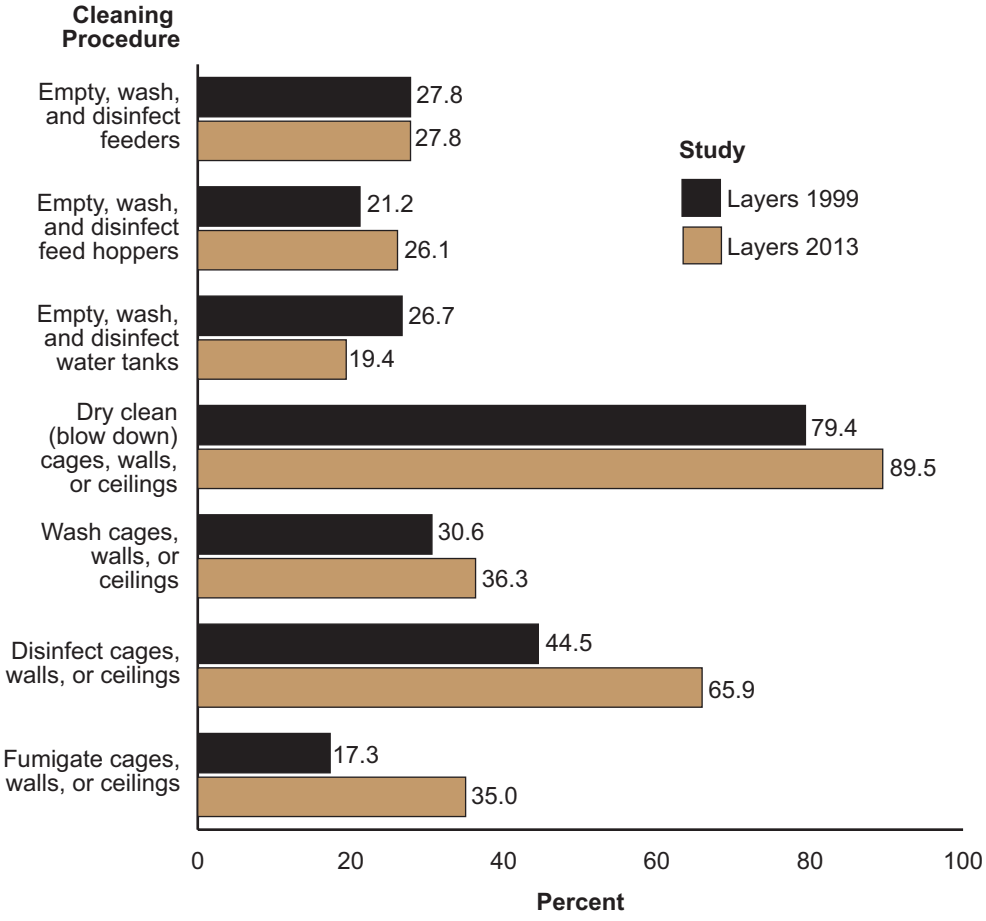
	Percent Farms			
	Study			
	Layers 1999*		Layers 2013	
Days empty	**Percent**	**Std. error**	**Percent**	**Std. error**
Less than 4	11.3	(3.0)	2.5	(1.1)
4–10	17.3	(3.0)	37.1	(4.1)
11–17	26.6	(4.9)	26.4	(3.9)
18 or more	44.8	(6.4)	34.0	(4.0)
Total	100.0		100.0	

The percentages of farms by cleaning and disinfecting procedures for feeders, hoppers, water tanks, and waterlines were similar in 1999 and 2013. However, a higher percentage of farms disinfected and fumigated cages, walls, or ceilings in 2013 than in 1999.

I.4. For farms that had the specified equipment, percentage of farms by cleaning procedure performed after every flock, and by study:

	Percent Farms			
	Study			
	Layers 1999		Layers 2013	
Cleaning procedure	**Percent**	**Std. error**	**Percent**	**Std. error**
Empty, wash, and disinfect feeders	27.8	(4.8)	27.8	(3.2)
Empty, wash, and disinfect feed hoppers	21.2	(4.5)	26.1	(3.0)
Empty, wash, and disinfect water tanks	26.7	(7.8)	19.4	(4.0)
Flush water lines	81.8	(3.4)	84.8	(1.8)
Disinfect water lines	57.3	(6.0)	59.6	(4.1)
Bacterial culture water source	18.8	(4.8)	31.1	(4.0)
Wash and disinfect egg belts or elevators	23.7	(6.9)	32.2	(3.1)
Dry clean (blow down) cages, walls, or ceilings	79.4	(3.7)	89.5	(2.6)
Wash cages, walls, or ceilings	30.6	(4.5)	36.3	(3.2)
Disinfect cages, walls, or ceilings	44.5	(5.4)	65.9	(4.7)
Fumigate cages, walls, or ceilings	17.3	(3.2)	35.0	(4.1)
Clean fans, ventilation system, or cool cells	82.9	(4.9)	92.3	(2.1)

For farms that had the specified equipment, percentage of farms by cleaning procedure performed after every flock, and by study



J. *Salmonella* Control

The percentage of farms that placed *Salmonella* Enteritidis-monitored pullets increased from 69.6 percent in 1999 to 95.9 percent in 2013.

J.1. Percentage of farms by method used to monitor for *Salmonella* Enteritidis in pullets (at the pullet farm), and by study:

	Percent Farms			
	Study			
	Layers 1999		Layers 2013[1]	
Method	**Percent**	**Std. error**	**Percent**	**Std. error**
Test "dead-on-arrival" chicks or chick-box paper	43.5	(3.9)	49.7	(3.9)
Culture of environment or manure	52.4	(4.1)	84.3	(2.3)
PCR (Taqman, BAX) or other rapid test (SDIX, Neogen) of environment/manure	NA		34.8	(3.5)
Test live birds[2]	8.9	(1.2)	11.4	(3.5)
Serology	19.2	(2.7)	NA	
Any of the above	69.6	(3.9)	95.9	(1.5)

[1]Pullets making up the most recently placed layer flock.
[2]In 1999, question read, "Culture birds."

In 1999, only 5.4 percent of farms (14.6 percent of layers) placed birds that had been vaccinated against *Salmonella* as pullets, whereas in 2013, 98.7 percent of farms (99.5 percent of layers) placed birds that were vaccinated as pullets.

J.2. Percentage of farms and percentage of layers on these farms in which the most recently placed layer flock was vaccinated for *Salmonella* as pullets, by study:

	Percent			
	Study			
	Layers 1999		Layers 2013	
	Percent	**Std. error**	**Percent**	**Std. error**
Farms	5.4	(0.9)	98.7	(0.7)
Layers	14.6	(3.0)	99.5	(0.3)

Testing finished feed and feed ingredients for *Salmonella* Enteritidis decreased from 1999 to 2013. Studies in the 1990s did not find feed to be an important risk factor for *Salmonella* Enteritidis, which may explain the decrease in the percentage of farms that analyzed feed for *Salmonella* Enteritidis.

J.3. Percentage of farms in which finished feed or feed ingredients were routinely tested for *Salmonella* Enteritidis, by study:

	Percent Farms			
	Study			
	Layers 1999		Layers 2013	
Tested	**Percent**	**Std. error**	**Percent**	**Std. error**
Finished feed	46.8	(4.1)	21.4	(2.7)
Any feed ingredients	51.6	(4.0)	27.3	(2.8)
Either	57.2	(4.0)	32.5	(3.1)

The percentage of farms that routinely tested for *Salmonella* Enteritidis in the layer houses increased from 58.0 percent in 1999 to 98.7 percent in 2013. The FDA egg safety rule requires environmental testing in layer houses when hens are 40 to 45 weeks of age and 4 to 6 weeks after molting; farms that only produce eggs for the breaker market are exempt from testing.

J.4. Percentage of farms that routinely tested for *Salmonella* Enteritidis in the layer houses, by study:

Percent Farms			
Study			
Layers 1999		Layers 2013	
Percent	**Std. error**	**Percent**	**Std. error**
58.0	(5.7)	98.7	(0.8)

For farms that tested for *Salmonella* Enteritidis, a higher percentage of farms collected samples from egg belts and elevator equipment in 1999 than in 2013. Manure is the preferred sample type prescribed in the FDA egg safety rule.

J.5. For farms that tested for *Salmonella* Enteritidis in the layer houses, percentage of farms by testing practice and by study:

	Percent Farms			
	Study			
	Layers 1999		Layers 2013	
Practice	**Percent**	**Std. error**	**Percent**	**Std. error**
Samples tested[1]				
Manure	89.7	(3.6)	97.7	(0.9)
Egg belts[2]	52.6	(9.2)	18.2	(2.1)
Elevator equipment[2]	42.0	(8.7)	9.9	(2.0)
Primary person who collected the samples				
Company or farm personnel	70.1	(6.3)	80.6	(4.8)
State or Federal personnel	8.5	(2.4)	0.7	(0.0)
Independent third party	NA		12.2	(4.1)
Other	21.4	(5.4)	6.4	(2.5)
Total	100.0		100.0	
Usual times for testing				
Before layers are placed (empty house)	29.4	(6.7)	24.0	(4.1)
After placement but before 40 weeks of age	NA		27.1	(3.2)
40–45 weeks of age	NA		92.7	(3.7)
After placement but before last 4 weeks of production	59.8	(8.1)	NA	
4–6 weeks postmolt[3]	NA		94.3	(2.9)
At end of production[4]	59.2	(9.0)	37.0	(4.0)
Any other age during production	NA		2.1	(0.9)

[1]In 1999 this was by culture; in 2013 these were samples tested by any method.
[2]For farms that had such equipment.
[3]For farms that molt.
[4]In 1999, question read, “in last 4 weeks of production.”

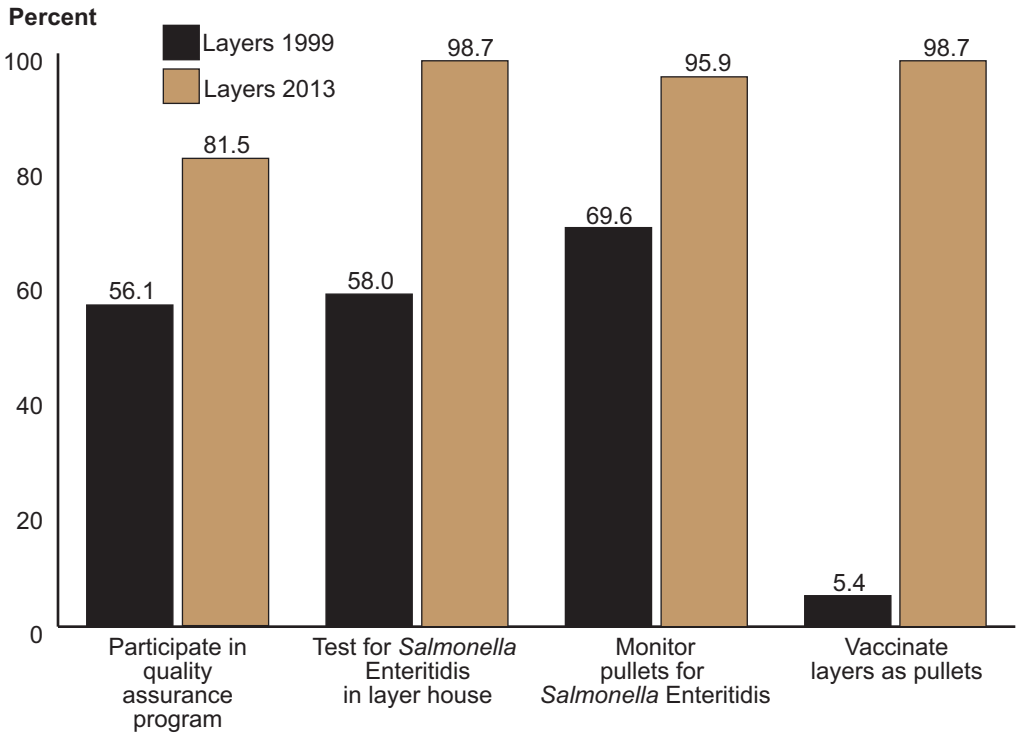
A higher percentage of farms participated in a *Salmonella* Enteritidis quality assurance program (especially State-sponsored programs) in 2013 than in 1999 (81.5 and 56.1 percent, respectively), .

J.6. Percentage of farms by participation in the following egg (*Salmonella* Enteritidis) quality assurance programs, and by study:

	Percent Farms			
	Study			
	Layers 1999		Layers 2013	
Program	**Percent**	**Std. error**	**Percent**	**Std. error**
State	22.7	(5.3)	48.9	(1.8)
Company sponsored	40.3	(5.3)	48.6	(4.8)
Commodity group (e.g., United Egg Producers)	28.4	(6.2)	34.8	(4.5)
Other*	0.0	(—)	1.3	(0.5)
Any	56.1	(5.7)	81.5	(2.1)

*In 2013 excluded FDA program.

Percentage of farms by *Salmonella* Enteritidis control practices, and by study



For farms that participated in an egg (*Salmonella* Enteritidis) quality assurance program, a higher percentage of farms in 2013 than in 1999 had an inspection by someone not associated with the farm or company to verify program compliance.

J.7. For farms that participated in an egg (*Salmonella* Enteritidis) quality assurance program (other than FDA's), percentage of farms in which someone not associated with the farm or company inspected the farm to verify compliance with the program, by study:

Percent Farms			
Study			
Layers 1999		Layers 2013	
Percent	Std. error	Percent	Std. error
55.0	(8.2)	81.2	(1.9)

The prevalence of *Salmonella* Enteritidis in layer houses was measured differently in 1999 and 2013. In 1999, a one-time sampling of layer houses was performed by data collectors, and samples were cultured for *Salmonella* Enteritidis. In 2013, producers reported the number of flocks that had been tested for *Salmonella* Enteritidis and the number that tested positive over a 1-year period. In 1999, 7.1 percent of layer houses tested positive for *Salmonella* Enteritidis. In 2013, 1.2 percent of flocks tested positive. Although the methodology for the 1999 and 2013 studies was different, these results suggest a reduction in the prevalence of *Salmonella* Enteritidis from 1999 to 2013.

J.8. Percentage of layer houses with at least one environmental culture swab positive for *Salmonella* Enteritidis as a part of the Layers 1999 biologic sampling (May 3 to October 22, 1999):

Percent houses	Std. error
7.1	(3.6)

J.9. For flocks that tested for *Salmonella* Enteritidis via environmental testing from June 1, 2012, to May 31, 2013, percentage of flocks that tested positive for *Salmonella* Enteritidis (producer reported), by time period of testing:

Time period of testing	Percent flocks	Std. error
June–August 2012	1.4	(0.7)
September–November 2012	1.4	(0.6)
December 2012–February 2013	1.5	(0.5)
March–May 2013	0.6	(0.4)
June 2012–May 2013	1.2	(0.4)

Section II: Methodology

Layers 1999 study

The National Agricultural Statistics Service (NASS) maintained a list of operations with 30,000 or more laying hens as a basis for estimating monthly egg production. An operation may have had one farm or multiple farms. All operations on the NASS list in 15 States[2] were eligible to participate in the study.

NASS enumerators visited operations and administered a company-level questionnaire. Farm selection for participation in phase 2 of the study occurred during the NASS enumerator visit. All farms were selected for operations with 10 or fewer farms. If an operation had more than 10 farms, a random sample of farms was selected. Selected farms were visited by a representative of APHIS–VS. A questionnaire was administered that addressed management practices. The severity of rodent problems on each participating farm was assessed by data collector observation. Data were weighted to reflect the population of operations with 30,000 or more laying hens in the 15 States.

Additionally, swabs from manure, egg belts, elevators, and walkways were collected from poultry houses and submitted for culture to the Agricultural Research Services laboratory in Athens, Georgia.

Layers 2013 study

Since all egg farms with 3,000 or more laying hens that produce eggs for human consumption are required to register with the FDA, a sample of table-egg farms having 3,000 or more laying hens was selected from the FDA list of registered premises in 19 States.[3] A questionnaire was administered that addressed management practices relevant to *Salmonella* Enteritidis, such as biosecurity, rodent control, molting, and vaccination. No biologic samples were collected.

Producers were asked about testing for *Salmonella* Enteritidis in the layer house environment between June 1, 2012, and May 31, 2013. Testing may have been by culture, PCR, or other rapid tests. Questions regarding pullet rearing, *Salmonella* Enteritidis testing, and vaccinating were primarily answered by a company representative, while questions relating to day-to-day layer management were primarily answered by farm personnel. Data were weighted to reflect the population of farms with 3,000 or more laying hens in the 19 States. Only farms with 30,000 or more laying hens were included in the analysis for comparison to the 1999 study.

[2] Alabama, Arkansas, California, Florida, Georgia, Indiana, Iowa, Minnesota, Missouri, Nebraska, North Carolina, Ohio, Pennsylvania, Texas, Washington.

[3] Alabama, Arkansas, California, Florida, Georgia, Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Nebraska, North Carolina, Ohio, Pennsylvania, Texas, Washington, Wisconsin, New England (considered as one State).

The following table summarizes the differences in study design for the two studies.

Comparison of 1999 and 2013 NAHMS layer farm studies

	1999 study	2013 study
List frame	NASS	FDA
Inference population	Operations with 30,000 or more laying hens in 15 States	Farms with 3,000 or more laying hens in 19 States (subset of farms with 30,000 or more laying hens for comparison to 1999 study)
Testing	Swabs of layer house environment collected one time by data collector for culture	Producer-reported test results for a 1-year period. Tests included culture, PCR, and other rapid tests.
Rodent assessment	One-time data collector observation	Producer-reported typical level of problem for a 1-year period

Appendix I: Number of Farms and Number of Layers, 2013

State	No. farms[1,2]	No. table egg layers on hand Jan. 2013 (x1,000)[3,4]
Arkansas	542	3,744
Georgia	506	8,993
North Carolina	435	5,796
Alabama	426	1,468
Pennsylvania	267	23,488
Texas	182	15,021
Ohio	126	27,784
Iowa	104	51,278
Indiana	87	25,549
California	73	18,990
Missouri	62	6,435
Wisconsin	62	4,728
Minnesota	57	9,379
New England[5]	25	5,761
Florida	23	8,070
Nebraska	21	9,221
Illinois	17	3,930
Washington	16	6,464
Michigan	14	12,022
19-State total	3,045	248,121
U.S. total	3,986	284,575

[1] Farms with 3,200 or more layers, including table-egg layers and breeders.
[2]NASS 2007 Census of Agriculture.
[3]On farms with 30,000 or more table egg layers.
[4]NASS “Chickens and Eggs” report, March 2013.
[5]Connecticut and Maine.

Appendix II: Study Objectives and Related Outputs

1. Update previously collected information on layer farm management practices relevant to *Salmonella* Enteritidis
   - "Part I: Reference of Health and Management Practices on Table-Egg Farms in the United States, 2013," June 2014
   - "Part III: Trends in Health and Management Practices on Table-Egg Farms in the United States, 1999–2013," October 2014
   - "Part IV: Reference of Organic Egg Production in the United States, 2013," expected November 2014
   - "Management Practices on Certified Organic Table-Egg Farms," info sheet, expected October 2014
   - "Trends in Management Practices on U.S. Table-Egg Farms," info sheet, expected October 2014

2. Estimate the prevalence of *Salmonella* Enteritidis on layer farms and investigate risk factors for *Salmonella* Enteritidis
   - "Part II: Control and Prevention of *Salmonella* Enteritidis on Table-Egg Farms in the United States, 2013," August 2014
   - "*Salmonella* Enteritidis on Table-Egg Farms in the UnitedStates," info sheet, expected October 2014

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Layers 2013: Part III