ENGINEERING TOMORROW'S POULTRY INDUSTRY

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What's Causing PAA Decay in Poultry Immersion Chillers?

Research at the Georgia Tech Research Institute's Agricultural Technology Research Program (ATRP) is shedding light on the root causes of peracetic acid (PAA) decay in poultry carcass chilling operations.

Poultry processors drop carcasses into large water-filled cooling tanks, known as immersion chillers, to lower their core temperature to a degree that inhibits pathogen growth. Antimicrobials like PAA are added to the water as an additional safeguard. However, conditions within the chiller can cause the PAA to decompose, resulting in varying concentration levels within the chiller water. A few years ago, the poultry industry expressed an interest in gaining a full understanding of PAA's decay rates within immersion chillers and the factors attributing to that decay. The hope is that the knowledge gained will allow processors to optimize PAA dosing. Too much PAA can result in an unnecessary cost burden, while too little poses an unacceptable food safety risk.

Photo: JBT Marel

Poultry processors drop carcasses into large water-filled cooling tanks, known as immersion chillers, to lower their core temperature to a degree that inhibits pathogen growth while also exposing them to antimicrobials like PAA. Processors have expressed an interest in understanding PAA's decay kinetics in order to optimize PAA dosing.

In response, ATRP researchers began an exploration into "What Killed the PAA?" Led by Daniel Sabo, senior research scientist, the team has explored several PAA decay culprits, ranging from chemical formulations and incoming water quality to fluctuating pH and temperature levels to high organic loads. Overall, results showed PAA remains stable under mild conditions but degrades rapidly at higher pH, increased temperature with organic load, and in the presence of combined total dissolved solids (TDS) components (proteins, cations, and blood).

Recently, the team took a closer look at the effect of air agitation on PAA's antimicrobial activity. Air agitation is widely used by processors to enhance PAA mixing and contact with the carcasses in the chiller water.

"We wanted to understand the impact of air agitation on PAA's antimicrobial activity so we can ensure that this common practice does not inadvertently accelerate PAA's degradation or reduce its effectiveness against microbial contaminants," says Sabo.

Specifically, the study investigated the antimicrobial efficacy of PAA on *Salmonella* present on chicken drumsticks, flats, and drumettes under different levels of air agitation during a simulated chilling process.

Experimental Setup

A tracer strain of *Salmonella* was used to ensure accurate reductions were monitored. After allowing *Salmonella* to attach to the chicken parts, samples were chilled for 60 minutes in water containing 100 parts per

continued on page 2

IN THIS ISSUE

What's Causing PAA Decay in Poultry Immersion Chillers?

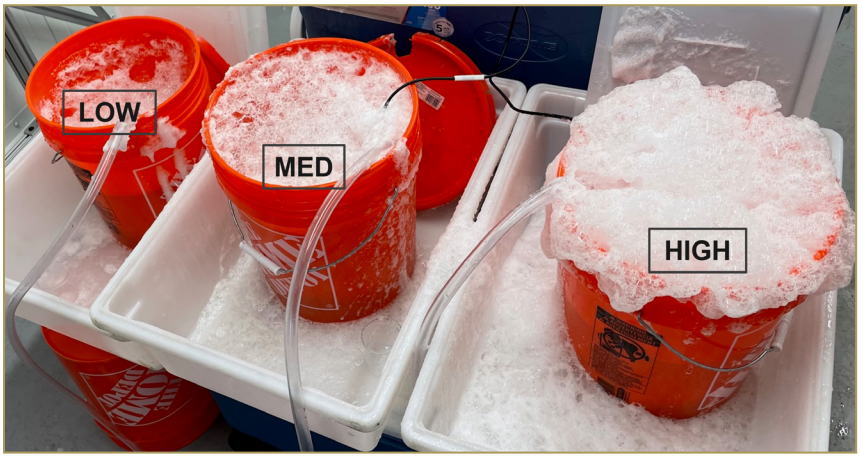
continued from page 1

million (ppm) PAA with applied air agitation. Air agitation intensity was classified as low, medium, or high by quantifying the amount of bubbles generated.

Results

Across four replicates, all levels of air agitation led to substantial reductions in *Salmonella*. High air agitation consistently produced the greatest reduction in *Salmonella* at 1.91 log or nearly 99% on average. Medium and low air agitation reduced *Salmonella* by 1.71 log and 1.27 log or roughly 98% and 95%, respectively.

Notably, as seen in the photo below, increased air agitation resulted in more foam formation, which was found to contain higher concentrations of total suspended solids (TSS), total dissolved solids (TDS), and fats, oils, and grease (FOG) than in the water portion. The water from high agitation treatments consequently demonstrated lower TSS and TDS, which Sabo says suggests that organic matter, known to accelerate PAA decay, was removed by the foam, allowing PAA to persist longer and exert stronger antimicrobial effects.



Varying air agitation levels at 100 ppm PAA.

"These results show that high air agitation, in particular, enhances PAA's ability to reduce *Salmonella*. This is likely due to the increased agitation shifting the foam together with the organic compounds away from the water. As a result, PAA's antimicrobial activity is sustained," adds Sabo.

Research continues with the overarching goal to provide the poultry industry with actionable, data-driven insights that support informed decision-making.

"PAA is a complex chemical, particularly when applied in the highly variable environment of poultry chiller media," says Sabo. "By generating needed high-quality data, we are helping processors better manage PAA and thereby support food safety."

The team has compiled a series of research briefs with more information arranged by topic. To learn more, scan the QR code or visit atrp.gatech.edu/research-briefs.

MANAGER'S CORNER

While the Agricultural Technology Research Program (ATRP) is well-known for its more than 50-year history of R&D advances, I'd like to remind our industry and community partners about ATRP's equally impressive Technical Assistance Program.

ATRP's Technical Assistance Program is an important component of our mission and is one of the best ways that we can provide immediate support to Georgia-based firms and individuals. While most technical assistance services are offered free-of-charge, for those involving significant time or testing, a nominal fee may be charged.

Services range from answers to simple help requests to extensive multi-year on-site collaborations in which researchers study specific challenges, collect data, and provide targeted recommendations or solutions (limiting environmental impact, improving food safety outcomes, and measuring animal welfare factors, worker safety and longevity, and robotics and automation solutions).

If you are in need of a solution to a challenge, big or small, please do not hesitate to reach out to ATRP by calling 404-407-8829. Requests also can be emailed to doug.britton@gtri.gatech.edu. Simply include your name, company, contact information, and the nature of your request, and a team member will contact you within 48 hours. After which a more in-depth discussion will be held, and if the request falls within the capabilities of ATRP or the greater Georgia Tech community, a plan and timeline for assistance will be established.

ATRP is pleased to be able to continue providing this excellent service. In fact, we often use input from these assists to gauge situations calling for new research initiatives in energy, environmental, safety, and other areas. As such, the Technical Assistance Program is just one of the key ways we seek to fulfill our vision of Transforming Poultry, Agribusiness, and Food Manufacturing through Advanced Technologies.

Doug Britton, Ph.D.
ATRP Program Manager

Adapting Robot Learning to Poultry Processing

BY BENJAMIN JOFFE

Attending a robotics conference in 2026 looks dramatically different than just a few years ago. The shift mirrors what happened in other AI domains — Computer Vision, Natural Language Processing, Audio — where the focus moved from engineering specific tasks to engineering the learning process itself. In robotics, this means robots now learn by watching humans, with AI models directly predicting manipulation trajectories rather than just identifying objects. This has enabled new complex manipulation tasks: robots are capable of folding laundry, using a commercial espresso machine, and packaging boxes. Practitioners of Robot Learning (as the field is called) now anticipate a "ChatGPT moment" in robotics — a breakthrough where a general-purpose AI model becomes widely useful across many applications.

Of course, we are some time away from that moment and current demonstrations have major limitations: the models are trained for specific environments and tasks and fail to generalize if there are major changes in the surroundings, robot embodiment, or product appearance and orientation. In addition, as an artifact of the demonstrations and hardware, the execution of tasks ranges from slow to glacial. Finally, the major focus of the research community is building a Generalist robot, rather than a robot that is exceptionally robust at a few specific tasks.

These limitations drive Agricultural Technology Research Program (ATRP) work in this area: how to adapt these increasingly capable and constantly evolving Physical AI models and bring them into the processing plant.

Robot Learning methods hold enormous promise for poultry and food processing, largely because these robots can learn the same way a new employee would — by watching and practicing. This approach addresses three critical challenges:

- **Diversity of tasks and environments**: a new task on a new processing line can be learned from a few dozen demonstrations without requiring manual programming.
- **Deformable and variable products**: traditional methods struggle to come up with a way to describe objects that are flexible and vary in size and shape, while end-to-end methods circumvent the issue by mapping the sensor input directly to robot actions.
- **Precise tasks need closed-loop control**: action models generate new trajectories 10-30 times per second, constantly adjusting to what the sensors detect. Importantly, Robot Learning does not require an engineer to program the robot. Instead, anyone proficient in a specific poultry task can train and update the models by letting the robot observe the demonstration.

Robot Learning methods hold enormous promise for poultry and food processing, largely because these robots can learn the same way a new employee would — by watching and practicing.

ATRP researchers have already demonstrated several poultry tasks in the lab learned entirely from demonstrations: for example, chicken breast alignment for DSI machines, wing segmenter loading, and cone loading. Recent work tackles the barriers to industrial adoption. SAIL [1], for instance, enables robots to execute learned tasks faster than the original human demonstrations by generating smooth temporally-consistent trajectories. Other advances focus on robustness — making AI models work reliably despite changes in camera angles, lighting, or product variations through techniques like Adapt3R [2], which anchors visual features in 3D space, and adoption of large Vision-Language-Action models that encode broad semantic and visual understanding.

Benjamin Joffe is a senior research scientist in GTRI's Agricultural Technology Research Program.

The field continues to evolve, and ATRP researchers have a couple of priorities ahead. One is World Models: AI systems that understand cause and effect in the environment, enabling robots to mentally preview actions before executing them. Another is Simulation and Reinforcement Learning, leveraging new methods that allow creation of high-fidelity digital twins of the real environment. This opens the door to training models in simulation and then transferring them to real plants, pushing success rates closer to industrial requirements.

Each iteration of the Robot Learning methods brings us closer to practical adoption in poultry processing. With them comes the promise of flexible automation that can be trained rather than programmed, reducing deployment time and enabling processors to adapt quickly to new products and line configurations.

References:
[1] N. R. Arachchige et al., "SAIL: Faster-than-demonstration execution of imitation learning policies," Conference on Robot Learning (CoRL), 2025, doi: https://doi.org/10.48550/arXiv.2506.11948.

[2] A. Wilcox et al., "Adapt3R: Adaptive 3D scene representation for domain transfer in imitation learning," Conference on Robot Learning, 2025, doi: https://doi.org/10.48550/arXiv.2503.04877.

Hydrogen Fuel for Poultry Cooking

Aklilu Giorges, principal research engineer, discusses his research project "Hydrogen Fuel for Poultry Cooking." The project's focus is on designing a specially tailored heating/cooking system for poultry, where hydrogen serves as the source of thermal energy.

Q: What industrial challenge is the project addressing?
A: The demand for energy continues to rise alongside population growth and the rapid expansion of energy-intensive industrial sectors, which strain existing energy infrastructure and fuel supplies. Thus, diversifying energy sources is crucial to all walks of life, including industrial and consumer food processing. Hydrogen could help mitigate these concerns. When it comes to poultry processing (cooking), the byproduct of hydrogen combustion is water vapor. This has a very positive effect on cooking by creating efficient utilization, and it also inhibits moisture loss from the cooked product — eventually reducing the energy cost while improving yield. In addition, hydrogen can be a non-carbon energy source, reducing the production of greenhouse gases.

Q: What is the project's approach and how is it different from current practice?
A: Hydrogen cooking is not applied in mainstream industrial cooking except by a few niche companies in Europe and Asia. We started this project to understand the implications of using hydrogen in poultry cooking processes, and quickly learned that several challenges must be overcome before the widespread integration of hydrogen in poultry processing occurs. Issues such as leakage and safety, compatibility with current energy infrastructure, flame stability and efficiency, and the design of cooking appliances are among the key factors that need to be addressed.

Our initial study has focused specifically on hydrogen flame stability and the challenges in burning for poultry cooking applications. Hydrogen flame shapes differ from conventional hydrocarbon flames due to hydrogen's unique characteristics. Its high flame speed results in a significantly different flame shape, especially when the fuel flow rate is lower than the flame speed, causing the flame to hug the burner surface. This can negatively affect burner materials, leading to high surface temperatures and potential material damage due to localized overheating. Additionally, high flame temperature facilitates the formation of elevated thermal nitrogen oxide (NOx), which is undesirable.

Flashback can also occur as a result of fuel and flame speed imbalance, creating a situation for the flame to propagate upstream into the burner or injector.

Q: What are the results to date?
A: To date, we have developed a simple burner system that includes a liquid reservoir. The liquid reservoir creates a barrier between the flame and fuel, effectively protecting the burner material and arresting flashback. Furthermore, since the surface temperature is much lower than a burner material without liquid integrated, thermal NOx is significantly reduced.

Q: What has been the most challenging and/or rewarding aspect of working on the project thus far?
A: We have been thinking about this project for several years. Although we have multidisciplinary experts in the fields of hydrogen, combustion, engineering, and processing, we have not yet addressed all the challenges of open-flame hydrogen combustion in food processing applications until the ATRP program gave us an opportunity to work on it. It is rewarding that we have managed to mitigate some of the detrimental effects of the flame, which has led to the development and patenting of a prototype hydrogen oven. We are all excited about the future applications of this technology.

Q: What are the project's next steps and long-term goals?
A: Our current prototype illustrates the feasibility of using hydrogen for poultry cooking and is fully functional. While it is still in its infancy, the current version includes an attached instrumentation and control system. Our goal is to simplify this design to make it similar to a conventional oven with a simple on/off switch. Furthermore, during operation, the prototype generates some flame noise; however, the team has identified the cause and knows how to reduce it. Recently, we have been working on an oven-like cooking process where the flame is contained in an enclosed space, paving the way for industrial applications.

Q: What are the potential benefits for poultry processors?
A: As mentioned earlier, the byproduct of hydrogen combustion is water vapor. In industrial poultry processing, hydrogen can be integrated into cooking methods where minimizing moisture loss is critical. As technology for locally generated hydrogen develops or supply challenges are resolved, the industry may find viable alternatives to current energy sources. Furthermore, hydrogen combustion can be applied to other areas of poultry processing, such as boiling water for scalding, washing, and sanitation.

RESEARCHER PROFILE

Joshua Ira

Job title: Research Engineer I

Education: M.S., Energy Systems, University of California–Davis; B.S., Mechanical Engineering, California State University–Sacramento

Areas of research expertise: Energy Science, Thermal Systems, Manufacturing

List of any poultry industry projects you're working on and your role:
- Enhanced Chilling for Poultry Processing Operations — Leading experimental trials both in the field and lab.
- Improved Core Temperature in Poultry Cooking — Leading fabrication/modification of experimental apparatus and instrumentation for data collection.

What I find most rewarding about working on poultry industry projects: Having an impact on such a prolific industry in the state.

A talent I wish I had: Fluency in multiple languages.

Another occupation I'd like to try: Head coach for a professional soccer team.

My first job: Dishwasher at a Hibachi Fast Food Restaurant ... funny story actually: I was 16, going door to door looking for work, and when I got to the restaurant and asked for an application, they asked if I could come sweep later that night. I did and they gave me the job.

If I could meet someone famous, who would it be and why: Ronaldinho — one of my heroes growing up. Joga Bonito!

One thing people may not know about me: I am semi-ambidextrous (I am confused).

My day would not be complete without: A (potentially unhealthy?) desire to go to McDonald's for lunch.

The last book I read: The Hobbit

The last movie I saw: Marty Supreme

My favorite song: At the moment: "Doggone Cowboy" by Marty Robbins

My motto: Slow is smooth, smooth is fast (from an old welding instructor).

My hobbies: Being in or on the water; going to Harbor Freight for things I didn't know I needed; missing fish on the fly; and wrenching on my 4Runner (because if anyone's gonna mess up the repair on my truck, it's gonna be me).

— SAVE THE DATE —

NATIONAL SAFETY CONFERENCE FOR THE POULTRY INDUSTRY

August 17-19, 2026
Hilton Sandestin Beach Golf Resort & Spa
Destin, Florida

The 2026 National Safety Conference for the Poultry Industry is designed specifically for poultry facility and corporate safety personnel. The three-day event features key presentations on important industry topics and updates on government policy. Other highlights include breakout sessions for discussing best practices and current challenges, as well as networking and knowledge exchange opportunities with other safety and health professionals.

To register, visit **uspoultry.org/programs/education/seminar**

Opportunities for AI in the Food Safety Space

BY WALKER BYRNES

Artificial intelligence (AI) is everywhere — on our phones, in our inboxes, even proofreading this sentence. Vendors promise transformative gains and revolutionary insights. The need for new technologies is real: despite extensive work from producers and regulators, in 2025, the USDA issued four public health alerts and recalled over five million pounds of chicken product [1]. If AI-equipped inspection, monitoring, and analytics can reduce the frequency of these events, the industry stands to benefit considerably.

For poultry processors, the real opportunity is in targeted, incremental adoption of AI where it strengthens existing food safety systems, not replacing the fundamentals with a cure-all black box solution.

Investment in AI for food safety has accelerated, with startups, equipment manufacturers, and large technology providers entering the space. Approaches range from "smart" equipment and plantwide tools that plug into existing QA programs to general "AI data platforms." Processors should ask: Which tools are mature enough for my facility? Where do they fit in my food safety plan? How do they augment my current monitoring practices?

Several near-term applications stand out. AI-driven foreign material detection technologies build on decades of computer vision research. Combining hyperspectral imaging, x-ray, and optical cameras with AI perception models can improve detection of plastics, bone fragments, and other foreign materials. Well-trained systems can adapt to natural product variability and changes in lighting or environment.

Beyond vision, AI models are adept at finding subtle patterns in multimodal data to drive process improvements. Language-based tools can help plants navigate regulations and policies and flag early signs of risk or non-compliance. Imagine securely querying your HACCP plans, regulatory documents, and training materials and getting clear, cited answers tailored for supervisors or new QA staff.

While these applications are promising, they are not plug-and-play solutions. A device being "AI-enabled" does not guarantee it will work robustly, and can pose a risk if applied improperly. Key considerations include data access and ownership, clear objectives, and training of personnel.

Data security is a major concern; many companies have leaked sensitive information through misconfigured AI tools [2, 3]. Retaining legal ownership of your data is not enough if third parties can access or learn from it. Distinguishing between truly local/on-premise tools and cloud-hosted services is critical; that choice can separate responsible AI use from a significant data leak.

Processors should also seek measurable impact from models: How will this tool affect yield, labor efficiency, audit performance, or risk reduction? What problem is it solving and how will you know it is working? No AI model is perfect. AI models are probabilistic and trained from historical data, so processors should maintain well-defined fallback procedures to catch new errors and avoid over reliance on automated decisions.

Walker Byrnes is a research engineer II in GTRI's Agricultural Technology Research Program.

AI will not disappear; it will only become more capable and embedded in operations as it matures. Producers must understand what these tools can and cannot do and implement safeguards around data, cybersecurity, and governance when using them.

Regulators should work with industry to establish policies and guidelines that both protect consumers and support innovation.

AI technologies can either strengthen food safety or introduce new vulnerabilities. The outcome depends on how they are integrated: clear objectives, alignment with HACCP controls, robust cybersecurity, and a well-trained workforce.

As with any emerging technology AI should be adopted deliberately, with careful testing and governance, to ensure it serves your organization's food safety and business goals.

References:
[1] https://www.fsis.usda.gov/food-safety/recalls-public-health-alerts/annual-recall-summaries/summary-recall-and-pha-cases-2

[2] https://www.infosecurity-magazine.com/news/leading-ai-companies-secret-leaks/

[3] https://www.tomshardware.com/tech-industry/cyber-security/vercel-breached-after-employee-grants-ai-tool-unrestricted-access-to-google-workspace

‘Bytes & Bites’: Cybersecurity Meets Food Safety

The following spotlight highlights a recent episode of the Georgia Tech Research Podcast, where ATRP’s Stephanie Richter discusses cybersecurity implications for food safety with Smith Sheehy, vice president of program development and board advisor for the Cybersecurity Association of the Food Industry (CSAFI).

As food production becomes more automated, connected, and data-driven, the greatest threat to a processing plant may no longer be a mechanical failure in the supply or cold chains, but a single malicious email. That’s the warning from Smith Sheehy, vice president of program development and board advisor for the Cybersecurity Association of the Food Industry (CSAFI), in a recent episode of the Georgia Tech Research Podcast.

Sheehy, a Georgia Tech executive MBA graduate, joined host Stephanie Richter, a researcher in GTRI’s Agricultural Technology Research Program (ATRP), to unpack why cybersecurity is now inseparable from food safety, and what producers, from major processors to small plants, can do today to reduce their risk.

Sheehy has spent about a decade as a cybersecurity and privacy consultant, specializing in assessing organizations’ security programs to help them “go from this point of maturity to a more secure one based on your budget and your business objectives.”

In the episode, she explains that the food industry faces the same core problem as every other sector: cybersecurity is expensive, and its return on investment is invisible when things are working well.

The discussion is an extension of a keynote talk she gave at the recent International Food Automation Networking Conference (IFAN), held at Georgia Tech. Her talk was titled “Bytes & Bites: Making Cybersecurity Appetizing for the Food Industry.”

She says a central, recurring theme whenever she speaks on the subject is “The automation and process equipment side of this industry is advancing fast.”

“More connected systems, smarter lines, data everywhere. And the reality is, most of it wasn’t built with security in mind. So, while there’s a lot to be excited about (and there should be), I can’t help but see every new connection as a new entry point.”

Many decision-makers still ask, “Why spend more if nothing bad has happened yet?”

To listen to the episode, scan the QR code below or visit gtri.gatech.edu/podcast

“There isn’t [a traditional] return on investment,” Sheehy explains. “If nothing happens, that’s your return on investment. You are investing in the hope that it doesn’t happen to you.”

However, she warns that waiting is costly. Plants built decades ago are now being retrofitted with smart sensors, robotics, and cloud-connected systems, often faster than cybersecurity measures are implemented to complement them. The longer organizations delay, the more expensive and disruptive it becomes to retrofit security into their infrastructure.

To illustrate the stakes, Sheehy discusses the ransomware attack on JBS Foods [disclosed publicly in June 2021], one of the largest meat producers in the United States, responsible for roughly 20–30% of the country’s meat supply.

The incident, she notes, is believed to have started with a single phishing email. A malicious link was clicked, malware spread quietly through the systems for months, and then, one day, everything locked up. The attackers demanded $11 million in Bitcoin.

Sheehy uses this case to highlight two core realities. Many attacks start with ordinary employees and everyday email; and without regular, secure backups, restoring operations can be slow, partial, and extremely expensive.

She compares digital threats to biological pathogens that food processors understand well:

“When we compare virus to virus … when you have *Salmonella* in your factory, you have to clean the entire thing out in order to make sure that we get back to ground zero. It’s the same with cybersecurity. You basically have to go in and carve out all the bad stuff.”

That “carving out” often means restoring systems from older backups — losing data, efficiency improvements, and time.

Smith Sheehy’s Cybersecurity Tips

Despite the scale of modern attacks, Sheehy stresses that basic, disciplined habits go a long way, especially for smaller organizations that feel stuck below a “cybersecurity poverty line.”

continued on page 8

‘Bytes & Bites’: Cybersecurity Meets Food Safety

continued from page 7

She highlights some concrete steps that individuals and companies can take right away:

- Use a password manager and stop reusing passwords.
- Reusing the same password across accounts is still one of the biggest vulnerabilities.
- Protect yourself on public Wi-Fi with a VPN.
    - Protect yourself and your data when at public networks, in airports and coffee shops, which are prime playgrounds for attackers.
- Invest in people and training.
    - Sheehy offers that regular, engaging training and clear policies (for example, “we do not reuse passwords”) are often more impactful than pouring money into yet another security product. She’s even a fan of deliberately cheesy training videos because they’re memorable enough to stick.

On the organizational side, she also urges companies to:

- Pull cybersecurity and IT teams in early when adopting new robots, sensors, or AI tools, instead of calling them only after something breaks.
- Standardize tools (such as an approved AI platform), rather than letting every employee choose their own.
- Implement consistent, automated backups — often as simple as scheduling frequent “snapshots” of systems and storing them safely offline.

Cybersecurity as Food Security

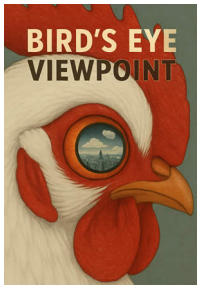
Throughout the episode, Sheehy repeatedly underscores that food, energy, and people are the pillars of a nation’s resilience — and that cyberattacks on food infrastructure are not theoretical.

“There’s been talks in my industry: if you’re going to shut down a country, you attack them on their energy, you attack them on their food, and then eventually their people,” she says. “The food industry is so critically important … any delay … could cause delays everywhere else because of how critical timing is in this industry, where quality deteriorates by the minute.”

Did You Know?

USPOULTRY Offers Viewpoint Blog

The U.S. Poultry & Egg Association (USPOULTRY) offers a regular blog called Bird’s Eye Viewpoint. According to USPOULTRY,



“**Bird’s Eye Viewpoint** offers a fresh perspective from the inside out. Get a behind-the-scenes look at the people, progress, and passion driving the poultry industry forward. From industry insights to staff stories across USPOULTRY’s communications, environmental, education, regulatory, HR & safety, research, IT, and membership teams — this is your all-access perch to see what’s hatching in our world.”

Check out the blog at **uspoultry.org/media-center/birds-eye-view-blog**

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Agricultural Technology Research Program
GTRI/ATAS/ISTD
Atlanta, GA 30332-0823

Phone: 404-407-8812
FAX: 404-407-8569

Angela Colar
Editor
angela.colar@gtri.gatech.edu

Doug Britton, Ph.D.
ATRP Manager/Editorial Adviser
doug.britton@gtri.gatech.edu

Online:
atrp.gatech.edu

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