Controlling pests is key to reducing salmonella infection in the food chain

Salmonella enteritidis is the most common strain of salmonella in our food supply and the most common serotype associated with poultry. The increased prevalence of Salmonella enteritidis in poultry products made it a food safety issue that came to light in the 1970s.

by Richard J. Hack,
RJH Consulting LLC, USA.

Poultry populations, in particular chicken and turkeys, are infected by salmonella via horizontal and vertical transmission and frequently without causing any clinical signs at the primary production level.

The presence of pests in poultry is suggested as the main risk factor, by allowing the bacteria to easily colonise the intestinal tract and thereafter table eggs and/or poultry meat for human consumption.

In Europe, it is assumed that the observed reduction in salmonellosis cases (32% between 2008 and 2012) is mainly due to successful control measures (involving surveillance, biosecurity including pest control, and vaccination) implemented in poultry/egg production with a focus on particular serotypes (S. enteritidis, S. typhimurium).

This article discusses the food safety, regulatory, animal welfare and production implications associated with the role that pests play, as carriers of salmonella, in poultry facilities.

Further, it examines the best means of reducing the presence of salmonella in poultry products in order to reduce the infection pressure on the food chain.

Salmonella infection's impact on the food chain

Salmonella can pass through the entire food chain from the animal feed, primary production, and all the way to households or food-service establishments and institutions. In industrialised countries, the main reservoir of salmonella is the intestinal tract of food producing animals, which readily leads to contamination of a diversity of foodstuffs.

Every year almost 1 in 10 people fall ill from salmonella infections. This results in annual productivity losses that equate to many lost worker years because people are too ill to attend work.

Such foodborne diseases can be severe, especially for young children. Diarrhoeal diseases are the most common illnesses resulting from the consumption of unsafe food with 550 million people falling ill each year – this figure includes 220 million children under the age of five.

Regulatory initiatives to control salmonella infections

The European Food Safety Authority (EFSA) was established to protect consumers from Salmonella spp., infections.

An integrated approach to food safety was developed from 'farm to fork'. EFSA plays an important role in protecting consumers from the public health threat by providing

independent scientific support and advice on human health and food safety-related aspects of salmonella. Key actors that support EFSA include EU member states, European Commission, European Parliament, and the European Centre for Disease and Prevention (ECDC). The US Food and Drug Administration has developed 'Guidance for Industry: Prevention of Salmonella enteritidis in Shell Eggs during Production, Transport-ation, and Storage; Small Entity Compliance Guide.'

Other countries have developed similar documents to reduce the incidence of salmonella in the food chain.

The role of poultry pests as vectors for transmission

The following pests, associated with poultry production, are known to carry and transmit salmonella within the flock and to consecutive flocks:

- Darkling Beetles or Lesser Mealworm are pests in broiler and turkey houses.
- Poultry Red Mites are pests in layers and breeder houses.

Continued on page 13

Table 1. Common pest infestations of poultry layer, breeder and broiler facilities.

Pest	Production affected	Impact	Identify
Darkling Beetles	Broiler and turkey houses	Salmonella disease transmission via contact, feed contamination and ingestion; damage to building infrastructure and bird performance loss (30g in weight gain, and four points in FCR in broilers)	
Poultry Red Mites	Layer and breeder houses	Salmonella disease transmission via contact blood meal; negative impact on overall health status (increase in mortality from 5% to 52%), production (causing a reduction in table egg production of 20%) and welfare (irritant to birds and workers)	
House Flies	Layer, breeder, broiler and turkey houses	Salmonella disease transmission via contact, feed contamination and ingestion; contamination of feed via contact; poor table egg quality (financial losses due to downgrading); and negative impact on welfare (nuisance stress to poultry and workers)	

Continued from page 11

- House Flies are pests in layer, breeder, broiler and turkey sites.

Transmission to other flocks in different housing, or on different sites, is also possible due to the mobility of pests over land and/or in the air. In addition, pests can be physically transported from farm to farm in vehicles or on workers, their clothing and their equipment.

Pests become disease vectors as they have the ability to obtain and transmit salmonella within the flock.

Transmission of salmonella infection can occur by direct contact with pests residing within the litter that carry the micro-organisms on their exoskeleton. Alternatively, birds may become infected by ingesting pests carrying the pathogen.

In the case of a permanent infestation by darkling beetles and/or poultry red mites the bacteria can persist throughout each of the life cycle stages and still have the ability to transmit the disease. This is what gives these pests the status of 'silent carriers'.

Darkling beetles live in litter where they are exposed to bird faeces that may be infected. These beetles can carry salmonella mechanically on the surface of their exoskeleton or inside their bodies. Salmonella can persist in the adult and larval stages maintaining the ability to colonise broiler flocks.

Transmission to the flock is by ingestion of the beetles by the birds. Salmonella pathogens are readily transmitted among flock mates mechanically and can persist in the flock for at least six weeks.

Salmonella can also persist through pupation, meaning that adult beetles emerging after clean-out and disinfection can re-infect a broiler house.

Mites become carriers of salmonella immediately after infection with 29% and 53%, respectively, for oral route and cuticular contact. The percentage increases over time to 95% and 80%, respectively. Transovarial passage as well as transtadial passage is observed. Previously infected mites are able to contaminate blood during a blood meal.

Poultry red mite may act as a biological vector under experimental conditions. It may represent a suitable environment for the development of salmonella and could be an additional factor for the persistence of salmonellosis between flocks.

House flies can carry the Salmonella spp., on their hairs but transmission occurs when the birds eat the flies. It is common knowledge that house flies are carriers of disease. When hens were challenged with salmonella for three days, and flies exposed to the hens, the bacteria were detected in, and on, 45-50% of the flies within the first 48 hours.

The levels of flies infected remained at 50% or higher for the following five days. Hens exposed to newly infected flies did not cause the birds to become infected, however eating the infected flies did. Minimal bacterial contamination of the bird's crop was observed, but intestinal colonisation occurred in about 38% of the birds by days six and 13.

Impact of pests on poultry production performance

Studies have established, and quantified, the negative impact of poultry-related pest infestations on the productivity of poultry production performance:

- **Beetles:**

A three-year study in Georgia demonstrated that good Darkling Beetle control resulted in increased bird weight and improved feed conversion when compared to marginal beetle control. This study demonstrated a 0.03kg improvement in weight gain and a four-point improvement in feed conversion.

- **Red mites:**

Parasitism by the red mites showed a reduction in egg production by 10% and an increase in bird mortality from 1% to 4%. In an additional study, egg production was reduced from 95% to 75% and bird mortality increased from 5% to 52%. Economic effects of red mites include reduced growth rates, reduced egg production, and reduced egg quality (poor shell integrity and blood staining of the shell's surface).

- **House flies:**

Large numbers of flies can negatively impact poultry farm operations including: some loss of poultry production, increased biosecurity risk, uncomfortable work environment, increased time and cost for fly control, damage to equipment, extra cleaning costs between flocks to remove fly excrement from equipment and building surfaces.

Flies, by defecation and regurgitation, cause spotting on the structure and equipment, on light fixtures (reducing illumination levels), and on eggs (presenting potential for transmission of pathogens into the freshly laid egg).

Egg producers with persistent fly infestations resulting in poor quality eggs may find that their accreditation to various food quality schemes are suspended, or that customers such as supermarkets decide to terminate their commercial agreements. Clearly, consumers have adverse reactions to dirty eggs.

Animal welfare issues

Large populations of Darkling Beetles will cause birds to be restless as they feel beetles moving in the litter under their feet.

Consequently, birds bunch together in areas where beetle populations are lower which is away from the feeders and drinkers. This is not optimal for bird health and growth performance. Additionally, in dry litter, beetles will seek moisture from the birds and this causes scarring. When feeding, red mites cause irritation and unrest to the birds. Farm workers, maintaining poultry operations affected by red mite infestations, will also experience discomfort caused by skin irritation, while allergic reactions to red mites are not uncommon. House flies are a nuisance to workers and reduce their productivity. On farms where flies are present, farm staff is constantly distracted by trying to reduce the annoyance (swatting).

Pest and infection control practices

The poultry industry needs to dedicate efforts on implementing a holistic approach to control pests in primary production (pre-harvest) based on general and specific interventions. This builds a foundation on which to reduce bacterial infection pressure at farm level:

- **General prophylaxis:** (biosecurity, rodent and pest control, cleaning and disinfection). To reduce the infection pressure and prevent salmonella from entering the farm/animal house.
- **Specific prophylaxis:** (vaccination; diagnostic and monitoring; nutritional management). To build bird immunity and to prevent dissemination of salmonella to susceptible birds.

Flock interventions include immunisation with vaccines using the recommended protocol and tactical medication with antibiotics in those countries where this is allowed.

Due to antibiotic resistance, selection of the right drug class, effective against present salmonella strains, is key to a successful treatment.

Biosecurity includes protecting the facility from salmonella entering, and dealing with salmonella if it is present:

- Disinfect all footwear, vehicles and equipment when entering and leaving a facility.
- Observe clean clothing protocols when entering and leaving the site.
- Eliminate or maintain low pest population numbers (including beetles, flies, mites and rodents).
- Use effective, proven pest control products according to label instructions.
- Pest eradication is not a realistic long-term goal, so pest management to acceptable levels is the best achievable objective. ■

Key points

- Salmonella is a foodborne pathogen directly linked to poultry production more than other food animal species.
- Out of the >2,600 existing serovars, only a few are highly relevant for the poultry industry with S. enteritidis and S. typhimurium being the most prevalent serovars of public health importance.
- Pests (beetles, flies, mites) have the ability to carry and transmit salmonella within a flock, or to other flocks, due to their ability to maintain viable salmonella for periods of time including within the different pest life cycle stages.
- Besides acting as vectors for salmonella, pests also have a direct impact on flock productivity.
- Pests also affect poultry industry animal welfare as they can cause unrest, blood depletion, nuisance to workers, and irritation to birds and farm workers.
- Regulatory guidelines enable a robust framework to systematically tackle salmonella infection throughout the food chain i.e. 'Farm to Fork'.
- General prophylaxis (for example biosecurity and systematic pest control) and specific interventions (vaccination using the recommended scheme) are crucial to reduce the load of bacteria that enter the food chain.

References are available from the author on request

For further information about the integrated approach for salmonella control please visit: www.salmonella360.com