2014 ANNUAL REPORT
Fiscal Year 2014 marked another productive year for the Agricultural Technology Research Program (ATRP) as we continued to pursue our four-part mission of research, education, technical assistance, and outreach in support and advancement of Georgia’s dynamic poultry industry.

As you will see in this report, our research projects are driving novel technology developments that address a number of food safety, animal well-being, worker safety, and environmental sustainability challenges facing poultry production and processing. At the same time, significant progress on our Intelligent Cutting and Deboning System and the Cone Line Screening System has allowed us to begin the process of partnering with industrial equipment companies to migrate these more mature technologies out of the research lab and into commercial products.

Our technical assistance and outreach initiatives continued, with researchers and staff responding to more than 30 requests for assistance and information, participating in several trade and industry events including the International Poultry Expo, and producing the highly acclaimed PoultryTech newsletter that highlights cutting edge research and provides valuable industry updates.

Our educational outreach included the direct engagement of high school and college students in ATRP research efforts as well as partnerships with a variety of Science, Technology, Engineering, and Math (STEM) programs in K-12 classrooms throughout the state. We also co-hosted the poultry industry’s only nationwide workplace safety conference in partnership with the U.S. Poultry & Egg Association.

The success of ATRP is significantly strengthened by the solid collaborative and supportive relationships we share with our industry and academic partners, and for this, we are extremely grateful. These partnerships enable ATRP to more effectively pursue our vision of being the technology innovation and development provider for poultry, agribusiness, and food processing.

Doug Britton, Ph.D.
ATRP Program Manager
Recognized as one of the leading programs of its kind in the country, the Agricultural Technology Research Program (ATRP) works closely with Georgia agribusiness, especially the poultry industry, to develop new technologies and adapt existing ones for specialized industrial needs. These innovations are designed to maximize productivity and efficiency, advance safety and health, and minimize environmental impact. The program is conducted in cooperation with the Georgia Poultry Federation with input from an external Advisory Committee consisting of representatives from leading poultry companies and allied organizations.

**MEMBERS**

David Bleth, Harrison Poultry (Chair)  
Jonathan Green, American Proteins  
Mikell Fries, Claxton Poultry  
Steve Snyder, Claxton Poultry  
Bill Crider, Coastal Meats  
Charlie Westbrook, Cobb-Vantress  
Phillip Rehberg, Crider Poultry  
Bob Dowdy, Keystone Foods  
John Wright, Fieldale Farms  
Alan Habegger, First Fresh Foods  
Joe Cowman, Gainco  
Ed Harmon, Georgia Power  
Kelly Horne, Griffin Industries  
Chad Ware, Marel Stork Poultry Processing  
John Weeks, Mar-Jac Poultry  
Joel Williams, Mar-Jac Poultry  
Heath Jarret, Meyn Equipment  
Jeramie Martin, Meyn Equipment  
Wally Hunter, Perdue Farms

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**ADVISORY COMMITTEE**

Mike Giles, Georgia Poultry Federation  
Abit Massey, Georgia Poultry Federation  
Louise Dufour-Zavala, Georgia Poultry Laboratory Network  
Mike Lacy, University of Georgia  
John Glisson, USPOULTRY Harold E. Ford Foundation
Preparation of Magnetic Beads for Low-Level Pathogen Preconcentration

PROJECT GOAL: To develop a prototype sampling system that uses coated magnetic beads to capture and hold pathogens/bacteria in fluid samples for food safety applications.

FY 2014 DEVELOPMENTS: Researchers prepared magnetic nanoparticles of various sizes and then coated a number of samples to enhance pathogen attachment. They found the capture of pathogens by coated magnetic nanoparticles to be fast and reversible, with greater than 95 percent cell capture efficiency of Salmonella from a sample buffer and above 50 percent cell capture efficiency from a whole bird rinse within 10 minutes. The research team also evaluated the ability of coated magnetic nanoparticles to reduce the turbidity of chiller water through protein absorption.

Intelligent Cutting and Deboning System

PROJECT GOAL: To develop a 3D imaging/robotic cutting arm to automatically perform precision cuts that optimize yield while eliminating the risk of bone fragments in finished poultry products.

FY 2014 DEVELOPMENTS: During laboratory testing, the prototype Intelligent Cutting and Deboning System performed clavicle/shoulder/scapula cuts on both sides of bird front-halves without cutting into bone. To date, the yield rivals that of a human deboner. Researchers were able to achieve this milestone by redesigning the knife holder to accommodate side-loaded birds and by improving the image processing algorithms to achieve better than 5 mm accuracy when predicting the bird’s internal structures from external features.

Monitoring Bird Status in Broiler Housing Using Audio

PROJECT GOAL: To analyze bird vocalizations to determine whether or not deviations from normal behaviors are occurring due to environmental conditions, disease, or other stressors.

FY 2014 DEVELOPMENTS: During FY 2014, researchers focused on collecting additional data for validation of the system’s audio processing algorithms. Specifically, they designed and implemented a Vocalization Processing Testbed (VPT). The VPT provides a framework for applying multiple speech processing techniques using audio spectra along with features that drive human interpretation. Researchers think this will allow for a more complete characterization of the soundscape of the growout environment. A smartphone application for data collection and remote monitoring of conditions within the house was also developed.

Chicken Egg Fertility Detection

PROJECT GOAL: To use noninvasive and rapid spectro-photometric techniques to track the changing embryo in-ovo or inside the egg, providing insight into a number of practices from animal health and well-being to the inoculation regime.

FY 2014 DEVELOPMENTS: During FY 2014, researchers explored whether the sex of the embryo could be determined. Various sensing methods were used to detect estradiol, but none proved effective as it was discovered that hormonal differences are small in the early stages of egg development. However, progress continued to be made in using high pressure liquid chromatography and fluorescence measurements to predict fertility and embryonic development.
Mobile Motion Capture System

**PROJECT GOAL:**
To develop a mobile system using smartphone technology and kinematic sensor modules to capture ergonomics data from workers in a poultry processing plant to assess worker rotation schemes and worker fatigue.

**FY 2014 DEVELOPMENTS:** During FY 2014, researchers updated the mobile system’s smartphone software and the materials needed to secure the modules on an individual worker’s wrist, arm, back, and leg for measuring ergonomic motions as work is performed. The system was used for an in-plant study to assess the motions of workers on a live hang line. The study gathered ergonomic data for 10 participants at a local poultry processing plant as they hanged birds in various line positions throughout their shift. Analysis of study results continues and will be used to prepare a report on rotation schemes for use by plant supervisory personnel.

Novel Separation Technologies for Poultry Processing Liquid Streams

**PROJECT GOAL:**
To investigate techniques to more selectively capture target impurities from poultry processing liquid streams in a way that facilitates the recovery of value-added byproducts while still meeting or exceeding water reuse guidelines.

**FY 2014 DEVELOPMENTS:** Researchers demonstrated a proof-of-concept bench-scale dynamic filtration system focused on achieving greater filter flux rates and solids removal compared to a traditional poultry processing secondary screening system using 0.01-inch (approximately 300 micron) sieves. The bench-scale system not only outperformed the 300-micron sieve, it also demonstrated efficacy at 75-micron sieve sizes. A 2.0-micron filtration of yeast at solids concentrations exceeding analogous poultry processing effluents also showed the system is potentially capable of operating using membranes.

Evaluation of Novel Intervention Strategies for Pathogen Control

Researchers explored a group of new antimicrobial compounds to reduce pathogens in food products. They found low levels of compounds can reduce *Salmonella Typhimurium* on chicken and lettuce more effectively than 50 ppm chlorine in 10 minutes. This discovery was confirmed by blind tests performed at the USDA-ARS Richard B. Russell Research Center and the Georgia Poultry Lab. It was noted that the antimicrobial efficiency was not affected by room temperature.

Adaptive Perception During Manipulation

Researchers are developing perception algorithms and 3D sensing modalities that will learn, model, and track deformable poultry objects (such as chicken front halves) for robotic manipulation. The goal is to develop a system that can continually track an object while it is being handled — gripped, pulled, flipped, cut, etc. — and adapt the manipulation in real time. This adaptive ability is crucial to robotic handling of poultry products, which are variable by nature.

Advanced Enrichment Reactor

Researchers are studying better low-pathogen concentration approaches to improve pathogen prevention and control in large-volume poultry processing samples. During FY 2014, the research focused on completing a repeatable method for deploying growth mediums within the reactor. Experiments used *Salmonella*-inoculated tryptic soy broth and whole bird rinses. Subsequent industry interactions highlighted the need to address
improvements to classical culture methods in order to reduce enrichment time and enhance viable pathogen recovery from non-liquid samples (e.g., ground poultry).

**Studying Animal Reaction to Robotics in a Broiler Growout House Environment**

Researchers evaluated the feasibility of using commercially available robotic systems to perform growout house management tasks (pictured on cover). The systems were outfitted with 2D and 3D sensors/cameras and operated in an experimental growout facility at UGA’s Poultry Research Farm in Athens, Georgia. Video and audio data were collected with 500 birds for a 6-week growout cycle in a miniature-scale house. Researchers developed and calculated metrics for the robotic systems and for humans, which allowed for quantitative analysis of the birds’ reactions to both. Results indicate that there is not a negative impact on the birds due to the operation of the robotic systems when compared to their reactions to humans.

**Automated Cone Loading with Low-Cost Robot Baxter**

Researchers programmed a humanoid Baxter robot manufactured by Rethink Robotics to assess its ability as a robotic solution for poultry processing tasks. They designed custom grippers in-house (based on a commercially available Robotiq gripper) and integrated them on Baxter. The in-house designed grippers proved effective at grasping bird front-halves from a moving conveyor and placing them on deboning cones.

**Ultrasonics for Poultry Processing Chiller Water Disinfection**

Researchers evaluated the effectiveness of ultrasound for the inactivation of *Salmonella* in poultry processing chiller water. In experiments using intentionally contaminated water, simulated chiller water, and actual chiller water, it was found in all cases that samples treated with ultrasound, combined with either different concentrations of chlorine or peracetic acid, exhibited slightly better disinfection than samples treated with the chemicals alone. Researchers concluded the study indicates that it may be feasible to use ultrasonic energy to enhance product safety; however, cost-effective scale-up of the technology may prove challenging given the incremental benefits.

**Aquatic Biomass for Poultry Feed**

Researchers explored the feasibility of using algae as feed for broiler chickens during growout. They found the use of chitosan in small concentrations to be a viable means of harvesting algae. They were also able to produce approximately 20 kg dry weight of algae and duckweed combined. It was decided that a full broiler trial would not yield sufficient data at this point, and instead, the team opted to conduct battery trials involving one-day-old chicks in a controlled environment requiring less feed.

**Systems Modeling of Poultry Plant Water Usage**

Researchers modeled the water usage in a typical poultry processing plant to define areas of potential optimization of water use. Based on the model, the plant can adjust water use for particular processes, which can be used to estimate fluctuations of food pathogen contamination. Researchers also developed a computer model for higher fidelity simulation of the poultry chilling process. The model keeps track of the temperature history of birds currently in the chiller and the water temperature of the chiller at various locations at each particular time.

**Enhancing the Water and Energy Efficiencies of Poultry Chilling via Ice-Water Slurries**

Researchers evaluated the incorporation of ice slurries in the poultry chilling process, with the goal of significantly reducing water use and allowing for faster chilling of product. It was thermodynamically quantified that a unit of ice slurry has a higher cooling capacity than a similar unit of liquid water and, therefore, should require less mass to achieve a comparable cooling result. For example, approximately 125 percent more liquid water is needed in comparison to an ice slurry (half ice-half liquid) given each system experiencing a 32°C temperature rise. There would thus be less total water needed (in slurry form) to address a chiller’s heat load. The ability to pump slurry throughout a facility adds to its attractiveness when compared to ice formation. In addition, the slurry serves as an excellent means of refrigeration load deferral to off-peak hours when leveraging cooling capacity storage. A software platform was used to begin quantifying this culminating economic benefit.

**TO LEARN MORE ABOUT ANY OF THESE PROJECTS AND OTHER RESEARCH WORK, PLEASE VISIT WWW.ATRP.GATECH.EDU**
TECHNOLOGY TRANSFER AND OUTREACH ACTIVITIES

Three issues of ATRP’s PoultryTech newsletter were published in FY 2014, with several articles reprinted in the trade press. The Intelligent Cutting and Deboning System was the focus of a Tech Connection article in the August 2013 issue of Meatingplace magazine. Headlined “Rise of the Robots,” the article highlighted the research team’s strides in automating the poultry deboning process to match the performance of humans. A feature article on the Growout Monitoring System appeared in the Winter 2014 issue of the Georgia Tech Alumni Magazine. In addition, the exploratory research project on growout robots was the focus of a spotlight article in the May 2014 issue of Mission Critical, the official publication of the Association for Unmanned Vehicle Systems International (AUVSI).

Research staff also generated more than 40 articles and technical presentations and filed one provisional patent and three invention disclosures.

ATRP exhibited at the International Poultry Expo, Georgia Ag Week Kick-off Celebration, and the Georgia Poultry Federation’s Spring Meeting and annual Night of Knights fundraiser. Together with the U.S. Poultry & Egg Association, ATRP co-hosted the annual National Safety Conference for the Poultry Industry.

ATRP also helped coordinate a staff of more than 150 volunteers for the Poultry World educational exhibit at the Georgia National Fair.

TECHNICAL ASSISTANCE

ATRP staff provided 33 technical assists to companies and individuals in the poultry industry across the state. These assists included simple inquiries regarding information or help needed to address a problem and extensive on-site consultations in which researchers collected data and provided a full report on their findings and recommendations. ATRP uses input from all assists to gauge situations calling for new research initiatives.

PROJECT COLLABORATORS

Industrial collaborators help provide direction and support to the specific research projects undertaken. They also participate directly in research projects by providing access to industry facilities for data collection and systems testing and contributing in-kind and cash support on an “as needed” basis. In addition, academic partners collaborate with research teams by providing cross-disciplinary expertise and experience as well as access to university research facilities.

**Intelligent Cutting and Deboning System** — Mar-Jac Poultry; University of Georgia, Department of Poultry Science; USDA-ARS Richard B. Russell Research Center; Wayne Farms

**Monitoring Bird Status in Broiler Housing Using Audio** — Georgia Institute of Technology, School of Electrical and Computer Engineering; Harrison Poultry; Michigan State University; University of Georgia, Department of Poultry Science; University of Georgia, Poultry Diagnostic and Research Center; University of Puerto Rico

**Chicken Egg Fertility Detection** — Auburn University, Department of Poultry Science; Georgia Institute of Technology, School of Chemistry and Biochemistry; Pilgrim’s Pride

**Novel Separation Technologies for Poultry Processing Liquid Streams** — Harrison Poultry; Mar-Jac Poultry; Sanderson Farms; U.S. Poultry & Egg Association

**Mobile Motion Capture System** — Harrison Poultry

**Automated Cone Loading with Low-Cost Robot Baxter** — Mar-Jac Poultry

**Ultrasonics for Poultry Processing Chiller Water Disinfection** — Enviro Tech Chemical Services; Harrison Poultry; Tip Top Poultry; USPOULTRY Harold E. Ford Foundation
OUR VISION
TO BE THE TECHNOLOGY INNOVATION AND DEVELOPMENT PROVIDER THAT ENABLES GEORGIA TO BE
RECOGNIZED AS THE UNDISPUTED LEADER IN POULTRY, AGribUSINESS, AND FOOD PROCESSING

OUR MISSION
TO PROMOTE THE ECONOMIC GROWTH OF GEORGIA AGribUSINESS (ESPECIALLY THE POULTRY INDUSTRY)
THROUGH:
- RESEARCH FOCUSED ON THE DEVELOPMENT OF NEW TECHNOLOGIES THAT IMPROVE PRODUCTIVITY
  AND EFFICIENCY
- EXPOSURE OF STUDENTS TO THE CHALLENGES OF DEVELOPING AND ADAPTING THESE TECHNOLOGIES
- TECHNICAL ASSISTANCE TO GEORGIA-BASED INDUSTRY MEMBERS WITH SPECIAL PROBLEMS
- RELEASE OF INFORMATION ON EMERGING TECHNOLOGIES AND IMPROVED OPERATIONAL MANAGEMENT
  THROUGH NEWSLETTERS, ARTICLES, SEMINARS, AND PRESENTATIONS TO SPEED ULTIMATE
  COMMERCIAL USE

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