Economic impact of the *Salmonella enteritidis* control program to the Egg Industry in California

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Salmonella enteritidis is not considered to be a significant cause of morbidity or mortality in commercial layer flocks. The major threat to the producer is that the farm will be implicated in a trace back investigation following a human illness due to *S. enteritidis* and the associated cost in fulfilling the regulatory compliance. For the industry as a whole there is the negative publicity from the public perception that eggs are linked to human salmonellosis. This risk associated public perception could translate in to a financial loss for the egg industry. Alternatively, if the producer chooses to implement a *S. enteritidis* control program, there may be a reduced risk of human salmonellosis, improved consumer confidence and the industry will benefit from sustained product demand and financial gain. However, implementing a *S. enteritidis* control program in a commercial layer flock is not simple and it could certainly increase production costs. There is no previous documentation dealing with the economic impact of the *S. enteritidis* control program. The purpose of this paper is to present two cost estimates: 1) a *S.enteritidis* control program for the California Egg Industry and 2) the loss of income incurred by a producer in the absence of a *S. enteritidis* monitoring program based on a retrospective study.

1. Cost estimates for Control Program

The limitations in estimating costs for a *S.enteritidis* control program stem from the many variations in flock sizes, age, type of housing and equipment, environmental conditions, and management practices. However, the great majority of California producers have joined the California Egg Quality Assurance Plan (CEQAP) and subscribe to common basic core program components. Therefore in estimating costs, components such as cleaning and disinfection, rodent control and testing for *S. enteritidis* etc. are required by the plan and assumptions are made that they are practiced by all participants. It is recognized that these farm practices existed long before the *S. enteritidis* problem but producers became more vigilant following the implementation of CEQAP. Cost estimates for rodent control and cleaning and disinfection were based on 2 companies' expenditures; a large company with a capacity of 1,776,900 birds, and a mid size company with a capacity of 63,000 birds.

Assumptions:

There are 32 companies,100 farms, 1000 houses with 23 million laying hens in California with an average of 23,000 birds per house. Eighty five percent of the companies hire veterinarians; and 25 % of the annual veterinary services, 50% of the rodent control and 25% of the cleaning and disinfection efforts are estimated for a *S. enteritidis* control (monitoring) program. Eight percent of the laying hens are vaccinated.

Annual Se monitoring cost estimates for the state of California Egg Industry

Cost of *S. enteritidis* testing
16 swabs per house (4 pools), 10 houses per farm
$45/ per pool, for 1000 houses
= $45 X 4 X 1000 ....$180,000

Cleaning and Disinfection
$1927 per house (25% estimated for the Se program)
= $1927 X 1000 (25%)=. $481,750 (18 months)
For 12 months =67%($481,750)..... $322,772

Rodent Control
$1327 per Farm (50% estimated for the Se program)
= $1327 X 100 (50%)..... $66,350

Vaccination for *S. enteritidis*
14 Cents per bird, 8% of 23,000,0000 birds
$0.14 X 1,840,000 .....$257,600

Consultation/Professional fee, $12,000/year/company (25% est., for Se)
32 companies, 85% hire veterinarians= 27
$3000X 27..... $81,000

Total **$907,722**

The Cost of not monitoring for *S. enteritidis*

When shell eggs are implicated in human salmonellosis, a trace back investigation is initiated by regulatory agencies. The cost of compliance with the regulatory protocol is very expensive because eggs are diverted to pasteurization or the infected flock is depopulated. Unlike some of the zoonotic diseases such as brucellosis and tuberculosis in cattle, there are no indemnities paid if the producer chooses to depopulate the infected flock. If the producer chooses to divert eggs for pasteurization the shell egg premium will be lost (by as much as 50%). Indirect income losses to the producer include lack of replacement pullets for example, if replacement pullets are not planned several weeks in advance the producer may incur cost of idle capital; other indirect costs may include the cost of purchasing eggs in the open market to fulfill existing contract obligations. Other costs include laboratory testing, liability claims, increased insurance premiums, decreased consumer confidence, etc.

2. Income loss associated with *S. enteritidis* phage type 4 outbreak in a commercial layer chickens (19 months follow up)– A Retrospective Study

In May of 1994 *S. enteritidis* phage type 4 (Se PT4) was isolated from five of six 27-week old layer chickens submitted for necropsy from a flock of 43, 000. Bacteriologic and epidemiological investigations on the farm revealed that 5 of the eight flocks (n=176,000) were infected. The prevalence of Se PT4 in randomly selected healthy birds ranged from 1.7% (cage birds) to 50% (free range birds) and the prevalence in culled birds (kept in dirt floor houses) ranged from 14 to 42%. The estimated overall prevalence of group D *Salmonella* was 2.28 per 10,000. The estimated prevalence of group *D Salmonella* in eggs from caged birds in three infected houses ranged from 1.5 to 4.1 per 10, 000, whereas in 2 houses of free range birds, prevalence was 14.9 to 19.1 per 10,000. Three of the 8 flocks on the farm remained negative for *Salmonella* throughout the observation period (May

1994 to December 1995). The producer voluntarily diverted eggs for pasteurization and there was no human illness associated with this outbreak and no trace back investigation was initiated.

Estimated loss of income associated with Se PT4:

The different age layer flocks were kept in 8 different houses and produced regular or specialty type eggs. For estimating loss, one price was chosen for all the eggs (large price +50 Cents) produced on the farm. At the start of the outbreak egg production was about 92% and a mortality of 0.2% per week was estimated thereafter until the flock was removed or marketed. Three flocks were never infected during the observation period (19 months). The other flocks became positive intermittently and eggs were treated according to protocol. This entailed testing 1000 eggs from a positive flock four times (every 2 weeks). During this testing period, eggs were diverted to pasteurization. If eggs became negative for four consecutive times, the producer was allowed to sell shell eggs and the flock was monitored for the rest of the production life by sampling 480 eggs every 3 months. If at any time eggs became positive, diversion to pasteurization would resume and eggs would be tested every 2 weeks (1000 eggs per house). The net loss from each flock was calculated by subtracting the sum of the sampling cost and the income from pasteurized eggs from the original value. Diverted eggs were estimated to be 50%of the shell egg price (Table 1). At the start of the outbreak the producer opted to hire a veterinarian and additional cost was incurred.

Table 1. Estimated Loss of Income (US $) Associated with Se PT4 Infection of Laying Flocks

Flock #	Original Value of Eggs	Cost of eggs used for testing	Net Value of eggs	Income from Eggs	Net Loss
1	1,493,957	1,253	1,492,704	156,250	1,337,706
2	761,830	844	760,986	94,344	667,486
3 Not infected	387,147	407	386,740	386,740	407
4 Not infected	246,842	329	246,513	246,513	329
5 Not infected	1,200,175	329	1,199,846	1,199,846	329
6	305,779	1,274	304,505	32,212	273,567
7	76,061	960	75,101	12,026	64,034
8	63,953	1,148	62,805	10,400	53,553
Total	**4,535,744**	**6,544**	**4,529,200**	**2,138,331**	**2,397,413**
Total Net Loss= Original value-income from diversion=(4,535,744-2,138,331)=2,397413					
Other Costs:					
			Flock Vaccination Cost (SE)		$ 2,195
			Professional fee		$ 4,500
Grand Total					**$ 2,404,108**

Laboratory costs related to the outbreak:

Collection of Samples (time)
31 trips, 3hrs each trip, $100/hr=$300 X31.....$9,300

Cost of necropsy and *Salmonella* culture of laying hens:
- 655 birds @ $ 30 per bird..... $19,650
- @5% positive for group D Salmonella
- 33 isolates serotyped ($12 each) and phage typed($11.00 each)
- = 33 X $23 =..... $759

Cost of environmental testing:
Drag swabs.180 @ $45 each. $8,100
13 % (23 isolates) serotyped at $12 each..... $ 276

Rodent and other feral animal sample culture..58 @ $30each..... .... $1740
Group D *Salmonella* was serotyped ($12 each) and phage typed ($11 each)
12 isolates @$ 23= 12X23= ..... $ 276

Feed Samples. 7 @ $30 each $210
One isolate of *Salmonella* serotyped @ $12 .....$12

Tank Water samples 8 @ 30 each.....$240
Cost of serotyping 6 isolates ($12 each) $72

Cost of testing eggs
85,360 eggs, pool of 20 eggs
4268 pools @ $17 per pool
4268X $17=..... ... $72,556
Cost of serotyping and phage typing=$23 each
58 group D *Salmonella* isolates =$23 X 58.....$1,334

Cost of testing Moore swabs (creek water) for *Salmonella*
40 swabs @$30 each. $1200.....$1,200
68 *Salmonella* isolates were serotyped
68 @$12 each $816
Total4 *Salmonella enteritidis* were phage typed
4 @$11 each..... .... $44

Total..... $116,585

Grand Total..... . ..... $2,520,693

Conclusion.

The *S. enteritidis* monitoring cost estimates outlined in this study would pale in to insignificance should the egg industry experience negative consumer confidence like what occurred in Europe in the 1980's. The 1994 Se PT4 outbreak in California caused significant financial loss to a producer and resulted in an estimated additional $5 million loss to the industry due to a short term trade embargo. It has also alerted the California Egg Industry to reinforce the importance of the Se monitoring program. It is imperative for the producer to weigh all the decision making factors whether to divert eggs or not. In this study the producer took a great risk and allowed the sampling process to continue in the hope that eggs would be negative. The loss would have been greatly reduced should he discontinued sampling of eggs and decided to depopulate the flocks.