Master of Public Health

Integrative Learning Experience Report

SALMONELLA INTERVENTION STRATEGIES IN THE POULTRY INDUSTRY: A COMPARISON OF THE UNITED STATES AND THE EUROPEAN UNION

by

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Abstract

This Applied Practical Experience (APE) delved into *Salmonella* and global policies and regulations for its management in food systems. The field experience took place at the United States Department of Agriculture (USDA) Food Safety and Inspection Service (FSIS). This report begins with a brief overview of *Salmonella* and its public health impact in the United States (US) and European Union (EU), including their financial burden per year. The differences in the US's and the EU's *Salmonella* reduction strategies in the poultry industry are compared and contrasted. The purpose of this APE was to gain knowledge of the global *Salmonella* regulations, in the US and the EU, as well as their prevention and intervention strategies. Additional experiential learning took place through participation in the international MObility of VEterinary Students and Food Biotechnologists (iMOVES&FB) program. This opportunity took place in Padova, Italy and increased the investigator's knowledge and experience in public health, food safety, and animal welfare in the context of the seafood and poultry industries. A fish processing facility was toured, exploring how they make Ready-to-Cook and Ready-to-Eat fish products. The investigator visited a chicken farm, and performed a poultry necropsy. Comparisons were drawn from the investigator's own experiences in similar production facilities in the United States, furthering the knowledge of EU *Salmonella* prevention strategies. The investigator created an oral presentation to educate USDA inspectors, students, and stakeholders on the USDA's *Salmonella* Performance Standards on Raw Poultry Products. The investigator produced an infographic fact sheet depicting the similarities and differences between the US and EU's *Salmonella* prevention and intervention strategies, and the impact on their public health. The work of this APE is significant due to the public health importance of *Salmonella*. Salmonellosis is the second highest cause of foodborne illness in both the United States and European Union. By learning about international approaches to *Salmonella* reduction, food safety professionals can understand the limitations of current strategies, analyze future research opportunities, and ensure regulations are effective in the hopes of mitigating the public health impact of this pathogen.

Subject Keywords: *Salmonella*, United States, European Union, performance standards, regulations, comparison, intervention strategies, poultry industry

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Chapter 1: Literature Review

1.1 Background: Overview of *Salmonella* in the United States and the European Union

Theobald Smith discovered *Salmonella* in 1885. However, the bacterium was named after Daniel Salmon, a veterinarian and the project's lead researcher. *Salmonella* is a gram-negative bacterium and is a facultative anaerobe; meaning it is highly adaptable regardless of its environment's oxygen content. *Salmonella* commonly populates the digestive systems of livestock and poultry. People become infected via the fecal-oral route. First, *Salmonella*-positive feces contaminates a food product. Then, a person consumes that contaminated food and they contract salmonellosis (Russell, 2012). The symptoms can start within six hours after ingestion; however, sometimes it can take up to six days (CDC, 2024). They include diarrhea, fever, and abdominal cramps. Most of the time, people get better on their own without treatment but, severe cases of salmonellosis can lead to hospitalizations and death. Individuals most at-risk for severe complications are young children, the elderly, pregnant women, and the immunocompromised. *Salmonella* can also cause people to experience joint pain and develop Reiter's syndrome, leading to arthritis (Russell, 2012).

Salmonella is the second leading cause of foodborne illness in the United States (US) and the European Union (EU), with poultry products being one of the most likely food sources (FDA, 2023; Koutsoumanis et al., 2019). An estimated 1.35 million cases of salmonellosis occur each year in the US, causing 26,500 hospitalizations and 420 deaths (CDC, 2024). Salmonellosis, just like any disease, has a social and economic cost. Lost wages from missing work, the cost of doctor's visits, and medical treatment expenses all add up. These costs become even greater when researchers total them across a nation or continent. In the US, the financial burden of *Salmonella* in 2023 was $17 billion (USDA-ERS, 2026). The EU on the other hand, has a smaller financial burden. The European Food Safety Authority (EFSA) estimates that there are over 91,000 cases of salmonellosis in the EU, costing as much as €3 billion each year (Koutsoumanis et al., 2019). The widespread and detrimental impact of *Salmonella* puts the disease and bacteria on the forefront of public health and food safety officials' minds and priorities.

1.2 Motivation: *Salmonella* Interventions in the Global Poultry Industry

In addition to the cost of human care and treatment, there is also a cost to the poultry industry for *Salmonella* prevention and elimination measures. These measures differ between the US and EU. The European Union focuses the majority of their efforts on implementing prevention measures prior to slaughter. In contrast, the United States uses more intervention strategies at the slaughter step. It is important to note that both the United States and the European Union vaccinate their poultry flocks. The target serotypes are different, so they each have to synthesize specific vaccines for their region. Therefore, a vaccine made for the US would not be as effective in European flocks (Russell, 2012).

In 1996, the United States Department of Agriculture (USDA) mandated that all meat and poultry establishments create and utilize a Hazard Analysis and Critical Control Points (HACCP) Plan (USDA-FSIS, 2026a, 2026b). This tool is available for slaughter and processing facilities to analyze every step of their process, then identify and control for all hazards that may occur. These hazards may be physical, chemical, or (in the case of *Salmonella*) biological. The USDA also constructed the *Salmonella* Performance Standards for Raw Poultry Products. These standards place establishments into three categories based on the total number of positive sample results and positive percentage rate of the total samples they have taken in a 52-week moving window. There are maximum allowable limits per each category and consequences for going into category three (USDA-FSIS, 2026a, 2026b). The primary intervention strategy for *Salmonella* in the United States is the use of chemicals during the slaughter and further processing steps. Facilities apply chemicals like peracetic acid (PAA) in key places within the process to maximize *Salmonella* reduction. Common locations for this to occur include after evisceration (gutting), after the water chiller, and prior to injection or marination in the further processing of retail products. Another intervention strategy the US uses is a zero tolerance for fecal material on poultry carcasses (USDA, 2023); if inspectors find a bird with fecal material, they document a regulatory noncompliance. The bird will undergo a chemical wash to remove the feces and any bacterial contamination. After that, USDA reinspects the bird. Once the bird passes inspection, it reenters the food supply.

The European Union also employs HACCP Plans in their food industry, although they were not mandated until 2004 (*The Origin and Evolution of HACCP*, 2025). Additionally, the EU has banned the use of chemical interventions. Therefore, they focus more on strategies that

take place in the steps before the bird goes to slaughter. One noteworthy strategy is to test an entire flock for *Salmonella*. If the flock tests positive, poultry producers cull or destroy all the birds in the positive flock. This practice is not feasible in the United States due to our larger flock numbers. The city of Athens, Georgia produces twice as many chickens than the whole country of Sweden (Russell, 2012). However, the practice of culling *Salmonella*-positive flocks is widespread in many European countries, including Italy. Another strategy is competitive exclusion. If producers find an adult bird to be free of *Salmonella,* it is assumed that they have something in their gut flora preventing *Salmonella* from colonizing. The animal is killed; after slaughter, producers remove the lining of their intestines to scrape into a container. Researchers culture the intestinal lining scrapings to create a large enough colony to be sprayed onto baby chicks. The goal of this strategy is to introduce good bacteria to the young chicks to lessen the chances of them becoming infected with *Salmonella*. Again, this practice cannot take place in the US. The Food and Drug Administration (FDA) requires researchers to identify all bacteria they use on chicks as nonpathogenic. Currently, researchers have not yet isolated or identified the good bacteria used in competitive exclusion (Russell, 2012).

1.3 Purpose of this Food Safety Public Health Project

The food supply chain grows increasingly more global each year. This project, pursued in the context of USDA-FSIS, and its added experiential learning, with the iMOVES&FB program, sought to gain knowledge that can be used to bridge the gap between the United States and the European Union. Both the United States and the European Union treat *Salmonella* as a significant foodborne pathogen. However, their perspective on how to strategically regulate the bacterium differs. Currently the US views *Salmonella* as a food safety concern; when present, the USDA FSIS typically takes some kind of sampling or regulatory action (depending on the severity of the contamination level). Thus, the US actively monitors and enforces *Salmonella* Performance Standards. In contrast, the EU monitors *Salmonella* as a way to monitor sanitation in the poultry industry; the EU views *Salmonella's* presence as an indication of the degree of sanitation (Russell, 2012). In the EU's thought process, a poultry establishment that supports good sanitation practices should have a lower level of *Salmonella* than an establishment with poor sanitation practices. Doing a deep dive into EU-US similarities and differences within the poultry industry was just the first step. Most of the poultry production operations are in the

southeastern US in places like Alabama, Georgia, Mississippi, and Louisiana. In Europe, they are located primarily in Poland, France, Spain, and Italy (Koutsoumanis et al., 2019). There is practical value in understanding the intricacies of both production systems; this includes their benefits and drawbacks, their successes and their failures.

These differences stem from perceived public risk and other public perceptions. Both the United States and the European Union deal with thousands of salmonellosis cases every year. Therefore, public health and food safety officials put in a lot of time, effort, and resources into reducing case numbers. Public concern over these issues rises and falls with every outbreak. Scientific research into *Salmonella* prevention and intervention strategies advances each year through improvements in vaccine development, faster and more accurate sampling and testing methods, and genomic and virulence studies. (USDA-FSIS, 2026a, 2026b). Even though our production processes are different, that does not necessarily mean new research cannot be beneficial on both sides of the Atlantic Ocean. If we can move past our differing perspectives and *Salmonella* reduction strategies, we can move forward by not only reducing the incidence of *Salmonella* in poultry and humans, but maybe we can also safely increase the global trade of poultry products.

Figures 1 and 2 below depict *Salmonella* infections within the United States and the European Union between the years 2013 and 2023. The graph for the United States (Figure 1) shows the incidence rate per 100,000 people. Incidence rates are a standard public health measure that is commonly used to illustrate disease numbers in large populations for a specific time period. In contrast, the graph for the European Union (Figure 2) uses total case numbers. This measure is basic quantitative data. It is easier to compare disease outbreaks between different populations using incidence rates, because it is a standardized measure. Although these two graphs use different measurements, the overall shifts and trends are the same.

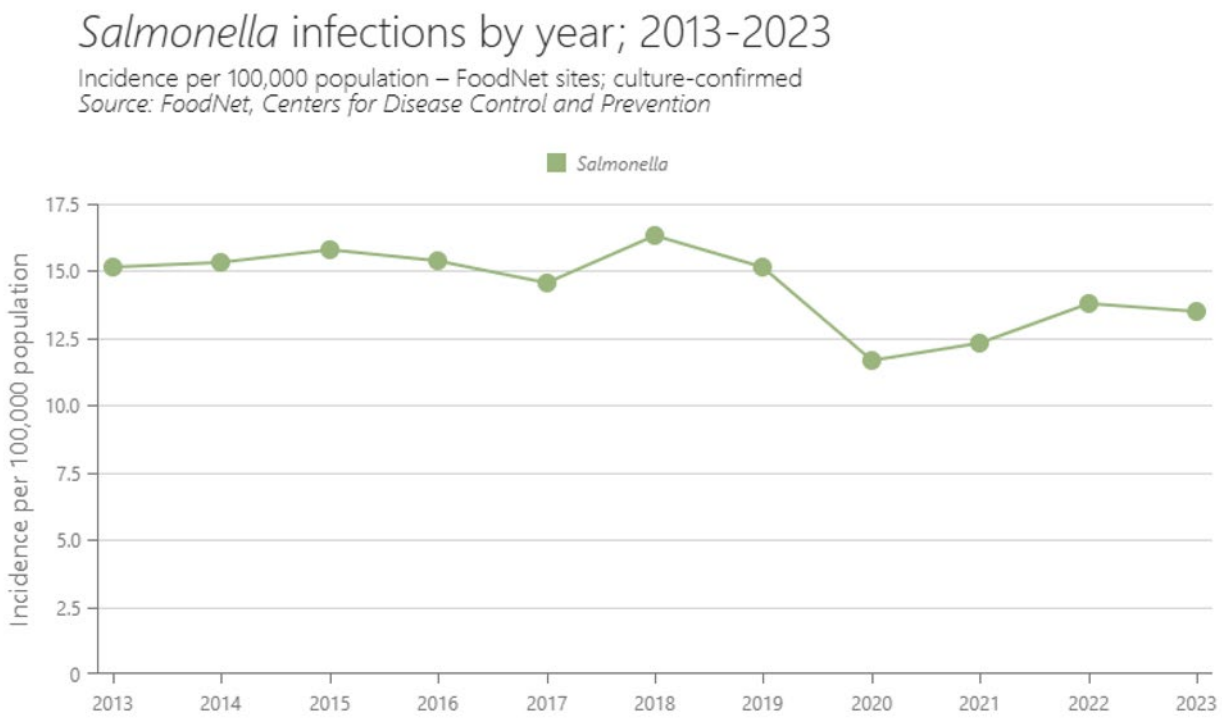


Figure 1: United States Salmonella Infections (2013-2023)

SOURCE: CDC. (2018, October 14). *Salmonella* Surveillance. CDC. Centers for Disease Control and Prevention. https://www.cdc.gov/FoodNetFast

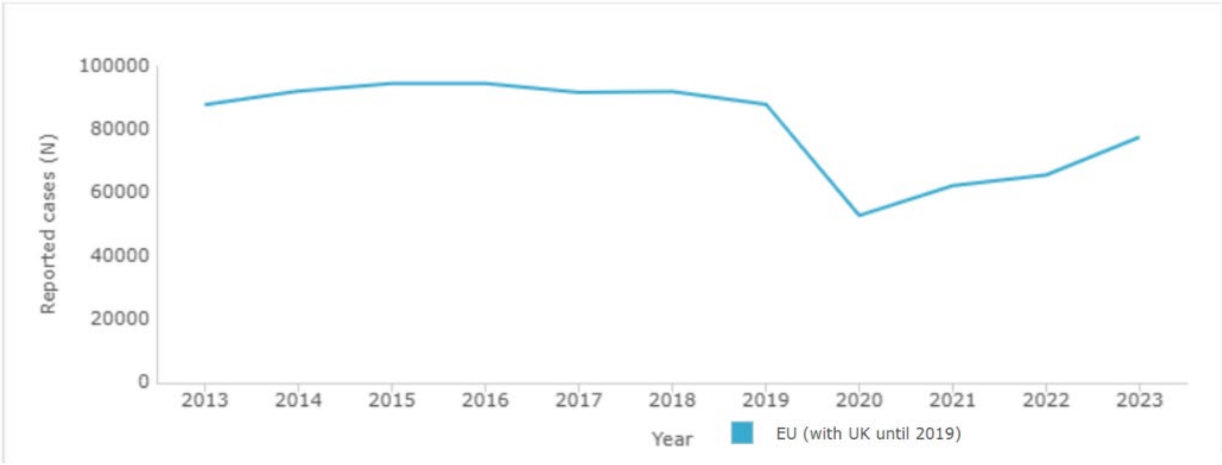


Figure 2: European Union Salmonella Infections (2013-2023)

SOURCE: European Centre for Disease Prevention and Control. (n.d.). Surveillance Atlas of Infectious Diseases. Retrieved July 10, 2026, from https://atlas.ecdc.europa.eu/public/index.aspx?Dataset=27&HealthTopic=46

1.4 Location, Preceptor, and Analytical Questions

The investigator completed the Applied Practical Experience (APE) at the United States Department of Agriculture (USDA) Food Safety and Inspection Service (FSIS). The USDA was established in 1862. The department has served over 150 years to keep our national and global food supply safe from farm to table. FSIS is the branch that inspects, regulates, and enforces regulations for all the meat and poultry products within the US. FSIS inspectors and staff monitor *Salmonella* as well as other bacteria and elements of concern, through sampling to ensure the process control of each establishment and the wholesomeness of their products.

The investigator works as an USDA-FSIS employee; however, she completed the APE outside of her work hours. The preceptor for this project is Dr. Christopher Gorencel. He graduated from Louisiana State University, receiving a Doctor of Veterinary Medicine. His career in the USDA spanned eleven years. In his most recent role as a Dallas District's Veterinary Medical Officer, he served as the primary contact for all veterinary duties in the northeast Louisiana area. He helped with questions and situations about food safety, animal welfare, foreign animal diseases, and export certifications. Dr. Gorencel has gone out of his way to help further the investigator's education by always being available for questions and concerns. He has dedicated his working life in civil service to food safety.

Under the guidance of Dr. Gorencel, the investigator pursued three analytical questions. These include the following:

- What challenges do the current *Salmonella* monitoring strategies have?
- When comparing the United States and the European Union, what differences in *Salmonella* prevention and intervention strategies stand out?
- What impact do EU and US regulations have on food safety and public health?

Chapter 2: Learning Objectives and Project Description

2.1 Objectives

The APE and its associated activities were designed to meet five objectives to support the learning of the investigator. These include the following:

- **Objective 1 –** Grow in resourcefulness regarding the information, including publications, available within the USDA-FSIS enterprise.
- **Objective 2 –** Refine public presentation skills.
- **Objective 3 –** Grow in international and global awareness.
- **Objective 4 –** Improve writing skills.
- **Objective 5 –** Acquire new skills in the area of infographics.

2.2 Methods and Project Description

The investigator began the APE with the USDA-FSIS in February of 2026, under the guidance of Dr. Christopher Gorencel. In mid-January Dr. Gorencel and the investigator met with her major professor Dr. Justin Kastner to outline the goals and scope of the research and field experience. They discussed the potential products that the investigator would create. The investigator synthesized information taken from the slides and transcript of a public meeting to learn about the USDA's *Salmonella* Performance Standards. Through this meeting, the investigator acquired a depiction of the 52-week moving window used for *Salmonella* monitoring. The investigator operated the LIMS Direct software and PHIS website to obtain *Salmonella* sample report data. The investigator utilized the creative software on the Canva website to create a new 52-week moving window diagram. The investigator created and delivered a presentation on these standards, including the new 52-week moving window diagram, to educate colleagues and stakeholders. With the aid of Dr. Gorencel, the investigator researched the European Union's poultry industry. The investigator explored their *Salmonella* prevention and intervention strategies as well as policies and regulations for poultry and its products. In June, the investigator joined Dr. Kastner and other students from Kansas State University, Texas A&M University, and the University of Pennsylvania to travel to Padova, Italy. Once there, the investigator met with students from the local university and learned about public health, food safety and biosecurity, as well as animal welfare in relation to the seafood

and poultry industries. Using knowledge gained from the research and experiences abroad the investigator again operated the software of the Canva website to create an infographic fact sheet illustrating the similarities, differences, and public health impact of the United States's and European Union's *Salmonella* reduction strategies. This project has broadened the investigator's awareness of different nation-states' perspectives on public health problems.

Chapter 3: Products and Results

3.1 Applied Practical Experience Products

This APE yielded two products for the advancement in the understanding of *Salmonella* policies and regulations. The investigator prepared and delivered a presentation over the USDA's *Salmonella* Performance Standards for Raw Poultry Products. The second product created was a two-page infographic fact sheet illustrating the similarities, differences, and public health impact of the *Salmonella* regulations and intervention strategies between the United States and the European Union.

Product 1 – USDA *Salmonella* Performance Standards Oral Presentation

To build the presentation (available in Appendix 3), the investigator started by researching publicly available information. The investigator used USDA-FSIS Directive 10,250.2 Performance Standards: *Salmonella* Verification for Raw Poultry Products. She analyzed the regulatory control actions USDA inspectors can take depending on which of the three categories an establishment is in. The investigator reviewed slides and transcripts from the USDA's public meeting about "Exploring Practical Strategies to Reduce *Salmonella* in Poultry Products." This meeting took place in January of 2026 and gave the option for industry stakeholders to be educated on the current practices for *Salmonella* reduction and to provide comments on six main questions. The stakeholders also took the opportunity to voice their concerns about other *Salmonella* related issues, such as the removal of the proposal to make *Salmonella* an adulterant for Not-Ready-To-Eat, Breaded Chicken products. The investigator gathered the most recent information and the material from directives and training manuals to create a presentation on the *Salmonella* Performance Standards. This presentation systematically addressed each individual standard, so they were easily understood. The investigator explained the math behind how the USDA categorizes an establishment. She created two process flow charts that depicted the steps the agency and the industry take when an establishment goes into category two or three. The investigator redesigned a diagram of the 52-week moving window that the USDA uses to organize samples. The USDA's current design is convoluted and very hard to read. The presentation also included *Salmonella* sample information that the USDA publicly posts online. One such posting occurs monthly, where the USDA designates which of

the three *Salmonella* categories applies to each poultry establishment in the nation. It shows how many large, small, or very small plants are in each *Salmonella* category. The presentation concluded with what the USDA and other scientists are currently researching. This includes new sampling and testing methods that may help establishments make business decisions in real time. The investigator delivered the oral presentation to a small group of colleagues, the investigator's major professor, and her preceptor. The investigator answered questions and provided opinions on where she thinks the performance standards' parameters should continue in the future.

Product 2 – United States-European Union Poultry and *Salmonella* Fact Sheet

For the fact sheet (located in Appendix 3), the investigator researched information published by the USDA, FDA, Centers for Disease Control and Prevention (CDC), EFSA, and the European Centre for Disease Prevention and Control (ECDC). She compiled all of this knowledge and organized it into a Venn diagram. The investigator chose to use a Venn diagram because it easily helps the audience visually compare and contrast two different topics. The whole point of a fact sheet is to quickly read information. The investigator supplemented the words inputted into the Venn diagram with images of the agency logos and graphics portraying the important differences. The back or the second page of this fact sheet focused on going into more detail of the key differences between the US and EU poultry regulations and how they pertain to *Salmonella* prevention and intervention strategies. The investigator explained that the United States sees *Salmonella* as a food safety issue and, therefore, has created the *Salmonella* Performance Standards to regulate its levels. In contrast, in the European Union, they only see it as a factor used to monitor the sanitation of an establishment. The fact sheet showed the public health impact that *Salmonella* has on both the US and the EU. The fact sheet lists the five target *Salmonella* serotypes for each regulatory system. These serotypes of concern are used to manufacture vaccines. Each vaccine targets one or more of these *Salmonella* serotypes for both the United States and the European Union. Some of the serotypes overlap, but not all. Therefore, both the US and EU must make their own targeted vaccines that will have the greatest impact on their flocks. The bottom of the fact sheet states how many cases of salmonellosis occur each year in the United States and the European Union and how large their financial burden is. As with the front, the back of the fact sheet features graphics drawing the audience's attention to key details.

3.2 Findings by Analytical Questions

The investigator answered the analytical questions via research and educational experiences. The findings include:

Question 1 - What challenges do the current *Salmonella* monitoring strategies have?

The main challenges of the current *Salmonella* monitoring strategies are the sampling and testing capabilities. The samples taken by USDA inspectors sometimes arrive at the lab on the next day. Sometimes they get there multiple days later. If samples arrive at the lab outside a specific window, the lab will not analyze the sample. Once at the lab, the samples take another one or two days to get tested for *Salmonella*, and the results posted on LIMS Direct. This is the timeline for the governmental agency monitoring *Salmonella* in poultry establishments. When the establishments themselves take samples, it can take up to two weeks to get results. This delay is due to mail carriers, lab capabilities, and lab capacity. Research into new sampling and testing methods may be able to cut down on this period. However, these innovative technologies will most likely be extremely expensive when they first hit the market. Establishments may not be willing to spend the money to make these upgrades.

Question 2 - When comparing the United States and the European Union, what differences in *Salmonella* prevention and intervention strategies stand out?

The differences that most stood out to the investigator were where the *Salmonella* reduction strategies occurred within the production process. The European Union utilizes strategies prior to slaughter, in the hopes of reducing *Salmonella* from entering the slaughter facility and consequently commerce. An example of this type of strategy is destroying all the birds in a *Salmonella*-positive flock. The US's reduction strategies take more of an intervention stance rather than being a preventive measure for *Salmonella*. Slaughterhouses and processing facility in the US apply chemical interventions to reduce *Salmonella* levels. The US has elected to adopt only a few reduction strategies prior to slaughter. Because of this, they must ensure that chemical interventions are effective in order to keep the public safe.

Question 3 - What impact do EU and US regulations have on food safety and public health?

The United States and the European Union both deal with thousands of salmonellosis cases every year. The investigator found that all the strategies researched reduced *Salmonella* levels. The human and poultry population sizes of the US and EU are different. This is just one

reason behind the different *Salmonella* prevention and intervention strategies. It is common practice for European poultry producers to destroy whole flocks that test positive for *Salmonella*. If that took place in the United States, the number of birds killed could be in the hundreds of thousands. This would put a major strain on the US poultry and food industries. To lessen the occurrence of *Salmonella*-positive flocks, both the Unites States and European Union producers use vaccines. Researchers identify target serotypes for both the US and the EU and use this information to create poultry vaccines. These vaccines target the specific Salmonella serotypes of concern. Overall, the US and EU's food safety system and policies are different, but they have the same goal of protecting public health.

Chapter 4: Discussion

4.1 Interpretation of Results of the APE

The investigator was already working in the food industry before deciding to pursue a Master of Public Health. Since that professional decision, she has gained a much deeper understanding and practical knowledge in public health and food safety through her education at Kansas State University and the Applied Practical Experience. *Salmonella* is a serious public health issue worldwide. The investigator found it interesting to research this issue—especially how the United States and the European Union have a different outlook and policies to solve it.

The investigator created an oral presentation (product 1) to educate her colleagues on the USDA's *Salmonella* Performance Standards for Raw Poultry Products. At first glance these standards seem complicated. However, the investigator systematically explained the *Salmonella* categorization process and the consequences of an establishment being in each category. The presentation sought to give inspection staff a clear understanding of the reasoning behind why they perform *Salmonella* samples in their poultry establishments. After viewing the presentation, the inspectors should be able to explain how these results monitor and assess the process control within their establishments.

The investigator created a fact sheet (product 2) that combined all her education, research, and experiences into one document. The investigator designed this fact sheet so that it can be read by anyone regardless of background. From the fact sheet, the audience gain an understanding that the *Salmonella* prevention and intervention strategies are vastly different between the United States and the European Union. This is due to their differing perspectives and regulations on *Salmonella*. The fact sheet shows that regardless of the differences in food safety and policies in the US and the EU, *Salmonella* impacts their population's public health every year.

The significance of doing this APE project was for the investigator to gain an understanding of the global public health impact that *Salmonella* has each year. Millions of people in both the United States and the European Union contract salmonellosis from contaminated food products every year. The annual financial burden of both the US and the EU is in the billions. If we can learn from the successes, failures, and current research into *Salmonella* reduction strategies, we may be able to adapt new approaches that are more effective.

4.2 Limitations of the APE

There were limitations in this APE project. The main limitation was the imbalance between the investigator's overall knowledge of the US's food safety system and policies versus her knowledge of the EU's food safety policies. This was to be expected due to her background and employment within the USDA-FSIS branch. The investigator learned about the USDA's *Salmonella* Performance Standards and presented them. The investigator would have liked to find standards or specific thresholds for *Salmonella* in the European Union's poultry industry that could have been compared in more detail.

4.3 Future Directions for *Salmonella* Control

As stated above, the two products created by the investigator have flexible messages that can be altered for future audiences. In addition to this, the oral presentation (product 1) can be easily presented over Microsoft Teams so that USDA inspectors from poultry facilities in other states and US territories can benefit. The presentation can also be recorded, so that if the investigator or another speaker is unavailable, inspectors and other stakeholders can still learn from this resource. The investigator constructed the fact sheet (product 2) in a format that can be easily dispersed via email or online platforms, as well as printed into pamphlets to hand out, or posters to hang on a wall. Therefore, its future distribution possibilities are endless.

Researchers must conduct more studies before policymakers can change the current strategies for *Salmonella* control and reduction. The USDA, universities, and private research groups are already researching new testing and sampling methods. Researchers from these organizations are studying serotypes of concern in poultry production as well as their prevalence in human salmonellosis cases. In addition to these prevalence studies, research into the virulence of common serotypes is also taking place. Researchers question if the common serotypes that infect people all have the same risk for severe illness. The USDA is also considering modifying the *Salmonella* Performance Standards for small and very small establishments. These modifications could include a smaller window of samples taken. The goal of using a smaller window than 52-week moving window is to more accurately reflect the number of samples taken and analyzed in small and very small plants.

4.4 Noteworthy Coursework and Experiential Learning

During her time at Kansas State University, the investigator took many noteworthy courses in public health and food safety. FDSCI 690 taught the investigator the requirements of writing and maintaining a HACCP plan. She created a HACCP plan as part of a group project. Through this project, the investigator found a new appreciation for those who write and evaluate these plans every day. In FDSCI 730, the investigator learned about food safety and security policies, risk analysis, and crisis management. The class discussed regulations like the Food Safety Modernization Act (FSMA), its requirements and how it improved food safety in the US. The investigator built on this knowledge in FDSCI 731 to study food protection and defense. The course explored instances of food fraud, when food is intentionally contaminated with a lesser quality ingredient or mislabeled. This is especially common in fish species, by labeling a common fish fillet as a more expensive species. This is the reason behind the USDA taking over control, from the FDA, of catfish inspection within the United States. USDA inspectors routinely sample catfish to ensure it is actually catfish. In DMP 816, the investigator received her first glimpse of the global food trade by exploring topics like the World Trade Organization's SPS Agreement. In the MPH 720 and MPH 818 courses, the investigator learned how to synthesize information from a large number of peer-reviewed journal articles into a comprehensive discussion post or report. Finally, in DMP 815 the investigator studied and practiced different forms of communication, both written and oral. Additionally, the course reviewed how to tailor a public health message to specific audiences based on their age, education level, and other factors.

In June, the investigator had the amazing opportunity to spend more than a week with the iMOVES&FB program in Italy exploring their culture and cuisine while learning from Italian veterinarians and professors on public health, food safety, and animal welfare. This trip specifically focused on the seafood and poultry industries. The students learned about different types of seafood parasites, the symptoms of their infections, and how to find the parasites in the muscles and the abdominal cavities of a fish. The European Union has regulations specifically for seafood parasites. It states all fish that will be eaten raw, such as sushi, must be frozen prior to consumption. This task most commonly falls on the food operator. But in fresh fish markets where they cannot freeze their products, labels are required to tell customers to freeze their fish if they want to eat it raw, for their protection. The investigator visited a fish processing facility that

receives fish species exported from around the globe, even from the United States. This facility produces Ready-to-Cook and Ready-to-Eat fish products. The investigator toured their facility, seeing live crustaceans, their warehouse, freezers and coolers, and production floor. It was incredibly interesting to see the similarities and differences in their establishment, when comparing them to the raw and Ready-to-Eat poultry processing facilities that the investigator works in every day. The investigator enjoyed learning from the establishment personnel about their pathogen monitoring programs for their facility environment.

Toward the end of the trip, the investigator traveled to a poultry farm. This facility raises hens for egg production. The birds arrive at one day old and stay for four months. Between batches of chicks, each barn stays empty for twenty-one days for biosecurity purposes. The length of this period is different for other poultry production schemes. For example, if they produce broilers, it would be a shorter period. The barns themselves and the surrounding areas have concrete floors for easy cleaning and sanitation. The facility visited had rodent traps around the barns for pest and *Salmonella* control. If a flock at this farm tests positive for avian influenza, the entire flock will be destroyed, just like flocks that test positive for *Salmonella*. Poultry farmers receive reimbursements for their losses. However, at least in Italy, those funds come out of the national healthcare budget. Every time a vehicle drives on to the property, they drive through upright bars that sanitize their vehicle of biological contaminants. Each employee and visitor must wear plastic booties and full body personal protective equipment (PPE). When employees enter a barn, they use a foot bath to sanitize their feet and the Danish entry system. Under this system, the plastic booties and full body suit are removed entirely and replaced before entering the interior of the barn. This is done as a biosecurity measure to cut down on the possibility of bringing *Salmonella*, avian influenza, or other disease agents into the barn. On the exterior of the barn, they have windows to open in the warmer months. Each window has a net across it to prohibit the entrance of wild birds and other vermin, who may introduce pathogens. At the back of each barn, there are exhaust fans. Walls built next to these fans direct the air flow away from the next barn's entrance. This practice reduces the spread of contaminants as well. The investigator performed a chicken necropsy back in the anatomy lab at the University of Padova. The investigator dissected the entire carcass to try and deduce a theory on its cause of death. The knowledge gained from this trip went beyond public health and food safety. The

investigator made connections with the students from the other universities, building her professional network.

The trip to Padova, Italy broadened the investigator's global awareness into public health and food safety, as well as animal welfare and conservation. She learned about history and cultural factors that went into the creation and adaptation of European Union regulations. The investigator experienced firsthand fish and poultry operations and compared them to the production operations she has worked at in the United States. This was a once-in-a-lifetime opportunity that many people will never have. The investigator asked questions directly to the chicken farmer and veterinarians that go to all the poultry farms in that region of Italy. She capitalized on their knowledge of *Salmonella*, which she used in this APE project; going forward, she will take this knowledge into her career work in the food industry.

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Appendix 1 - Synthesis and/or Integration of Competencies

Table A.1 Synthesis and Integration of Competencies

Competency	**Description of Synthesis and Integration**
Compare Health Systems Across National and International Settings – Foundational Competency # 5	Between February and July, the investigator researched the *Salmonella* regulations for poultry in both the United States and the European Union. The investigator knew quite a bit offhand about the US's policies, due to her work at the USDA. She read the material in the directives to learn new information about the *Salmonella* Performance Standards that directly affect her job duties. The investigator also researched the European Union regulations for *Salmonella* and poultry. In addition to this, the investigator also attended online and in-person lectures from Italian professors and experts in these areas. The investigator became aware of these similarities and differences through her experiences in Italy. The tours of the fish processing facility and the chicken farm were the most informative. Throughout the project, the investigator constantly compared the policies and systems of the United States and the European Union, whether on paper or in practice.
Apply Awareness of Cultural Values and Practices to Public Health Policies – Foundational Competency # 8	Being raised in Texas, the investigator already valued agriculture. Through her graduate studies, she learned more of the cultural values behind public health and the food industry. The investigator used information published by the USDA to research in detail the US's policies on *Salmonella* in the poultry industry. By traveling to Italy in June, the investigator became emersed in the Italian culture and learned firsthand their values on these subjects. The investigator gained an education in their perspectives on chemical interventions and how this shaped the EU poultry regulations. She

	learned directly from Italian veterinarians, professors, and industry stakeholders as well as the Italian students. The investigator synthesized the information and research gathered to show the different cultural values and their impact on *Salmonella* and public health policies.
Food Safety Policy and the Global Food System – FSB Emphasis Area Competency # 4	Both the United Sates and European Union have strict food safety polices to protect their populations. They struggle annually with salmonellosis. The investigator researched the food safety regulations that the US implements in the context of *Salmonella* in the poultry industry. Such as how they perform samples, and deal with S*almonella* outbreaks. The investigator conducted online research and in-classroom learning on the EU's food safety policies for *Salmonella* and poultry. In Italy the investigator and other participants discussed how the differences of the two systems and their food safety standards limit the trade of poultry products. One reason the US cannot export their poultry to the EU is based on the use of chemical interventions. This is common practice in the US but is never used in the EU due to the concern over antimicrobial resistance.

The investigator explored the cultural values of the United Sates and the European Union, across the APE project. She researched how these values impact their respective food safety policies and regulations on *Salmonella* and the poultry industry. The investigator compared these international food safety systems. Her previous experiences in the USDA granted a background in the US side of food safety. Through research, lectures, discussions, and tours of the fish processing facility and poultry farm, the investigator learned the EU's perspective and regulations. With every new piece of information, the investigator tried to directly relate it to the other regulatory system. The US does this, but the EU does that. The investigator found a vast number of differences, but the passion of the people who work in each food safety system is the same. Everyone wants to produce safe food for their customers.

Appendix 2 - Demonstration of Competency Attainment

Table A.2 Attainment of Competencies

Practice-Based Products that Demonstrate Competency Attainment			
Specific Product		**Competency Addressed**	
1	USDA *Salmonella* Performance Standards Oral Presentation	# 12	The oral presentation the investigator created discussed the history and the changes that the USDA's *Salmonella* Performance Standards have gone through. It explained the reasoning behind why the USDA chose *Salmonella* as an indicator organism to monitor a plant's process control. The presentation also mentioned what research the USDA is currently doing to ensure that the standards are up to date and effective.
		# 15	For this product, the investigator reviewed and presented the purpose behind the USDA *Salmonella* Performance Standards. They were implemented to limit salmonellosis cases and impact public health. Towards the end of the presentation, the investigator also explained that the USDA continues to monitor the standard's efficacy and public health impact.
		# 18	The purpose of this presentation was to create a training tool for other USDA inspectors and staff. Therefore, the audience could include members who know virtually nothing or are experts on these standards. The investigator tried to formulate the message in way that easily broke down the information but was not too simple and redundant. The presentation can also be adapted in the future if its current format is not appropriate for an audience.
2	United States-European Union Poultry and *Salmonella* Fact Sheet	# 5	The United States and European Union fact sheet compared and contrasted the similarities and differences of their food safety regulations. This product crossed international boundaries to create a

			comprehensive list of the US's and the EU's differences and the public health impact of *Salmonella* annually.
		# 8	In the fact sheet the investigator highlighted the differing cultural practices in the context of *Salmonella*. In the United States, it is seen as a food safety issue. In the European Union, it is merely a sanitation indicator. Another cultural value that they each take a different stance on is the use of chemical interventions. The fact sheet depicted that practice is banned in the EU but is very common in the US.
		# 15	The purpose of this product was to educate the general public. Therefore, the information was not overly academic and easily understood. Larger concepts were broken down and their context explained. The fact sheet incorporated graphics to draw the audience's attention to important details. A more in-depth version can be created for USDA inspectors, veterinarians, and industry stakeholders

Foundational Competency 5 - Compare the organization, structure, and function of health care, public health, and regulatory systems across national and international settings

Throughout the APE the investigator constantly compared the United States to the European Union, specifically their public health and food safety regulations. The investigator took all this knowledge and experience, and synthesized a Venn diagram that illustrates the similarities, key differences, and the public health impact of *Salmonella* on the US and EU.

Foundational Competency 8 – Apply awareness of cultural values and practices to the design, implementation, or critique of public health policies or programs

The investigator learned the cultural values of food safety during her graduate studies at Kansas State University and her trip to Italy. The investigator applied these experiences to the APE research and products. She explained how the cultural values influenced the food safety regulations that are in place today in the United States and European Union in the infographic fact sheet.

Foundational Competency 12 – Discuss the policy-making process, including the roles of ethics and evidence

The investigator discussed the policy making process in both the oral presentation and fact sheet products. She explained how historical events shaped perspectives and fears and pushed for food safety reform. The investigator gave examples on how both the United States and European Union used and continue to utilize scientific evidence to maintain and adapt their policies and regulations.

Foundational Competency 15 - Evaluate policies for their impact on public health and health equity

Both the products evaluated the impact policies have on public health. The oral presentation displayed how the USDA *Salmonella* Performance Standards dropped the overall *Salmonella* levels in poultry establishments across the nation. The US-EU fact sheet showed how the different food safety policies on *Salmonella* and poultry affected both the United States's and the European Union's public health.

Foundational Competency 18 – Select communication strategies for different audiences and sectors

Both the oral presentation and fact sheet communication strategies were generalized for an audience of multiple education levels. The investigator tried not to make them overly technical. The oral presentation included basic information on the slides that can be explained in as much detail as desired, for any given audience. Both products' messages can be altered for a more knowledgeable and skilled audience in the future.

Appendix 3 – Portfolio Products

Appendix 3 features the totality of portfolio products (listed below, and sequentially following) for Kaitlin Alexander's APE.

Product 1 – USDA *Salmonella* Performance Standards Oral Presentation

Product 2 – United States-European Union Poultry and *Salmonella* Fact Sheet (and reference list)

USDA *Salmonella* Performance Standards for Poultry

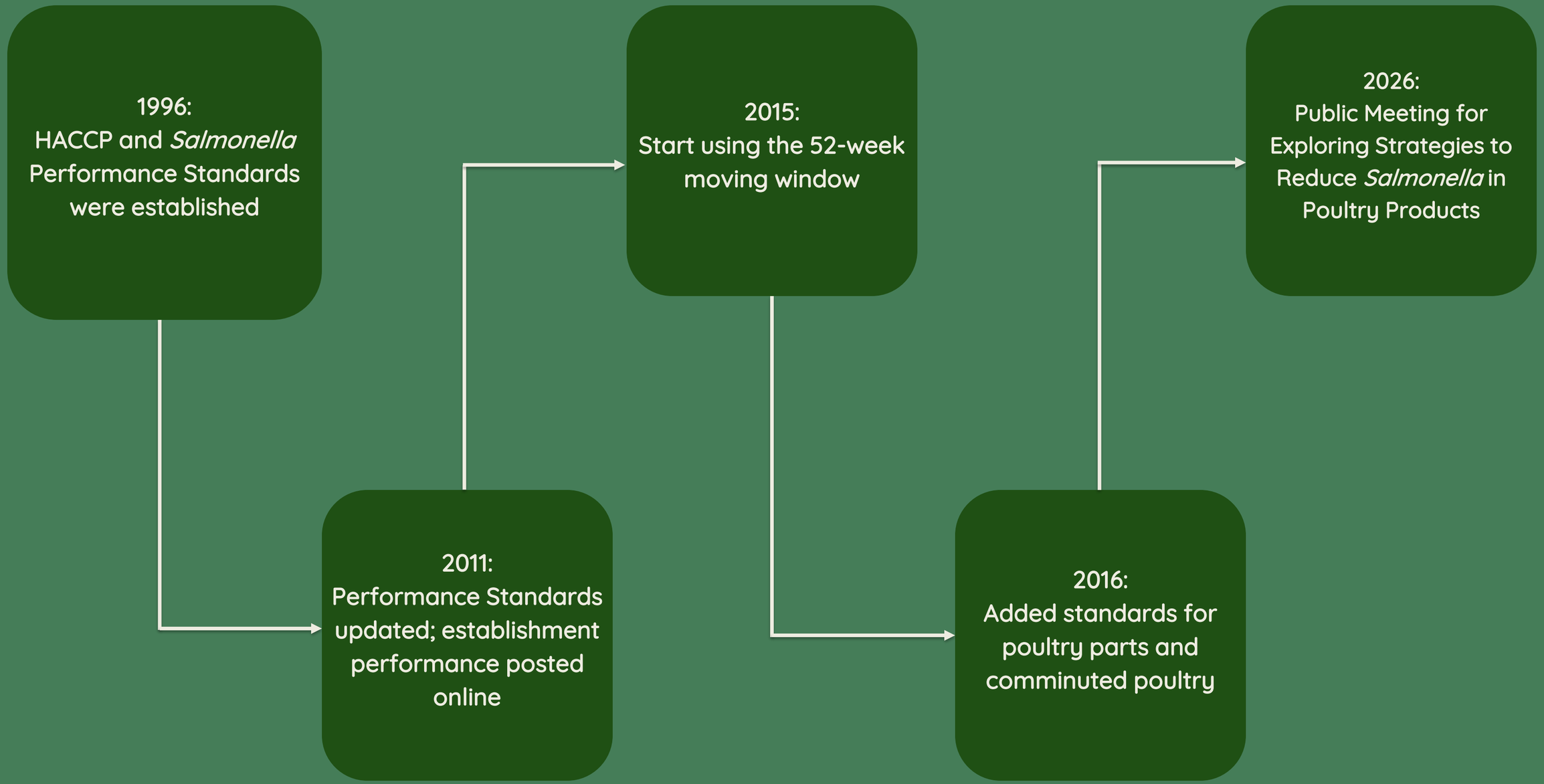
Kaitlin Alexander
MPH Student

Overview

Acronym Index
History
Why *Salmonella*?
What Poultry Products are Sampled & How
Performance Standards
52-week Moving Window
Categories & Agency Actions
Public Availability
The Future!

USDA Acronyms

FSIS	Food Safety and Inspection Service
PHIS	Public Health Information System
EIAO	Enforcement, Investigations, Analysis Officer
CSI	Consumer Safety Inspector
HACCP	Hazard Analysis & Critical Control Points


1996:
HACCP and *Salmonella* Performance Standards were established
2011:
Performance Standards updated; establishment performance posted online
2015:
Start using the 52-week moving window
2016:
Added standards for poultry parts and comminuted poultry
2026:
Public Meeting for Exploring Strategies to Reduce *Salmonella* in Poultry Products

Why *Salmonella*?

- Most common foodborne pathogen across all species
- Found in intestinal tract of animals
- Contamination occurs during slaughter and further processing
- Levels can be minimized through good sanitation practices and antimicrobial agents/processes

Goal of The Performance Standards: assess an establishment's process control and protect consumers

What Poultry Products are Sampled & How

Products Tested

- Whole Young Poultry Carcasses
- Chicken Parts (Legs, Breast, Wings)
- Comminuted Poultry

Types of Sampling

- Rinse
- Swabs (Turkeys)
- Comminuted Samples

Laboratory Testing

- Eastern Lab (Athens, GA)
- Mid-Western Lab (St. Louis, MO)
- Western Lab (Albany, CA)

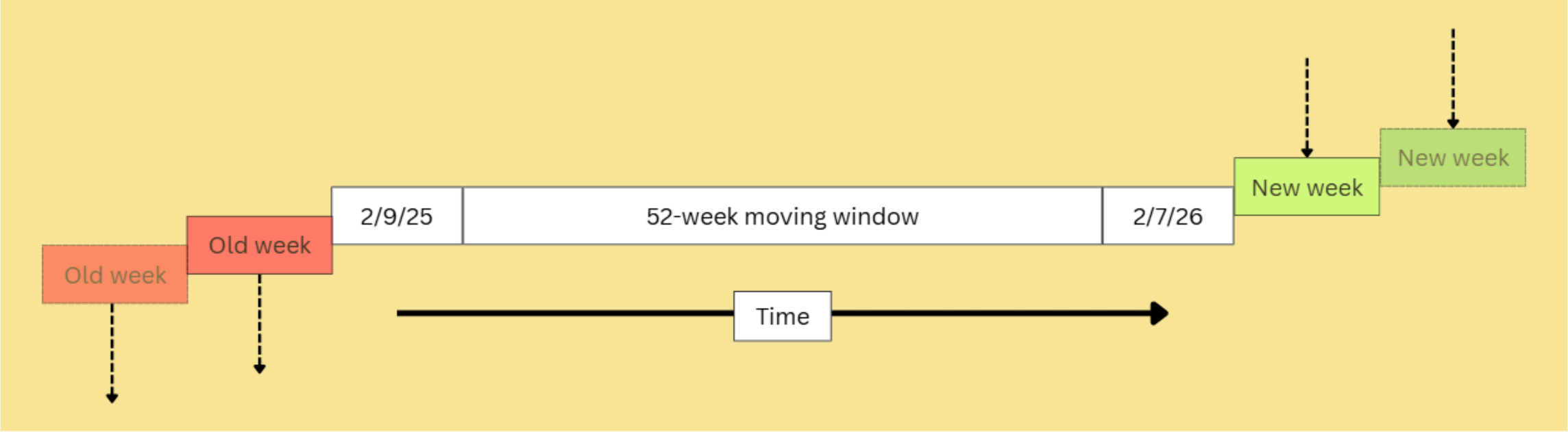
Performance Standards

Product	Performance Standard	Maximum Acceptable Percent Positive	Minimum Number of Samples
Chicken Carcasses	5 of 51	9.8%	11
Turkey Carcasses	4 of 56	7.1%	14
Chicken Parts	8 of 52	15.4%	10
Comminuted Chicken	13 of 52	25%	10
Comminuted Turkey	7 of 52	13.5%	10

$$\frac{13}{52}$$

$$\frac{\text{Maximum Allowable Positives}}{\text{Target Number of Samples Collected \& Analyzed}}$$

52-week Moving Window



Category Definitions

Category 1

Consistent Process Control

The total number of positive samples is under the maximum allowable number AND the total percentage is under 50% of the maximum percent positive allowable in the 52-week moving window

Category 2

Variable Process Control

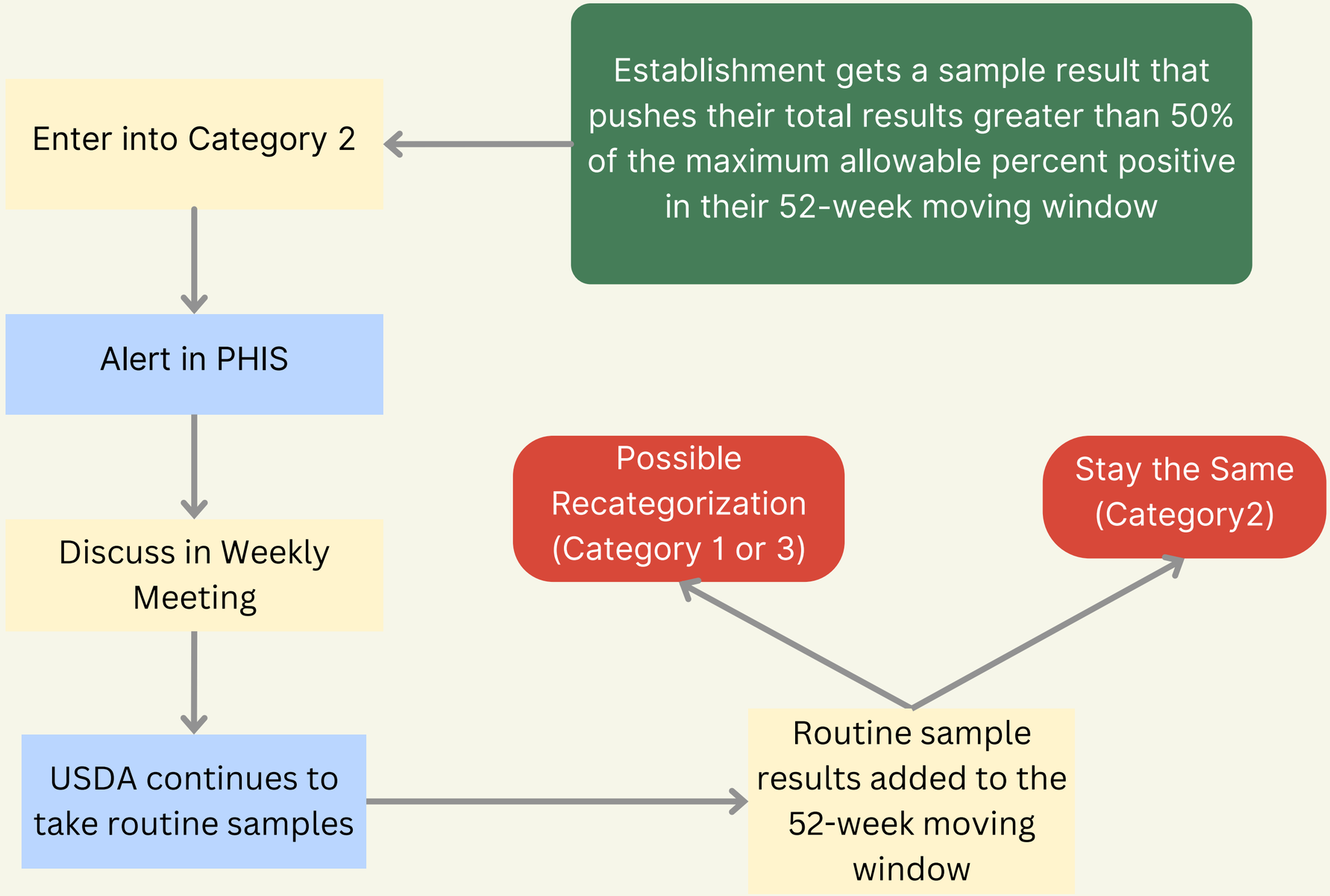
The total number of positive samples is under the maximum number, BUT the total sample results are greater than 50% of the maximum percent positive allowable in the 52-week moving window

Category 3

Highly Variable Process Control

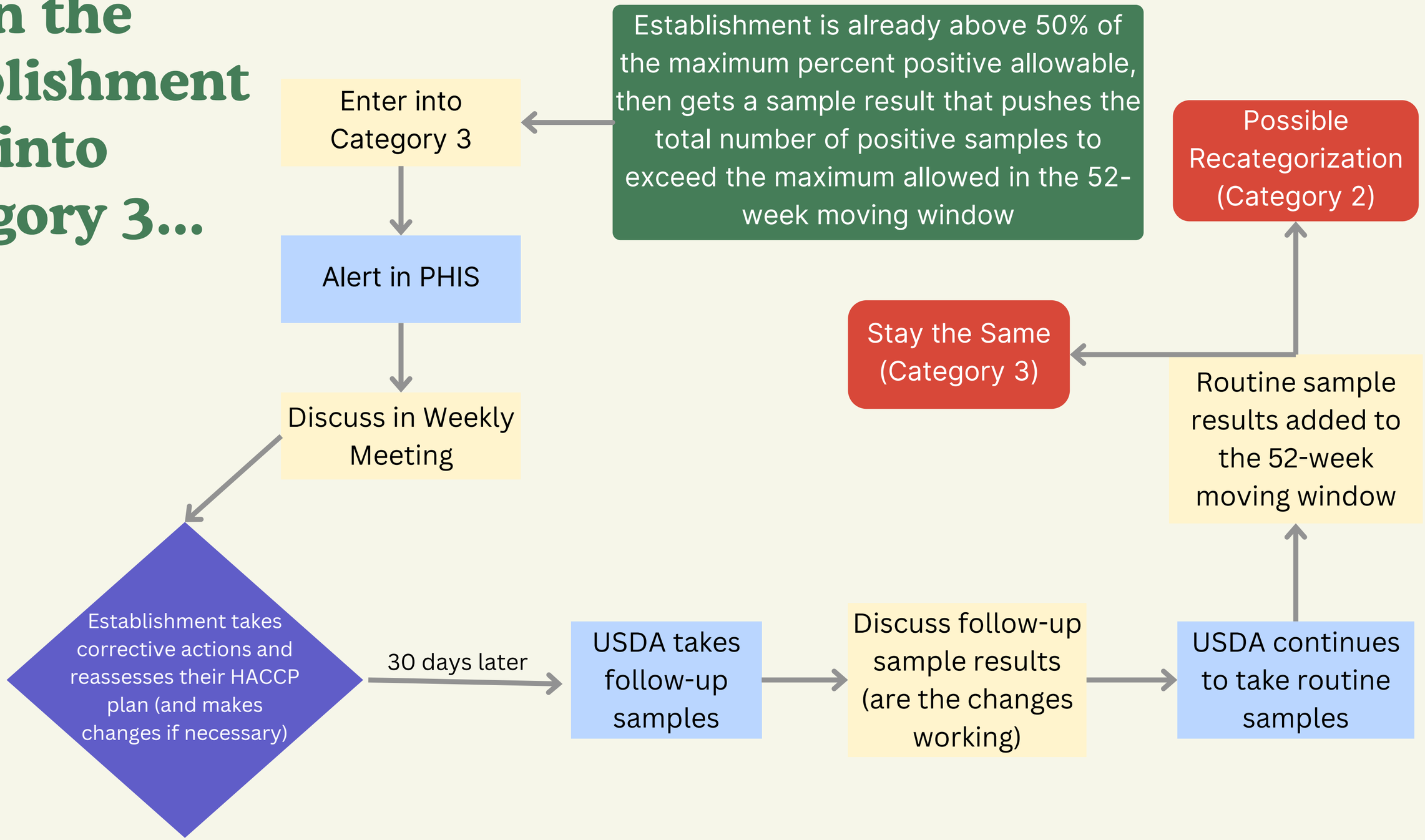
The total number of positive samples is greater than the maximum allowed AND the total sample results are greater than 50% of the maximum percent positive allowable in the 52-week moving window

When the establishment goes into Category 2...



Now what happens if the establishment keeps getting positve sample results, and goes into Category 3?

When the establishment goes into Category 3...



What can happen if an establishment is in Category 3?

- EIAO (Enforcement, Investigations, Analysis Officer) comes in to:
  - Performs a Public Health Risk Evaluation (PHRE)
  - Possibly conducts a Food Safety Assessment (FSA)

Sample Results Publicly Available

Poultry Products: Quarterly

- Mass data for all poultry sample results for total fiscal years
- Available in JavaScript Object Notation (JSON) not always user friendly

Salmonella Verification: Monthly

- Represents establishments categorization
- Can show every establishment's category throughout the nation
- Can show total number of establishments in each category; also splits into establishment size

Salmonella Serotypes: Quarterly

- Includes all species & all sample types other than ones for Performance Standards
- 10 most frequent serotypes listed separately, other serotypes grouped together

Antimicrobial Resistance in *Salmonella* : Annually

- Started in FY25
- Includes more than just *Salmonella*
- Product and cecal sampling

The Future!

Proposed Alternative Parameters for the Performance Standards:

- Pathogen Enumeration
- Serotypes & Virulence
  - 21 serotypes of concern (SoC)
  - 8 key Highly Pathogenic *Salmonella* (HPS) virulence genes
- Genomic based factors

Technology Enhancements:

- New sampling methods
  - MicroTally ® Swab: The Mitt
- One tube threshold test
- 8 marker Assay

Questions?

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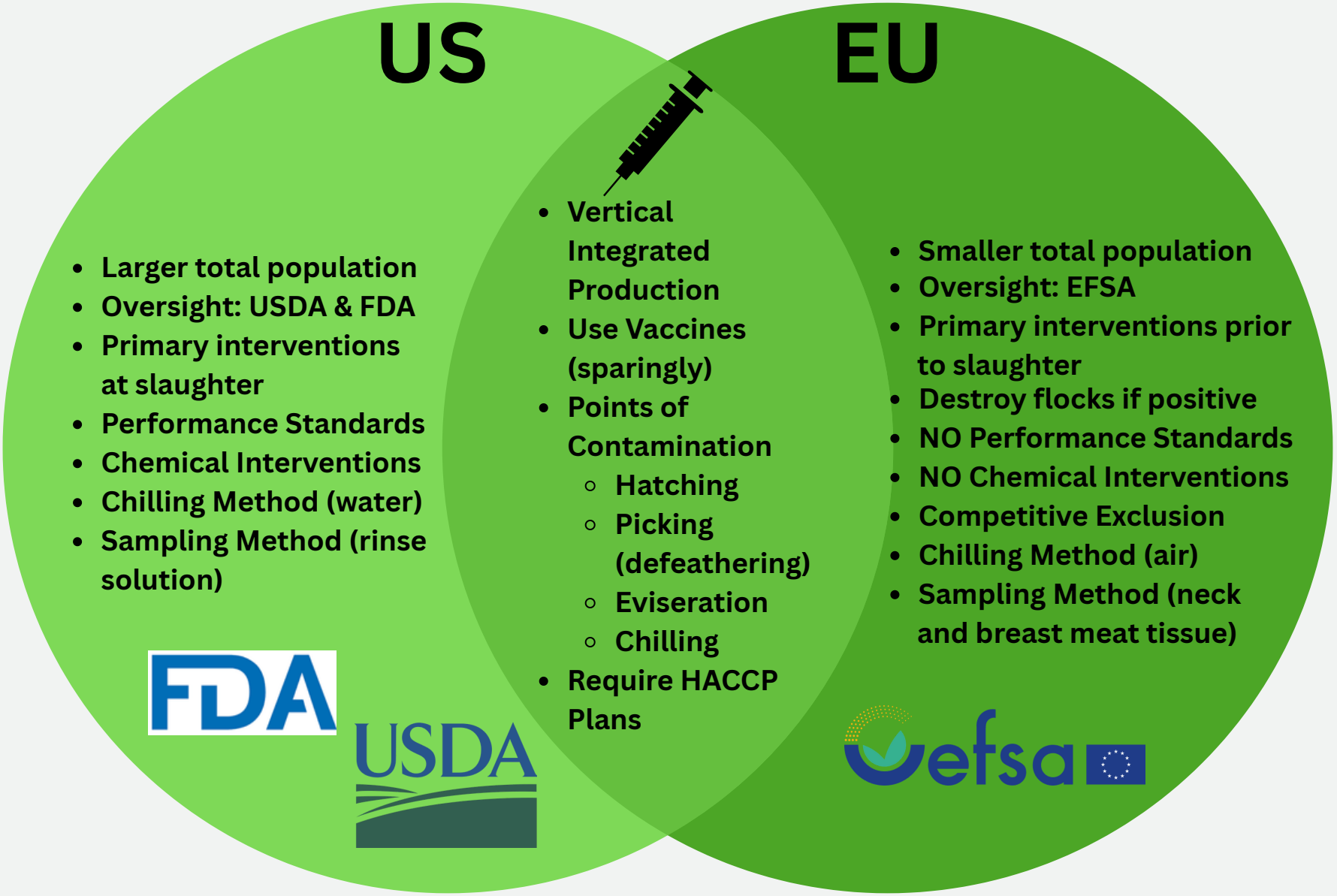
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Global *Salmonella* Intervention Strategies: United States vs European Union



Major Differences

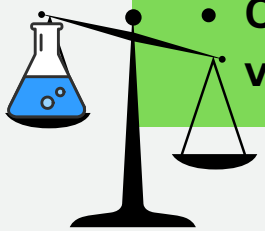
Interventions Implemented:

EU: Before Slaughter:

- Competitive Exclusion
- Destroying Positive Flocks

After Slaughter:

- US: Chemical Interventions
- Chilling Method (US: water vs EU: air)





Salmonella Approach:

- US: Performance Standards to monitor process control
- EU: Seen as a sanitation indicator





Public Health Impact

Similar top 5 target serotypes (used for vaccine manufacturing)

United States

- Enteritidis
- Typhimurium
- 1,4[5],12:i:-
- Heidleberg
- Infantis

1.35 million cases/year

Cost: $17 billion/year

European Union

- Enteritidis
- Typhimurium
- Hadar
- Virchow
- Infantis

91,000 cases/year

Cost: €3 billion/year