PREHARVEST SALMONELLA CONTROL
RAISING THE STANDARD FOR SAFE POULTRY
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HIGHLIGHTS OF A ROUNDTABLE DISCUSSION

Welcome

More stringent standards implemented by USDA’s Food Safety and Inspection Service (FSIS) have put increased pressure on producers to reduce the prevalence of Salmonella in poultry meat. It’s no longer realistic to expect processing plants to bear sole responsibility for food safety. It’s therefore clear that preharvest Salmonella control has taken on added importance.

There are hundreds of Salmonella serotypes. Only a few affect poultry and, of those, even fewer affect people. Nevertheless, FSIS considers all Salmonella types equal, regardless of serotype. If live production and processing allow Salmonella Kentucky to slip through — a serotype that poses little risk to consumers — it can just as easily leave the door open for Salmonella Enteritidis, which does pose a food-safety risk.

As part of its Integrated Food Safety Management initiative, Zoetis is helping poultry companies address these challenges. Toward that end, it organized a roundtable where poultry experts could exchange ideas for improved control of Salmonella during live production. Zoetis is pleased to share highlights from that discussion herein.

Jon Schaeffer, DVM, PhD
Senior Director, US Poultry Technical Services
Zoetis

jon.schaeffer@zoetis.com
TABLE OF CONTENTS

6 PUBLIC HEALTH IMPLICATIONS
8 COMPETING SALMONELLA SEROVARs
10 REGULATION VERSUS ‘TRUE’ FOOD SAFETY
12 LOOK TO BREEDERS
14 ELIMINATING WEAK LINKS IN PRODUCTION
16 VACCINATION DECISIONS
19 BROILER VACCINATION TRIALS
22 ASSESSING VACCINE EFFICACY
24 SALMONELLA AND GUT HEALTH
26 IMPACT OF LITTER QUALITY
29 WATER ACIDIFICATION
31 EVALUATING INTERVENTION SUCCESS
34 PREPROCESSING STRESS AND SALMONELLA
36 SALMONELLA PREVALENCE IN NAE FLOCKS
39 REGULATORY CONCERNS
HIGHLIGHTS OF A ROUND TABLE DISCUSSION

PANELISTS

KALEN COOKSON, DVM
Zoetis

ELIZABETH DALE, DVM
Pilgrim’s

CHARLES HOFACRE, DVM, PhD
Southern Poultry Research Group Inc.

ROBERT O’CONNOR, DVM
Foster Farms

KEN POWELL, DVM
Aviagen

PHIL STAYER, DVM
Sanderson Farms

BRUCE STEWART-BROWN, DVM
Perdue Farms

SCOTT WESTALL, DVM
Cobb-Vantress

MODERATOR:
JEAN SANDER, DVM
Zoetis
PUBLIC HEALTH IMPLICATIONS
We’re past the point on the live side where we can simply tell consumers to thoroughly cook their product and wash their knives and cutting boards...that’s why I think it’s really essential we continue to develop 

Salmonella control on the live side.  

Elizabeth Dale, DVM
COMPETING SALMONELLA SEROVARS
Dr. Hofacre has told us the serotypes of concern to human health. What are the Salmonella serotypes you’re most often finding?

S. Kentucky seems to be the predominant species of Salmonella a lot of us are finding. Does anyone know why? We find other bad actors out there, but they’re a much smaller population than S. Kentucky.

O’Connor
We don’t include S. Kentucky in our autogenous pullet vaccination. I want to eliminate or reduce the S. Heidelbergs and S. Typhimuriums. As an industry, are we allowing Kentucky to become predominant because we’re trying to prevent the top three or top four?

Stayer
We’ve been using an autogenous vaccine for over a decade in our pullets — sometimes with, but mostly without, S. Kentucky. S. Kentucky’s always been our predominant species. We haven’t really seen a change with the vaccines we’ve been using.

O’Connor
We’ve been using an autogenous vaccine since 2006, and I don’t think we’ve ever included S. Kentucky. I want to eliminate the other serotypes.

Stewart-Brown
We don’t focus on S. Kentucky in parents, either, but for maybe a little different reason. I just don’t believe vaccination is going to do much for S. Kentucky.

Hofacre
S. Kentucky has a unique ability to out-compete its neighboring Salmonellas. It does that in the test tube and it does it in the chicken. When we vaccinated broilers with an S. Kentucky isolate as if it was a vaccine and vaccinated another group with one of the commercial S. Typhimurium vaccines and then challenged them all with S. Heidelberg, there was a significant reduction in Salmonella colonization when S. Kentucky was used as a vaccine — although it wasn’t as large a reduction of the S. Heidelberg as the commercial live vaccine.
REGULATION VERSUS ‘TRUE’ FOOD SAFETY
SANDER
What happens if you have a high prevalence of *S. Kentucky* since it’s not a major food-safety threat?

DALE
For us, there’s a place for two approaches — decreasing the prevalence and displacing serovars of concern. It’s the difference between food-safety regulation and true food safety.

You’re worried about prevalence if you know you have a serovar known to be of concern to the CDC — and it may be in a tray pack where you’ve got raw product going into consumers’ homes. Then your goal is probably going to be getting rid of those serovars versus worrying about failing overall counts for *S. Kentucky*.

O’CONNOR
I completely agree. There’s a public health risk and then there’s a regulatory risk. Are you going to be shut down due to a regulatory violation or are you going to be the cause of a human outbreak? If you have one of the top three or four serotypes that pose a greater risk to people and there’s a risk of an outbreak, that’s the bigger priority and a bigger risk for your company.

“There’s a public health risk and then there’s a regulatory risk.”
Robert O’Connor, DVM
We have three metrics in breeders: houses that become positive for \(\text{Salmonella}\) Bs, those that might be Ds and those that are anything else. The Bs and Ds go on a priority list and are tracked heavily.

Bruce Stewart-Brown, DVM
ELIMINATING WEAK LINKS IN PRODUCTION
What can be done to shore up weak links in the production system that enable Salmonella to get into a flock?

There’s a long list of ways that Salmonella can get into a flock. On a daily basis, there are three things I focus on regularly. One is the feed contamination rate. Mainly look for coliform levels, because that’s the easiest to find and quantitate. The other two are the management of gut health and rodent control.

There are certainly other potential sources of influx into a flock such as beetles, dust or maybe the farm is located near a cornfield at harvest time or hay is being baled nearby, which stirs up dust or rodents. Additionally, Salmonella can be amplified the last few hours birds are in the house during feed withdrawal.

Focusing on some specific serogroups (Bs and Ds) and those farms that repeat on those higher-priority serogroups has helped us narrow our focus on the “weak links.” Study the repeating farms, look at them from every angle — rodent control, biosecurity, vaccination, etc. Don’t stop till you break the cycle.

A slow vertical leak, whether it’s in the embryo or on the shell, is probably the most dangerous. Then it gets into broilers, and you have a higher number of birds shedding it and the potential for horizontal transmission.

But other things — biosecurity or the people involved — are really key regarding other points of introduction. After the avian influenza breaks in 2015, biosecurity throughout the entire industry improved dramatically, especially with respect to personnel and equipment.

However, I think there’s a blind spot — or an opportunity — regarding structural and pest-management biosecurity. We have much stricter programs in place, but there’s a perception among a lot of people that if you have out bait boxes every 100 feet and you’re checking them, you have a rodent-control program. That’s just a monitoring program.

At some farms, and despite a producer’s program and inspections, the job’s just not getting done controlling some of the vectors for Salmonella.
VACCINATION DECISIONS
There are two scenarios where I would consider vaccinating broilers against *Salmonella*.

Scott Westall, DVM
**DALE**

In my experience, vaccines don’t have an impact on prevalence. They’re more successful at displacing specific serovars. Now, if you’re trying to get out of Category 3, you probably need a short-term and a long-term plan. The short-term plan may be throwing everything in the kitchen sink at the problem, but the long-term plan includes a lot more, as we’ve discussed: looking at your management practices, your litter quality and moisture, biosecurity, your pest control, as well as the serovars you have, and testing and vaccination of breeders.

**COOKSON**

It’s important to hold vaccination crews accountable to help ensure flocks are vaccinated properly. That’s one of the most powerful tools we have. When they know they’re being checked, they realize they need to bring their A game.

“It’s important to hold vaccination crews accountable to help ensure flocks are vaccinated properly. That’s one of the most powerful tools we have.” — Kalen Cookson, DVM
BROILER VACCINATION TRIALS
Dr. Cookson, you’ve been involved with broiler vaccination trials. What do they show? Can they help a producer get out of Category 3?

In most cases, levels of *Salmonella* in the plant are driven by *S. Kentucky*. Not always, but if someone is in USDA’s Category 2, going into Category 3, or the plant is solidly in Category 3, it’s often 80% *S. Kentucky*-driven. There are studies that clearly show a reduction in *S. Kentucky* when broilers receive live *S. Typhimurium* vaccines. In the field, it’s a different situation than a controlled-challenge study, but we’ve seen reductions in positive bird rinsates. I just don’t think the reductions are on the same level as we see against the B and D serotypes. There are shared antigens between the Bs and Ds.

When did these studies begin?

The broiler-pen studies started about 15 years ago. Instead of challenging the broilers, investigators relied on what we’re talking about here — the link from breeder to broiler. Investigators confirmed that chick-box papers were positive for *Salmonella* serotypes B and C. There was a 30% to 60% reduction in *Salmonella*-positive carcass rinsates after rehang.

Haven’t there been more recent broiler trials with the live vaccine?

Yes. Since then, there have been some fairly large-scale studies that produced similar results. In one live *S. Typhimurium* vaccine trial, there was a 60% reduction in positive rinsates at rehang. Investigators broke it down by serotype; *Salmonella C* serotypes made up about 75% of all the isolates recovered from the unvaccinated birds, and Bs accounted for the other 25%. In contrast, there was a 50% reduction of *Salmonella C* and no recoveries of *Salmonella B* in the vaccinates.

In a second trial, investigators saw about a 30% reduction and that included a 25% reduction in *Salmonella C* serotypes and a 50% reduction in *Salmonella B* serotypes. So again, limited data confirms there were better reductions in *Salmonella B* serotypes when broilers are vaccinated. Investigators did not see much Group D.

What do you recommend based on these studies regarding vaccination of broilers?

There aren’t enough numbers to make firm conclusions. But we might infer that if you’re in USDA’s Category 3 and that’s driven by the presence of *Salmonella* serotype C, then maybe you are willing to spend more and vaccinate your
In most cases, levels of *Salmonella* in the plant are driven by *S. Kentucky*. Not always, but if someone is in USDA’s Category 2, going into Category 3, or the plant is solidly in Category 3, it’s often 80% *S. Kentucky*-driven.

*Kalen Cookson, DVM*

Broilers. You know, the earlier you can intervene with a vaccine — like at the hatchery — the better the chances are for affecting change.

**Powell**

Do you find that vaccination works better in a small-bird or big-bird program — or any particular program?

**Cookson**

There isn’t enough experience yet with birds of different sizes, but investigators did see reductions in medium- to large-sized birds. In pen studies, they’ve also seen reductions in birds anywhere from 7 to 8 weeks of age.

**Hofacre**

Research shows the live *S. Typhimurium* vaccines do not give as much cross protection against *Salmonella* C serotypes as they do for the B and D serotypes. If you’re in USDA’s Category 3 or are about to go there, using a live *Salmonella* vaccine for a serogroup C may not be as effective as for B or D serotypes.

Dr. Cookson, were one or two doses used in the broiler trials you described?

**Cookson**

Two doses.

**Powell**

Does anyone worry that use of a live *Salmonella* vaccine will show up upon testing at the processing plant?

**O’Connor**

Brilliant question. We have seen it — very, very rarely but we have seen it. But I don’t see it enough for me to be alarmed about it.
Let’s turn to assessing vaccine efficacy. How do each of you determine if a vaccine program is effective or not?

**Powell**
I have a burning question about monitoring a vaccination program. How do you measure the efficacy of killed Salmonella vaccines, especially the autogenous bacterins for breeders? There are obviously ELISA tests, but none are specific.

**Stewart-Brown**
We get three boot-sock samples in the course of a breeder’s life. We’ve been doing this for about 10 years. One of the sample sets is for pullets and two are for hens. We get a yes/no associated with those boot socks for Salmonella serotypes B and D, and there’s another general category for anything else. You put the results on a graph and look at it monthly.

Over time, you tweak your vaccine and watch that number. We’ve had some cases where it moved, based on what we believed was associated with a bad decision in the vaccination approach. And vice-versa. With this approach, we’ve had a lot of success getting the Salmonella prevalence down. But, of course, we also worked on rodent control and other Salmonella-control measures.

**Powell**
So you’re not measuring titers and the vaccine efficacy itself?

**Hofacre**
No one has shown that there is a correlation between an ELISA titer and protection. Dr. Stewart-Brown is watching the prevalence of Salmonella in breeders, which will eventually show up in the processing plant. That’s a very effective way to monitor.

**Powell**
What should the proportions be if there are multiple serotypes in an autogenous vaccine?

**Hofacre**
There’s no science.
HIGHLIGHTS OF A ROUNDTABLE DISCUSSION

SALMONELLA AND GUT HEALTH
Dr. Powell, can you tell us more about the relationship between coccidiosis and Salmonella?

POWELL
Coccidiosis can change the gut microflora in such a way that Salmonella will colonize or amplify in the GI tract. Specifically, beneficial microflora, such as lactobacillus, decline in numbers, and pathogenic opportunistic microflora, such as clostridium, will proliferate.

By monitoring coccidiosis with oocyst numbers (oocysts per gram), gross or microscopic lesions, and with polymerase chain reaction (PCR) to quantitate clostridial levels in the lower intestinal tract, I have found these numbers peak in broiler flocks on built-up litter between 14 to 21 days of age. In antibiotic-free production systems with total cleanouts, you tend to see coccidial challenges later — between 28 to 35 days of age.

To me, from a gut-health standpoint, focusing on these times of prevalent coccidial activity would have merit for controlling Salmonella.

Do you see a difference in Salmonella counts at processing in larger birds since they have more time to recover from a coccidial challenge compared to smaller birds?

STAYER
We have big and bigger chickens. We don’t have small chickens, so we don’t really see a difference in our Salmonella counts relative to size. We do see different results post-processing from production units within 30 miles of each other, which is probably related more to processing-plant interventions than it is to grow-out conditions.

DALE
We have chickens of all sizes. We don’t see a difference either based on cocci cycling levels or bird size as much as a noticeable geographic difference, as Dr. Stayer mentioned. Whether there’s a difference due to bird size or Eimeria maxima, scores would be very difficult to differentiate just because of all the other variables — house management, biosecurity, litter quality, the breeder vaccination program, etc.

You’ve got to control coccidiosis whether that’s in the pullet, breeder or broiler house. A producer could have an undetectable level of Salmonella and then coccidiosis cycles and amplifies it. You drop the ball on gut health, and Salmonella is in every chicken. This is why I focus much of the Salmonella-control efforts on gut health.

With poor pullet immunity against coccidiosis, it is possible to have breaks upon the move to the breeder house, and it wouldn’t be unusual to isolate Salmonella in a breeder flock after that.
IMPACT OF LITTER QUALITY
The point made about good paw quality is valid since good paw health can reflect litter dryness. But quite honestly, in our experience, we have not seen a linkage between paw quality — as a reflection of litter quality — and *Salmonella* at processing.  

*Phil Stayer, DVM*
I believe gut health can also affect the prevalence of *Salmonella* by indirectly affecting litter moisture. If birds have coccidiosis and develop enteritis, for instance, they’re going to put a lot more moisture back into the litter, so it’s a vicious cycle.

**O’CONNOR**

I totally agree. Enteritis goes along with coccidiosis. I see an absolute trend upward during January and February, which in California are wet months. Then we hit a very nice trough through summer, and then interestingly, the prevalence starts to go up again in August. Why does it go up in August, when it’s very hot and dry? Because that’s when we’re misting and putting a lot of moisture into the air, which drops on litter.

“I totally agree. Enteritis goes along with coccidiosis. I see an absolute trend upward during January and February, which in California are wet months.”

Robert O’Connor, DVM
WATER ACIDIFICATION
Sander
What about water acidification? Can it reduce the prevalence of Salmonella?

Stayer
We’ve tried water acidification. Sometimes you get promising results and sometimes not. It really depends on where you start — where your water pH is to begin with. It’s not consistent.

Hofacre
I believe one of the biggest reasons for inconsistent results with acidification is the pH of the water to start with, which can vary widely between neighboring farms. I’ve conducted studies with water acidifiers and they work really well, but the pH and hardness of the water need to be tested before determining what dose or use rate to use.

Dale
We’ve run a lot of trials with acidification, waterline sanitation or probiotics, and that silver bullet does not seem to be out there yet. Nothing is consistently effective in every location. Part of the issue with that is having assays that can consistently and accurately monitor the impact.

We’ve tried water acidification. Sometimes you get promising results and sometimes not.
Phil Stayer, DVM
EVALUATING INTERVENTION SUCCESS
Sander
How do you measure the efficacy of your Salmonella-control efforts, whether it’s vaccination or in-house interventions? What tools do you use?

O’Connor
On the live side, we use boot socks. But I can’t tell you why a particular region or complex almost always runs a lower prevalence. What I’m really looking for are trends. If they’re normally averaging about 40% and I see them creeping up to 60%, 70%, then I think, okay, we’ve got a problem on the live side.

We consistently use boot socks on every farm before it processes. We do it within 2 weeks of processing. There’s probably some inconsistency in compliance to the protocol for sampling, but again, I’m looking for overall trends, not results at a specific farm.

Cookson
You mentioned 2 weeks prior to slaughter? I’m curious. Is there an ideal time to gauge that level of Salmonella?

O’Connor
Yes, it’s within 2 weeks of processing. Most of us see Salmonella as an intermittently shed bacteria, and birds shed the most during stressful periods. In a broiler’s life, I’d say those last 2 weeks are going to be some of the most competitive, stressful periods of their lives, so that’s when we test for Salmonella.

Cookson
Do you try to avoid the last 2 or 3 days before processing?

O’Connor
The house is denser closer to processing, which makes it harder to get four boot socks through the house. Again, I’m not reacting to the boot-sock results; I’m looking at aggregated information and trends, not the results from one individual farm.

Hofacre
In a study Roy Berghaus and I conducted several years ago, we evaluated whether boot socks or drag swabs for Salmonella correlated to the level coming into the plant. We looked at 3 weeks, 2 weeks and the week the birds were processed. Only the week the birds were processed did the results correlate to whole birds with feathers on rinse, so you won’t have the culture results in time to do much about it.

Dale
There are a few companies working on more rapid-turnaround diagnostics that might enable us to implement interventions. But currently, I think drag swabs have value, especially if you’re looking at overall trends.

For monitoring our overall Salmonella-control program, I still look to the overall Enterobacteriaceae count and the Salmonella prevalence at rehang because that’s as close as I can get to what we’re bringing in from the field. There’s the stress of catching and transport, but ultimately it’s what’s coming in the door of your plant.
In a broiler’s life, I’d say those last 2 weeks are going to be some of the most competitive, stressful periods of their lives, so that’s when we test for Salmonella.  Robert O’Connor, DVM

SANDER

Other than boot-sock sampling and environmental testing, are there any other diagnostics used to monitor Salmonella in flocks, whether that’s for breeders or broilers?

DALE

Boot socks are of limited value. You can pick up Salmonella with boot socks but it’s a lot easier to test, for example, hatch-tray residue swabs or even chick papers. There are other sampling methods if it’s coming out of your breeder-source flock.

STEWART-BROWN

We have been trying to work on an “organic load” metric. These could be super practical and simple but important metrics — are the birds coming in clean or not? We also have camera monitoring in our processing plants now to judge feather cleanliness and paw health at the farm level. This results in a soiled-feather score and a paw-health score.

HIGHLIGHTS OF A ROUNDTABLE DISCUSSION

PREPROCESSING STRESS AND SALMONELLA
If we're concerned about gut health in stressed pullets that we're moving to a breeder house, we use a program with an organic acid and probiotic, often administered simultaneously in water. We try to preempt stresses that affect enteric health.  

Ken Powell, DVM

We also have installed a newer, full live-haul trailer-module sanitation system. Trailers as well as modules are fully sanitized. The transport vehicles have tops; the ceiling goes up and the transport modules go on, then the ceiling comes down. That helps with air flow. There are also curtains. I'm excited by these developments. These things are associated with improved bird comfort, but I'll be interested to see if we get improved food safety too.

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**SANDEL**

We need to address the impact of feed withdrawal. How does the timing of feed withdrawal affect the prevalence of *Salmonella* going into the processing plant?

**O’CONNOR**

I don’t think the 8 to 12 hours of feed withdrawal prior to processing has changed. But the longer birds are off the feed, the more issues you’re probably going to have with gut upset. You’re going to stress them out, and they’ll shed more *Salmonella* in the litter right before they’re to be picked up.

**STEWART-BROWN**

I agree. But there are all kinds of other variables at play. If we get feed withdrawal down to 6 hours, there’s no certainty that would help reduce the prevalence of *Salmonella* going into the plant.

**SANDEL**

Let’s elaborate on that point because transport to processing is a big stressor for poultry and may be associated with a bigger *Salmonella* load going into the plant.

**POWELL**

We have those concerns when we move breeders. If it’s a rainy day or a cold day, you can do things like cover the transport trailer. If we’re concerned about gut health in stressed pullets that we’re moving to a breeder house, we use a program with an organic acid and probiotic, often administered simultaneously in water. We try to preempt stresses that affect enteric health.

**STEWART-BROWN**

We’re looking at a new transport module and transport system. We believe we’ll see a significant benefit with new trailers designed to give birds a higher level of comfort during transport.
SALMONELLA PREVALENCE IN NAE FLOCKS
Reports are mixed on the prevalence of *Salmonella* in poultry meat from antibiotic-free and conventional production systems. What's been your experience with the *Salmonella* prevalence in flocks raised without antibiotics?

**STEWART-BROWN**

We started in 2002 moving to “no antibiotics ever” (NAE) production in every one of our 12 facilities. As we progressed with the NAE program and charted the percent positive for *Salmonelllas*, they were inversely related. In other words, as NAE came in, *Salmonella* came down. I'm not necessarily attributing that to the NAE program because we were doing a million other things, which, by the way, I think you do need to do.

All the breeder work had to be done ahead of time, and that still goes on. Gut health is really important for a million different reasons. Gut health remains really important not just for feed efficiency and livability but for the food-safety component. If you plotted our livability to percent NAE, livability has gotten better the last several years. But again, that's associated with working every aspect of the program.

*Can others who have experience with both NAE and conventional flocks comment?*

**DALE**

I can't say that in our flocks I've found as strong a consistent correlation between NAE production and a reduced *Salmonella* prevalence as Dr. Stewart-Brown has seen. I do think that since the removal of gentamicin from hatcheries, the industry has seen a trend.

There are presentations at the conference showing the difference in *Salmonella* loads between NAE-type programs and in flocks receiving BMD® after a necrotic enteritis (NE) challenge. There are tangential or ancillary facts associated with removing antibiotics, but they may be related to other health or disease conditions.

**HOFACRE**

*Salmonella* lives primarily in the ceca. NE occurs primarily in the small intestine. In challenge studies where you create NE and give *Salmonella*, you don’t see more *Salmonella* with NE.

But when you look at what happens with an NE flock, you get uniformity issues. You have small birds and big birds, and those small birds are more prone to having crops and intestines torn, resulting in more contamination on the carcass. I think indirectly there’s a link for NE (gut disease) to contribute to *Salmonella*, but as Dr. Stewart-Brown said, once you learn to control those variables and reduce your gut-health issues, you don’t have as much impact when you take out gentamicin.

There are ways to keep the bugs that maintain gut health happy. The simplest way is with an antibiotic. The more

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*Charles Hofacre, DVM, PhD*
expensive way to do it is without an antibiotic, and you’re going to have to do a lot of other things to accomplish that.

**O’Connor**

We have organic flocks. We have NAE flocks. We have conventional flocks. It depends on who you ask and who’s giving the answer and their biases. I don’t believe NAE flocks are necessarily more prone to being *Salmonella*-positive. And I definitely don’t believe that if positive, they’re more prone to have a serotype of human-health concern. I think you’d really have to study the data before you answer that question.

**Dale**

I’ll agree with that. I don’t think the hard data is there to say one way or the other from what we’ve seen.

**O’Connor**

I think there is an impact on *Salmonella* prevalence in preharvest organic production due to the restrictions on disinfectants. If I run a probiotic, the inert materials in it have to be organic. You are limited more on the interventions you can use.

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*Robert O’Connor, DVM*
REGULATORY CONCERNS
Let's shift gears and address regulatory issues. As you know, FSIS plans to publish results of Salmonella testing for chicken parts as well as carcasses. Will this put added pressure on producers to intensify preharvest Salmonella-control programs and will it affect their relationship with their customers?

**O'Connor**
What they're intending to do by publishing results is motivate processors to hit the standard.

**Stayer**
If you're in a category where you don't want to be, you're going to do everything. Then when you get where you want to be, you'll back down.

**Dale**
I'll echo that. You're going to initiate a lot of the interventions we've touched on and you're going to do more of it. The other thing that hopefully will help us keep moving forward will be development of more precise assays for monitoring and determining the impact of the different interventions we use.

Is it true that some vendor contracts specify that all their products must be sourced from Category 1 and 2 processing plants?

**Stewart-Brown**
Sure. That's in a number of purchasing contracts for raw materials, generally, based on the contracts I've seen.

**O'Connor**
So far, I don't feel there's been much customer scrutiny based on publication of carcass findings. It'll be interesting to see how customers respond to publication of results with parts.

Would you all get out your crystal ball and tell us where you think the industry will be in 5, 10 or even 15 years from now regarding Salmonella prevention and control?

**Dale**
One of the most exciting aspects of this industry for me as a veterinarian, and one of the most enduring characteristics, is that we have a very adaptable, progressive industry. We'll probably continue to reduce Salmonella levels and maybe even surpass what we previously thought was impossible. Part of how we'll be able to do that is through better science — better diagnostics and monitoring and hopefully those aren't my numbers. That's what the government says we are doing, which is very encouraging.

I don't know if there's a direct correlation there to human cases of Salmonella, and we're not the only source for those infections. But according to the government's own data, we are making progress.

Given all the new interventions the industry has put into place, do you think we're making progress regarding control of foodborne Salmonella?

**Dale**
I have the most recent government data here, which says that 98.5% of all whole-chicken tests for Salmonella are negative. That's from large plants. Chicken producers have reduced Salmonella in whole chickens 66% over the past 5 years.
We’ll probably continue to reduce Salmonella levels and maybe even surpass what we previously thought was impossible. Part of how we’ll be able to do that is through better science — better diagnostics and monitoring and hopefully with better vaccines as well. Elizabeth Dale, DVM

with better vaccines as well. It’s yet to be determined exactly which interventions will turn out to be the best.

STAYER
I’d agree. Technologies need to be in place, and I don’t think we’ve yet figured out which are the best interventions apart from basic good management practices.

STEWART-BROWN
I also agree with Dr. Dale, especially when Salmonella and food-safety metrics start to be managed like production metrics. The industry once focused on production management and has done a phenomenal job. The more difficult task will be applying that metric to Salmonella control at the farm level, but once that’s done, I think we’ll be amazed at what we can do.

HOFACRE
Dr. Stewart-Brown and I can remember the day when we didn’t have ELISA testing, when it became routinely available, and it changed the way we actually established vaccination programs once we could test, measure and verify effectiveness.

There are a lot of companies really pushing forward to find new ways for us to test for Salmonella on the live side. Once we have those tests, we’ll have the opportunity to make more progress on specific farms. I believe that new testing methods will be one of the keys for progress in the future.

O’CONNOR
Plus/minus is my prognosis. I’ve observed that larger companies are being very proactive. They’re moving ahead with interventions. They’re trying to get things in place, for instance, to meet the standard. I see smaller companies that want the parts standard eliminated, and they are asking basic questions about interventions. Based on my experience in the industry, we’re sometimes better at being reactive than proactive, but when we get into a crisis — which might occur if companies have trouble meeting the parts standards — we are really good at being reactive. I guess that’s my prognosis for the next 5 years.

SANDER
Thanks to all of you for sharing an unbelievable amount of information and providing insights that will help the industry improve food safety and feed the world with an abundant and wholesome product. I’m proud to be a part of this industry.