ENGINEERING TOMORROW'S POULTRY INDUSTRY

# PoultryTech

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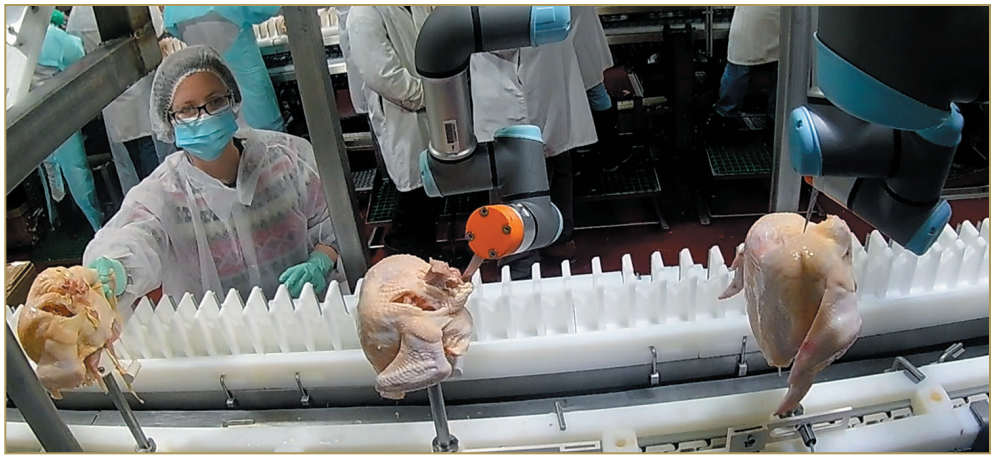
## AI Robotic Automation Key to Poultry Processing Evolution

BY LOUISE POIRIER, SENIOR EDITOR, *MECHANICAL ENGINEERING MAGAZINE*
ASME (THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS)

https://www.asme.org/topics-resources/content/harnessing-ai-robotics-to-debone-chickens


Although the advent of the assembly line helped set the stage for increased productivity and efficiency across numerous industries, some benefited more than others. The poultry industry has taken some steps to adopt assembly line strategies but has remained somewhat stagnant with limited addition of robotics at the product level, still relying heavily on human workers to debone chickens to get the most meat yield possible at processing plants. But a team from four research institutions — the University of Arkansas, Georgia Institute of Technology, University of Nebraska-Lincoln, and Fort Valley State University — is leading an effort to develop industry-specific AI and robotics specifically for this purpose.



*Researchers in the Georgia Tech Research Institute's (GTRI) Agricultural Technology Research Program (ATRP) are part of a $5 million grant from USDA-NIFA that establishes the Center for Scalable and Intelligent Automation in Poultry Processing. Led by the University of Arkansas System Division of Agriculture, the collaborative effort aims to adapt robotic automation to the poultry processing industry. Pictured above is ATRP's prototype Intelligent Cutting System. The system's robotic arm is equipped with a knife that will execute a unique knife path to extract the maximum amount of meat from each unique carcass on a deboning line in a poultry processing plant. GTRI has received $2.1 million of the grant to further development of the system as well as other advanced robotics.*

A four-year $5 million grant from the U.S. Department of Agriculture's National Institute of Food and Agriculture establishes the Center for Scalable and Intelligent Automation in Poultry Processing. Led by the University of Arkansas System Division of Agriculture, this collaborative effort will merge AI, machine learning, and robotics to advance chicken meat processing operations, sanitation, and even the social effects of AI robotics on the industry.

### Industry hurdles

Unlike machinery assembly lines, chicken deboning lines face tremendous biological variability, explained project director Jeyam Subbiah, a professor and head of the food science department for the Division of Agriculture and the Dale Bumpers College of Agricultural, Food and Life Sciences at the University of Arkansas.

"There are few robotic deboning systems implemented in the industry," he said. "So, one of the things we are trying to look at is how do we use AI

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and how do we individualize the cut based on each bird? That's the main objective."

Raw chickens are slippery and squishy, affecting how they respond to robotic manipulation. Automated robotics has lagged not only in meat processing, but in other processes where there are innumerable variables, such as harvesting fruits and vegetables outdoors.

"Because of AI's ability to use deep learning, where you can give the computer just lots and lots of examples of chickens or lots and lots of examples of peach trees, it'll figure out the patterns that will allow you to make sense of that unstructured environment," explained Ai-Ping Hu, principal research engineer, Agricultural Technology Research Program, at Georgia Tech. "So that's how we're leveraging those technologies that again have really just come to the forefront within the last couple of years, and we want to apply it to a place where it's critically underserved."

Some tasks are automated, but don't really deal with handling the product, but rather after it's been packaged or the packaging process, Hu added. Poultry processing plants rely on workers, who typically stand in refrigerator-like temperatures for 8-10 hours a day deboning chickens at a rate of about 35 to 40 a minute. Although it's the most skilled job at the plant, it also has turnover of 50 percent or more annually.

Add to that "no rehire" policies that exist at some facilities, and now some plants are to the point of bussing people in from neighboring counties since they've run through everyone nearby, Hu noted.

**Assistance unlocked**

Researchers are focusing their efforts on four core objectives. The first two are merging AI and robotics to help the poultry industry achieve better yields at chicken deboning facilities and introducing virtual reality-assisted robotics.

Georgia Tech has received $2.1 million of the grant to develop the first automated poultry processing lines. "The way we're doing that is we're using machine vision to be able to characterize each unique bird carcass," Hu said. "From that, we're able to predict where that shoulder joint is to a few millimeters."

***"There have actually been plants that put in fixed automation solutions at really high costs, and they've actually taken it out because they find that they lose too much yield, and they put people back in. We've got a solution where we can adjust to every unique bird because you've got a robot that can move and adjust itself, just like a human arm can."***

***– Ai-Ping Hu, Ph.D., GTRI principal research engineer***

A robotic arm equipped with a knife will then execute a unique knife path that will extract the maximum amount of meat from that unique carcass. Although fixed automation machines do exist, they are limited in settings and take too much of a one-size-fits-most approach, leaving too much meat behind. Automated deboners will leave 16 percent to 17 percent of meat on a carcass, Subbiah said, while human deboners will only leave about 13 percent.

"There have actually been plants that put in fixed automation solutions at really high costs, and they've actually taken it out because they find that they lose too much yield, and they put people back in," Hu said. "We've got a solution where we can adjust to every unique bird because you've got a robot that can move and adjust itself, just like a human arm can."

Profit margins are slim, and the loss of even one percent of yield would translate to around $1.5 million per plant per year, Hu explained. "That's like a couple of nickel's worth of meat per carcass. That really adds up if you're cutting hundreds of birds per minute."

The team aims to have a plant-ready system that has been tested within a plant for at least six months, to prove that it's ready for commercialization and can perform at parity or better than human workers.

"We think that with proper programming and learning from human trials that we can actually come up with a system that will exceed what people can do," Hu added.

To further assist with machine learning, the second objective will explore the use of VR to change how labor is performed in chicken processing plants.

"We have an interface that allows a headset wearer to be virtually inside a plant and they'll actually work with the robot to do a task such as picking a bird out of a big pile and then putting it onto an assembly line," Hu explained. "Because AI is not really 100 percent accurate quite yet, there are still things that a person's able to do better. The idea is collaboration between the robot and that headset. Once the robot knows where to approach that carcass, it does the rest because it's physically inside the plant."

This approach would diversify the workforce, making it possible for

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## Celebrating the Past and Looking Toward the Future

For the Georgia Tech Research Institute's Agricultural Technology Research Program (ATRP), 2023 marks an incredible milestone as we celebrate 50 years of driving innovation in poultry, agribusiness, and food manufacturing. On April 27, more than 150 attendees gathered at the Historic Academy of Medicine at Georgia Tech to celebrate the people and projects that made the program's first five decades a success. What began in 1973 with a $100,000 appropriation from the Georgia General Assembly to involve Georgia Tech in studies supporting the poultry industry has today grown into a multi-million dollar investment that continues to support Georgia's number one agribusiness sector.

While the support of the State of Georgia and the University System of Georgia (USG) have certainly made it possible for us to do this work, it is the remarkable people who have been part of the program over the years that have really made it stand out. It was my distinct honor to welcome ATRP past and present team members, program supporters including industry, university, and government partners, and representatives from our state and federal legislative offices to enjoy the anniversary celebration and luncheon.

An especially memorable part of the celebration was our recognition of two very important individuals. F. Abit Massey, president emeritus of the Georgia Poultry Federation, was honored as the ATRP Champion for his unending support and advocacy that have been a major catalyst in the growth and success of the program. J. Craig Wyvill, ATRP director emeritus, was honored as the ATRP Pioneer; it was under his leadership that ATRP blossomed and grew into a vibrant and internationally recognized program. In recognition of their significant legacies, the program has established the F. Abit Massey Champion Award and the J. Craig Wyvill Pioneer Award. Moving forward, the awards will be presented as deemed appropriate to individuals who exhibit the qualities of each award's namesake.

In addition to Abit and Craig, it was a privilege to have USG Chancellor Sonny Perdue, Georgia Commissioner of Agriculture Tyler Harper, Harrison Poultry President and CEO David Bleth, Georgia Tech Executive Vice President for Research Chaouki Abdallah, and GTRI Director Jim Hudgens all provide remarks highlighting the importance of technological solutions for the future viability of poultry and Ag. At the conclusion of the celebration event, all attendees had the opportunity to browse the research showcase and demos of current technologies under development.

One of the most enjoyable aspects of my role with ATRP has been the opportunity to develop so many lifelong friendships. While I have said it before, the 50th celebration really cemented for me how special the people of ATRP really are. This includes all of the past and present researchers, staff, and students who have and continue to contribute to the program, as well as all of our external industry, academic, and federal lab partners, without whom the program would not have the impact that it does today. As I look toward the future, I am very excited, as the next generation of bright and energetic people continue to build on the incredible ATRP legacy, and drive forward the innovation needed to keep poultry and Ag a viable industry for years to come. So here's to the next 50 years of ATRP, and thank you for being a key part of our future success!

Doug Britton, Ph.D.
ATRP Program Manager


*ATRP has established the F. Abit Massey Champion Award and the J. Craig Wyvill Pioneer Award as part of the continuing legacy of the program and in recognition of each individual's contribution to the development, growth, and sustainment of ATRP.*

*Pictured (l-r): Jim Hudgens, GTRI director; F. Abit Massey, president emeritus of the Georgia Poultry Federation; J. Craig Wyvill, ATRP director emeritus; and Doug Britton, ATRP program manager.*

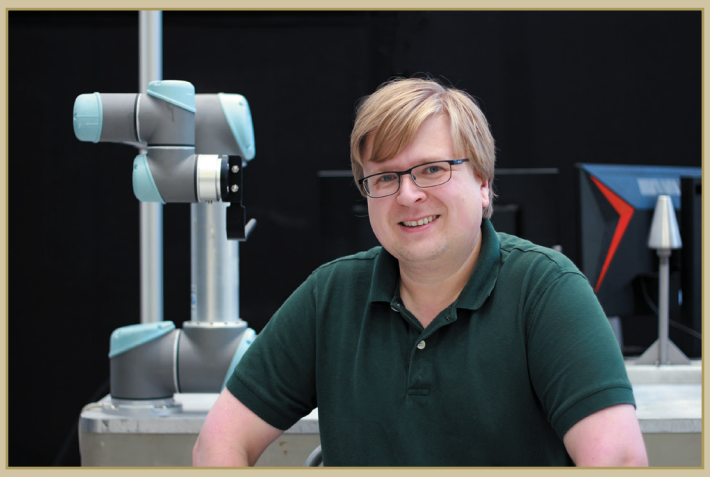
For a glimpse into the program's history and to listen to a special podcast series commemorating the anniversary, visit the 50th Anniversary webpage at **atrp.gatech.edu/atrp50**

# R. Harold and Patsy Harrison Research Faculty Fellowship in Poultry Technologies Expands Opportunities for Early-Career Researchers

*The R. Harold and Patsy Harrison Research Faculty Fellowship recognizes innovative, promising early-career research faculty interested in exploring breakthrough applied engineering and science research to address poultry industry challenges. The three-year fellowship, within the Georgia Tech Research Institute's Agricultural Technology Research Program (ATRP), is awarded to an entry-level researcher through a competitive application process. The fellowship's first recipient, Konrad Ahlin, recently completed his tenure, and PoultryTech asked him to share his thoughts on the experience.*

***Q: PoultryTech – What drove you to apply for the fellowship?***

***A: Ahlin –*** I was driven to apply for the fellowship so that I could learn more about the poultry industry. I have a background in robotics and mechanical systems, and I wanted to help apply these skills to food processing. The dexterity and coordination required to emulate manual labor is beyond the capacity for machines to replicate, so I believe that food processing and agriculture will be the next frontier of robotics. This fellowship was an amazing opportunity to learn more about how poultry products are made in this country and where the challenges are.



*Konrad Ahlin, Ph.D., the first recipient of the R. Harold and Patsy Harrison Fellowship in Poultry Technologies, is a research engineer II with expertise in robotics, controls, and path planning.*

***Q: PoultryTech – What was the focus of your research?***

***A: Ahlin –*** The focus of my research was on manipulation of products. One of the crucial and most challenging aspects of robotics is the boundary where machines meet the real world. Understanding the nuances of grasping, lifting, and manipulating is crucial if we want robots to interact with manufacturing. Within the poultry industry, strategies for handling the product change with every step of the process, compounding the complexity of introducing mechanical labor.

***Q: PoultryTech – What was the most rewarding aspect of your fellowship experience?***

***A: Ahlin –*** The most rewarding aspect of the fellowship was the opportunity to meet people. I spoke last year at the RMC [American Meat Science Association's Reciprocal Meat Conference], and, at that event and others, I have talked with people from every stage of poultry processing. From farmers who raise the birds, to the operators who debone the product, to the owners who run the processing facilities. Also, learning about how poultry is processed has been extremely rewarding. The infrastructure is amazingly complex, with hundreds of nuances threaded through each task.

***Q: PoultryTech – Did the fellowship provide you with any insights that you hadn't anticipated?***

***A: Ahlin –*** I have a philosophy when it comes to robotics: if you want to automate a task, you first have to do it yourself. The insight that most impressed itself on me through this process is how far robotics still has to go before it can compete with the dexterity and subtle artistry of a person. Often, if a person performs a task for long enough, they will find the most efficient means of performing the task. As a roboticist, I strive to learn from people so that I can apply those methods to machinery. What I hadn't expected was just how optimized these tasks have become under human-powered labor. People always find the best, most efficient way to do something within their constraints.

***Q: PoultryTech – Were there any opportunities the fellowship provided that you may not have had otherwise?***

***A: Ahlin –*** This fellowship was an opportunity for me to learn. Before the fellowship, I had some limited insights into the poultry industry. However, during the fellowship, I had the freedom to explore and experiment with different ideas to gain a better understanding of how the poultry industry operated.

***Q: PoultryTech – How has the fellowship influenced your research path and career goals?***

***A: Ahlin –*** This fellowship has pushed me out of my comfort areas. I don't know that my research will drastically change the industry, but I do know that nothing will be changed by tame questions or timid ideas.

***Q: PoultryTech – What advice would you give to other early-career researchers who may be interested in applying for the fellowship?***

***A: Ahlin –*** I would suggest that any researcher who is interested in applying for the fellowship should go into the experience with questions rather than answers. Researchers want to find solutions; it's the nature of the job. However, take the time to listen to those in industry. Observe how it's done. Find out what the needs are. Only then should you find the questions that interest you and pursue them. Take risks, be bold, and see what you can discover.

# RESEARCHER PROFILE

## Jordan Ash

*Job title:* Research Scientist II

*Education:* B.S., Food Science & M.S., Chemistry – Purdue University

*Areas of research expertise:* I am an analytical chemist with a specialty in instrument analysis. I also work on novel filtration and sensing technologies.

*List of any poultry industry projects you're working on and your role:*
Currently, I am helping to develop and implement a new way for determining peracetic acid concentrations within the poultry processing line in a plant.

*What I find most rewarding about working on poultry industry projects:*
Food safety and food deserts are both something that I care a lot about; I feel that my work in this space can make an impact in making it safer and easier to supply to those in need.

*A talent I wish I had:* Play the piano

*Another occupation I'd like to try:* Pilot

*My first job:* My first job post all of my schooling was as an Explosive Chemist for the U.S. Army.

*If I could meet someone famous, who would it be and why:* Ozzie Smith, favorite baseball player

*One thing people may not know about me:* I have lived in more than half of the states.

*My day would not be complete without:* Coffee

*The last book I read: Words of Radiance*

*The last movie I saw:* Dungeons and Dragons

*My favorite song:* "All the Small Things"

*My hobbies:* I enjoy working out, playing sports, and all things fantasy/science fiction.

# — SAVE THE DATE —

NATIONAL SAFETY CONFERENCE FOR THE POULTRY INDUSTRY

**August 14-16, 2023**
**Hilton Sandestin Beach Golf Resort & Spa**
**Destin, Florida**

The 2023 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**

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anyone with access to VR goggles and haptics gloves to, once trained, work in such a facility remotely. It would also allow for plants to be more ideally located to reduce transportation costs and environmental impacts. "The intent is really to help the poultry industry to advance and be more sustainable," Subbiah added. It could even be applied to other industries once refined.

Although the person helping the robot via VR would slowly work their way out of the job because AI will continue learning, that is the goal. The team hopes to have a proof of concept where the VR robot could at least match human workers' output. "We also want to have proof of concept that it's actually learning by itself," Hu said.

Pilot processing plants in Arkansas and Georgia will help the researchers test modules, Subbiah added.

**Broadened scopes**

As for the final two objectives, the center will explore robotic and sensor assisted sanitation and determine the social impacts the use of such technology will have on industry and people near to it.

The Arkansas Agricultural Experiment Station, the research arm of the University of Arkansas' Division of Agriculture, received $2.2 million from the grant to focus on food safety automation.

Among the goals are looking at robotic sanitation, where an automated vehicle with hoses and scrubbers can go around a poultry plant to clean. Another is using a mobile robotic platform that uses a biosensor to "biomap" the facility, highlighting hot and cold spots, where organic material or bacterial populations are high, Subbiah explained. "Then where it seems to be high, the robot takes a swab for a traditional microbial analysis. Then you can see places that need to be cleaned better. So, we'll automate environmental mapping so that we can proactively improve food safety."

The team is also working on a hyperspectral imaging system to detect the foreign materials on the processing line, such as pieces of plastic, gloves, or other nonmetallic items that an x-ray would otherwise detect.

A proof-of-concept system with robots cleaning plants is the end goal. "We also think that with an automated solution where the robot can see exactly what places need more attention, you can actually save water [during the sanitation process], so I think there's an environmental component there as well," Hu added.

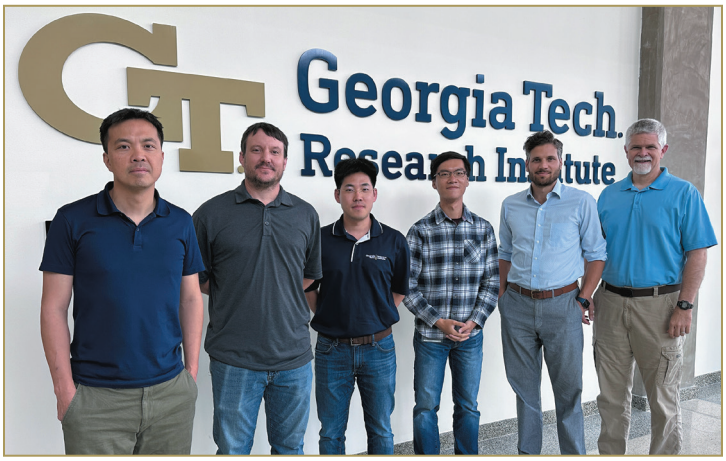
Remaining grant funds have been allocated to the University of Nebraska-Lincoln and Fort Valley State University in Georgia. The UNL team is leading the fourth objective, which examines the social components of this entire effort and will be led by Julia McQuillan, Willa Cather professor of sociology.

"They'll be answering questions such as, if you start introducing robots into these environments that have never seen robots, what is the implication to the people working inside the plant? What is the implication to the whole food chain? All those kinds of not strictly technical problems, but rather the 'silo' impact," Hu explained.

This effort will culminate in a set of guidelines or best practices for how the industry introduces automation and other such technology.

At the end of the four-year process, the Center for Scalable and Intelligent Automation in Poultry Processing will look to license out the resulting technologies for scaling and production at a commercial level.

"I think it's rare in an engineer's career to be able to work on a project that will impact so many people, and where there's such a clear need for it," Hu said. "I think a lot of times — and I'm guilty of this as well — when you do research projects, oftentimes in a sense, the justification for why it's important is fairly cursory. Here, there's a demonstrated need. I know it's going to have a real-world impact on lots of people from all different strata of the industry."




*GTRI Team Members (l-r): Ai-Ping Hu, principal research engineer; Colin Usher, senior research scientist; Michael Park, research engineer I; Yu Hang He, research engineer I; Benjamin Joffe, research scientist II; and Doug Britton, principal research engineer. Not pictured: Konrad Ahlin, research engineer II.*

*Also not pictured: Shreyes Melkote, who holds the Morris M. Bryan, Jr. Professorship in Mechanical Engineering at Georgia Tech and serves as associate director of the Georgia Tech Manufacturing Institute and executive director of the Novelis Innovation Hub, joins his GTRI colleagues as a member of the team.*

# U.S. Poultry Industry Provides 2 Million Jobs and $556 Billion in Economic Impact

***Updated Study Quantifies the Economic Impact of the Poultry Industry in the United States***

The U.S. Poultry & Egg Association (USPOULTRY), National Chicken Council, National Turkey Federation, and United Egg Producers recently released an updated economic impact study that highlights the positive impact the poultry industry has on jobs, wages, and federal and state revenue in the United States.

A dynamic and integral part of the national economy, the U.S. poultry industry provides 2,012,269 jobs, $125.6 billion in wages, $555.9 billion in economic activity, and $33.7 billion in government revenue.

"We are pleased to continue providing this valuable tool across the industry that shows the positive economic impact the poultry industry has on our nation and communities," said John Starkey, president of USPOULTRY.

The data is hosted on interactive websites that can be viewed collectively or by individual product, and then sorted nationally by state, congressional district, state house district or state senate district, and county. For more information about the U.S. poultry industry's economic impact, visit:

poultryfeedsamerica.org
chickenfeedsamerica.org
turkeyfeedsamerica.org
eggsfeedamerica.org

USPOULTRY funded the economic impact study, which was conducted by New York City-based John Dunham & Associates. The study was updated using the most current methodology available and uses data from 2022.

The study breaks down poultry into three subcategories: chicken, turkey, and eggs. Key economic data from each is shown below:

The chicken industry provides:
1,517,797 jobs
$94.9 billion in wages
$417 billion in economic activity
$25.5 billion in government revenue

The turkey industry provides:
362,437 jobs
$22.7 billion in wages
$99.5 billion in economic activity
$6.1 billion in government revenue

The egg industry provides:
112,723 jobs
$6.9 billion in wages
$33.7 billion in economic activity
$1.8 billion in government revenue

## Technical Assistance Is Just a Phone Call Away

The Agricultural Technology Research Program (ATRP) provides no-cost technical assistance to Georgia-based firms and individuals in the poultry industry. These assists range from simple inquiries regarding information or help needed to address a problem to extensive on-site consultations in which researchers collect data and provide a report on their findings and recommendations. The program also offers in-plant energy usage/cost assessments and workplace safety evaluations.

ATRP uses input from all assists to gauge situations calling for new research initiatives in energy, environmental, safety, and other areas. Researchers provided more than 20 technical assistance services in FY 2022.

To inquire about the program or to schedule an assist, call ATRP Program Manager Doug Britton at (404) 407-8829 or email him at doug.britton@gtri.gatech.edu.

## Did You Know?

### Chicken Production in the U.S. is more sustainable than ever before.

The U.S. chicken industry is committed to environmentally responsible and sustainable chicken production practices to ensure a healthier planet.

The environmental footprint of chicken production has **decreased by 50%** since 1965.

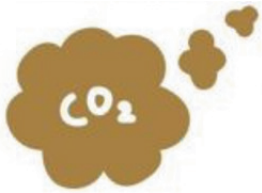
It takes **75% fewer resources** to produce the same amount of chicken than it did in 1965 and ...

**72% less farm land**

**58% less water**

**39% less fossil fuels**

Over **95% of poultry litter** is recycled and reused to fertilize crops.
Poultry litter is an extremely valuable resource in agriculture. Farmers collect and store poultry litter to be used as an organic fertilizer for crops. Plants feed the chickens and chickens fertilize the plants — it's a closed, sustainable nutrient loop.




**36% reduction in greenhouse gas emissions.**
Chicken farmers are continuously adopting new technology to reduce energy use.

**Beyond the chicken meat, how is the rest of the chicken used?**
Beyond your chicken breasts, wings, legs, and thighs, every part of the chicken is utilized. Here are some ways that chicken is repurposed and recycled:

- Chicken feathers are especially valuable. The U.S. poultry industry produces 1.6 million tons of feathers every year. Most feathers are ground up into "feather meal" and used as animal feed as they are an excellent source of protein for livestock. Feathers can also be used as plastic fortifiers.
- Chicken feet are known as "paws" in the poultry business. The U.S. exports about 330 tons of chicken paws every year, mostly to Asian nations where they are considered a delicacy. In the U.S., you can find them in Asian markets and in pet stores as dog treats.
- Chicken organs, like chicken hearts and chicken livers (gizzards), are often sold in your local grocery store for human consumption. Extra chicken organs may be sent to a rendering plant to be made into pet food.

*Source: chickencheck.in/faq/sustainability (a website sponsored by the National Chicken Council)*

## Like Us on Facebook

ATRP's Facebook page features information about exciting research initiatives underway, interesting poultry and food industry news, industry events, photos, videos, and more!

**facebook.com/ATRP.GTRI**

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