

Salmonella Control in Integrated Broiler Complexes: Practical Perspectives

► *Salmonella* is one of the leading causes of foodborne illness in the United States, often linked to poultry products because the bacteria can colonize chickens without symptoms and spread during processing. Control requires a multihurdle approach across the production chain: strict farm biosecurity, use of feed additives such as probiotics and organic acids, litter treatments, and vaccination; thorough cleaning and disinfection in hatcheries and transport; and HACCP-based interventions in processing plants, including logistic slaughter, rapid chilling, and antimicrobial treatments. No single measure is sufficient, and combined strategies and consumer education on safe food handling are essential to reduce *Salmonella* contamination and illness.

Why Does *Salmonella* Matter?

Salmonella is a leading foodborne pathogen in terms of hospitalizations and deaths in the United States. While there are more than 2,500 different *Salmonella* serovars, the most common are *Salmonella* Enteritidis, *Salmonella* Typhimurium, and *Salmonella* Newport, which account for a high number of foodborne Salmonellosis in humans.

These foodborne infections are usually self-limiting and often require no antibiotic therapy. However, in young children, older adults, and patients with compromised immune status, the infections may require antibiotic therapy and could even be lethal. Unfortunately, these foodborne Salmonellosis infections are linked to contaminated poultry and meat products more than 23 percent of the time.

One of the challenges is that non-typhoidal *Salmonella* is a commensal of chickens, meaning it thrives in the chicken's intestinal tract and can multiply up to 10,000,000 cells per gram of feces without producing any visible signs of illness in infected birds. When these contaminated birds are slaughtered and processed, there is a risk of contamination on the final raw carcass and a possibility of cross-contamination into ready-to-eat food products. It has been reported that between 100,000 and 1,000,000 *Salmonella* cells can cause foodborne illness in healthy adults. However, this number is reduced in young children, older adults, and immunocompromised individuals. Therefore, the US Department of Agriculture Food Safety Inspection Service (USDA FSIS) performs routine screening for *Salmonella* in commercial poultry processing and categorizes the raw chicken products (whole carcass, parts, and ground chicken) into different categories 1, 2, and 3, with category 1 being the best performer in controlling *Salmonella*.

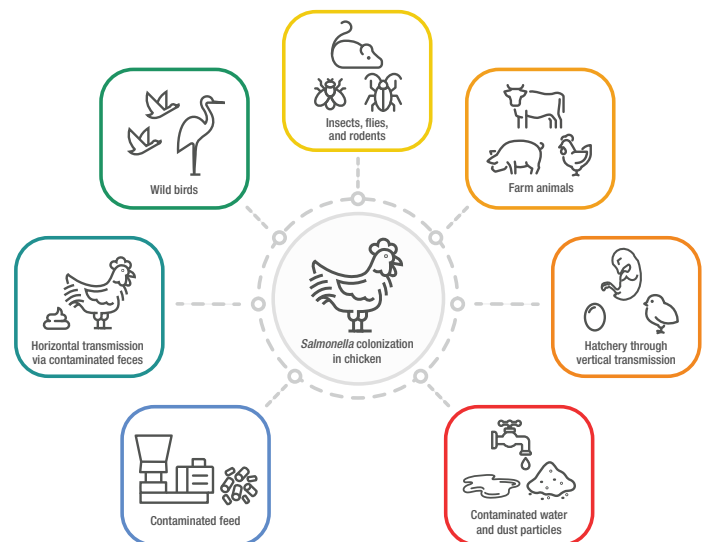


Figure 1. Possible sources of *Salmonella* contamination in broiler chicken farms

Where Does *Salmonella* Come from in Broiler Chicken Farms?

Salmonella is commonly present in the intestinal tract of domestic and wild animals, including birds. It can also survive under environmental conditions inside and outside chicken houses and facilities. It can be introduced or reintroduced into broiler chicken flocks from many sources and can remain persistent in a broiler chicken production environment even after cleaning and disinfection. As shown in figure 1, contaminated feed and drinking water, crawling insects, rodents, wild birds and animals, contaminated equipment and personnel, dust particles, contaminated chicks from hatcheries, or contaminated fertilized eggs from breeder farms are considered common reservoirs of *Salmonella*. In modern poultry production systems, the pelleting process in feed mills and the use of water sanitizers have significantly decreased the entry of *Salmonella* to broiler chicken farms through these routes.

However, other sources can potentially transmit bacteria from both the outside and the inside environments of chicken houses into the birds. Once the birds are infected, *Salmonella* colonize and multiply in the intestinal tract, particularly in the ceca. Infected birds usually remain asymptomatic but can shed large numbers of bacterial cells into the outside environment in the chicken houses. *Salmonella* is transmitted to healthy birds through the fecal-oral route, thereby increasing the percentage of positive birds in the broiler flocks. Moreover, contamination can further increase during transport and processing in commercial slaughterhouses. Two *Salmonella* surveillance studies at Auburn University showed that there are multiple entry points for *Salmonella* along the broiler chicken production systems. The DNA analyzed in these studies showed that the transmission of the same *Salmonella* strain between the environment around live poultry farms and facilities can ultimately contaminate the final product in poultry slaughterhouses. Therefore, it is crucial to continue developing and using strategies to reduce or eliminate *Salmonella* in and around broiler chicken flocks to reduce contamination of the final raw chicken products.

What Control Strategies Can Be Adapted on the Farm?

Biosecurity is one of the most cost-effective and practical ways to prevent *Salmonella* and many other harmful organisms from entering the chicken house. These include restricting visitor access, using footbaths, eliminating vegetation around buildings (using rocks instead), ensuring easily washable and disinfected building surfaces, implementing effective rodent and insect control programs, following all-in-all-out principles, and introducing *Salmonella*-free birds from hatcheries. Other good practices include having proper fencing around poultry houses, keeping a visitor logbook, having a changing room with a shower, and routinely monitoring for *Salmonella* throughout the total production chain. These are some of the major biosecurity measures that can be applied as interventions to reduce *Salmonella* from entering the chicken house (figure 2). Ensuring adequate sanitary practices and restricting unnecessary personnel visits to broiler chicken farms are crucial to avoiding the entry and re-entry of *Salmonella*. Cleaning of spilled feed in and around the chicken house will prevent rodents, wild birds, and insects from potentially introducing *Salmonella* to the flock. Consistent and

accurate use of disinfectants, proper hardness and temperature of cleaning water, and proper cleaning of the poultry house environment before disinfection will prevent biofilm formation by bacteria, thereby reducing *Salmonella* in the next broiler chicken flock.



Figure 2. Intervention strategies against *Salmonella* on the farm

Feed prebiotics, probiotics, postbiotics, phytobiotics, and synbiotics in the form of feed additives or supplements have been shown to help minimize *Salmonella* bacteria in the chicken intestinal tract by improving the competition with beneficial bacteria. In addition, the use of nanoparticles and bacteriophages, viruses that infect and destroy bacteria such as *Salmonella*, has been investigated for its potential to reduce *Salmonella* in poultry production. Similarly, organic acids in drinking water and feed have been shown to increase crop acidity, thereby reducing *Salmonella* levels. Appropriate poultry litter treatment, such as windrow composting studies conducted at Auburn University, demonstrated impressive results in destroying *Salmonella* and other pathogens.

Another control method for *Salmonella* is vaccination. *Salmonella* vaccines are commercially available for use in breeder flocks and for young broiler chickens. Furthermore, studies have been conducted to increase the effectiveness of available vaccines and provide a wider range of cross-protection against different *Salmonella* bacterial types.

What Control Strategies Can Be Adapted in the Hatchery, Transport, and Processing Facilities?

The use of cleaned and sanitized chick baskets is essential for the transport of *Salmonella*-free day-old chicks from the hatchery to grow-out broiler chicken houses. In the hatchery, cleaning and disinfecting different compartments, equipment, and chick baskets with appropriate agents is necessary to reduce or eliminate the bacterial load. This is because *Salmonella* can be vertically transmitted from parent flocks to the grow-out broiler birds via contaminated fertilized eggs. Eggs from *Salmonella*-colonized parent flocks can also introduce this bacterium to the hatchery environments, which has been shown to lead to *Salmonella* contamination in broiler chicken grow-out farms.

During harvest of market-age broiler chickens, the presence of *Salmonella* could be further increased during transport and slaughter due to cross-contamination. A meta-analysis of 10 surveillance

studies of *Salmonella* conducted in the United States showed that transportation of birds to the processing plant had the highest *Salmonella* recovery rate (62 percent) among the production and processing stages of integrated broiler complexes. Effective cleaning and sanitizing of transport cages after each load would help reduce *Salmonella* levels present during transport. Researchers at the University of Maryland reported effective elimination of *Salmonella* biofilms from transport containers using disinfectants like bleach (0.05% vol/vol) and hydrogen peroxide (1% wt/vol). Similarly, researchers at Auburn University have demonstrated that pressurized steam followed by forced hot air reduced *Salmonella* transfer to broiler chickens compared with uncleaned coops. If possible, it is beneficial to hold the empty trailers or transport coops under the sunlight to allow them to dry and limit the use of trailers or transport cages to one specific broiler farms each day (figure 3).

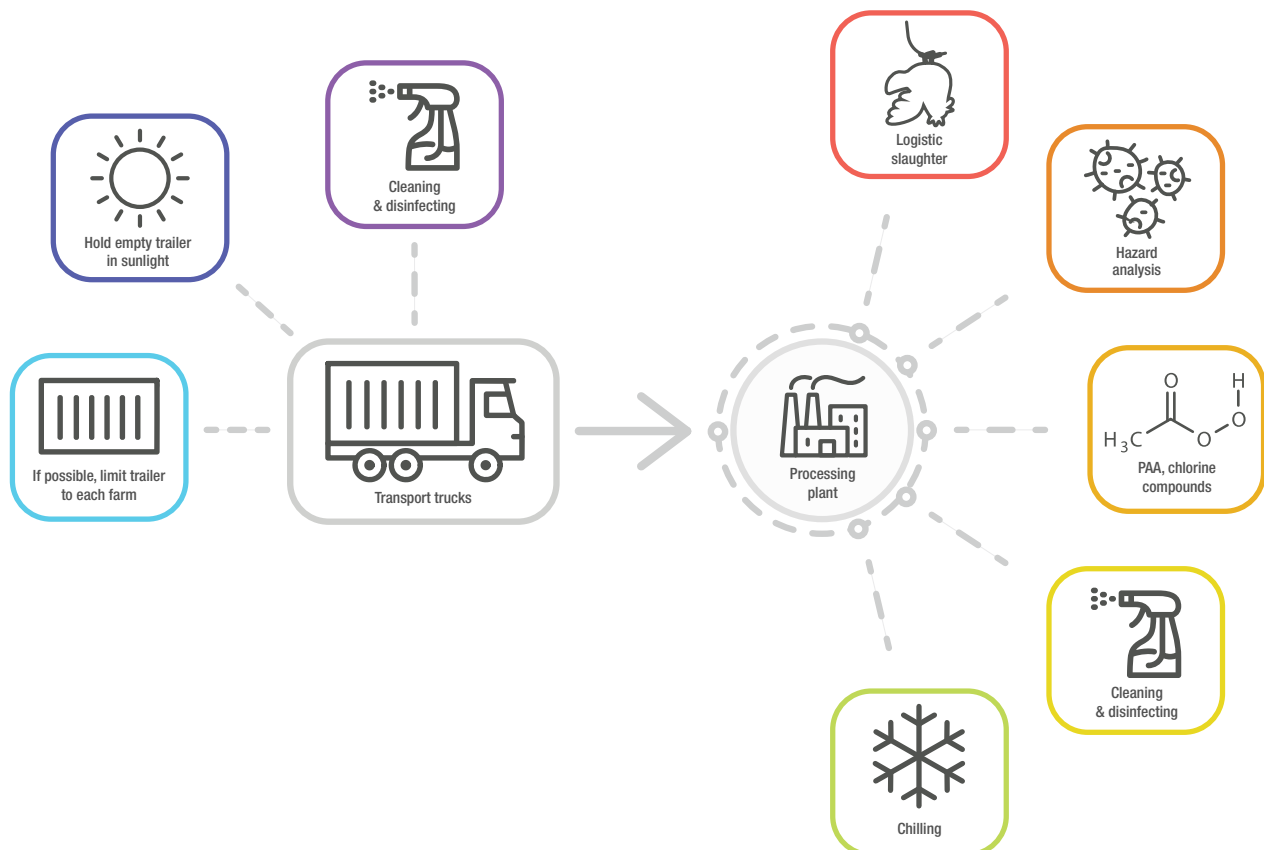


Figure 3. Intervention strategies at transport and poultry processing facilities

In the processing plant, broiler chicken flocks known to be *Salmonella* negative can be slaughtered first, followed by those *Salmonella*-positive flocks (known as logistic slaughter). Efforts should focus on reducing stress in birds and minimizing fecal contamination during live bird transportation, slaughter, and processing. Adequate feed withdrawal duration (8 to 12 hours), appropriate bird density during catching, use of dark-blue light while hanging live birds on shackles, and humane slaughter of birds are some of the efforts to reduce stress in finished birds before processing. A Hazard Analysis and Critical Control Points (HACCP) based approach is applied in commercial poultry processing facilities to control processes and ensure the production of a wholesome product. This approach helps identify potential hazards and determine critical control points that can prevent or reduce *Salmonella* contamination during the processing of broiler chickens. Quickly reducing the meat temperature to refrigerated conditions helps slow the growth of any bacteria present. Different levels of peracetic acid are commonly used in carcass chillers to reduce potential *Salmonella* contamination effectively. The use of ozone nanobubbles and different combinations or concentrations of essential oils or organic acids has also been researched for their application in poultry meat products.

Currently, there is no single intervention strategy that will control *Salmonella* in raw poultry. However, it is important to identify the critical entry points and transmission patterns across various stages, including parent pullet and breeder farms, broiler farms, hatcheries, transport, and processing plants. Once the critical points and transmission patterns are identified, intervention strategies against *Salmonella* can be targeted to those points with the greatest impact. A multihurdle approach that includes strict biosecurity measures, best management practices, the use of probiotics, prebiotics, or feed supplements, and vaccination is a useful tool for *Salmonella* control. For public health concerns, properly cooking food, washing hands frequently, avoiding cross-contamination with other food items, proper refrigeration, and consumer awareness and food safety training for food handlers are major preventive measures suggested by USDA FSIS to reduce the incidence of *Salmonella* infections.

References

- Adhikari, Y., Bailey, M.A., Kitchens, S., Gaonkar, P., Munoz, L.R., Price, S.B., Bourassa, D.V., Huber, L., Buhr, R.J., Macklin, K.S., 2025. Whole-genome sequencing and phylogenetic analysis of *Salmonella* isolated from pullets through final raw product in the processing plant of a conventional broiler complex: a longitudinal study. *Microbiol. Spectr.* 13 (2): e02090-24.
- Adhikari, Y., Bailey, M.A., Krehling, J.T., Kitchens, S., Gaonkar, P., Munoz, L.R., Escobar, C., Buhr, R.J., Huber, L., Price, S.B., Bourassa, D.V., Macklin, K.S., 2024. Assessment and genomic analysis of *Salmonella* and *Campylobacter* from different stages of an integrated no-antibiotics-ever (NAE) broiler complex: a longitudinal study. *Poult. Sci.* 104212.
- Interagency Food Safety Analytics Collaboration (IFSAC). 2022. Foodborne illness source attribution estimates for 2015 for *Salmonella*, *Escherichia coli* O157, *Listeria monocytogenes*, and *Campylobacter* using multi-year outbreak surveillance data, United States. Accessed October 2025.
- Macklin, K.S., Hess, J.B., Bilgili, S.F., 2008. In-house windrow composting and its effects on foodborne pathogens. *J. Appl. Poult. Res.* 17(1): 121-127.
- Crabb, H. K., Allen, J.L., Devlin, J.M., Firestone, S.M., Wilks, C.R., Gilkerson, J.R., 2018. *Salmonella* spp. transmission in a vertically integrated poultry operation: Clustering and diversity analysis using phenotyping (serotyping, phage typing) and genotyping (MLVA). (ADS Sant'Ana, Ed.). *PLOS ONE* 13(7): e0201031.
- Ramesh, N., Joseph, S.W., Carr, L.E., Douglass, L.W., Wheaton, F.W. (2002). Evaluation of chemical disinfectants for the elimination of *Salmonella* biofilms from poultry transport containers. *Poult. Sci.* 81(6): 904-910.
- Reina, M., Urrutia, A., Figueroa, J.C., Riggs, M.R., Macklin, K.S., Buhr, R.J., Price, S.B., Bourassa, D.V., 2024. Application of pressurized steam and forced hot air for cleaning broiler transport container flooring. *Poult. Sci.* 103: 103276.



Yagya Adhikari, Postdoctoral Fellow; **Dianna Bourassa**, *Extension Specialist*, Associate Professor; and **Kenneth Macklin**, Emeritus Professor, all in Poultry Science, Auburn University

For more information, contact your county Extension office. Visit www.aces.edu/directory. Trade and brand names used in this publication are given for information purposes only. No guarantee, endorsement, or discrimination among comparable products is intended or implied by the Alabama Cooperative Extension System.

In accordance with Federal law and U.S. Department of Agriculture (USDA) civil rights regulations and policies, this institution is prohibited from discriminating because of race, color, national origin, sex (including gender identity and sexual orientation), age, disability, and reprisal or retaliation for prior civil rights activity. Program information may be made available in languages other than English. Persons with disabilities who require alternative means of communication for program information (e.g., Braille, large print, audiotape, and American Sign Language) should contact the Alabama Cooperative Extension System Human Resources Department at (334) 844-5531 or the State of Alabama Governor's Office on Disability (GOOD) at (888) 879-3582 or USDA's TARGET Center at (202) 720-2600 (voice and TTY) or contact USDA through the Federal Relay Service at (800) 877-8339. To file a program discrimination complaint, a complainant should complete a Form AD-3027, USDA Program Discrimination Complaint Form, which can be obtained online at <https://www.usda.gov/oascr/how-to-file-a-program-discrimination-complaint>, from any USDA office, by calling (866) 632-9992, or by writing a letter addressed to USDA. The letter must contain the complainant's name, address, telephone number, and a written description of the alleged discriminatory action in sufficient detail to inform the Assistant Secretary for Civil Rights (ASCR) about the nature and date of an alleged civil rights violation. The completed AD-3027 form or letter must be submitted to USDA by mail: U.S. Department of Agriculture Office of the Assistant Secretary for Civil Rights, 1400 Independence Avenue, SW, Washington, D.C. 20250-9410; Fax: (833) 256-1665 or (202) 690-7442; or Email: program.intake@usda.gov.

New April 2026, ANR-3232 © 2026 by the Alabama Cooperative Extension System. All rights reserved.