The Agricultural Technology Research Program is guided by our vision to “drive transformational innovation in advanced technologies for poultry, agribusiness, and food processing.”

I am pleased to share our 2017 Annual Report, which highlights our latest progress toward fulfilling that vision. I hope the report gives you insight into our various research projects and their potential to reshape agricultural technology development here in Georgia and beyond.

It is worth noting that many of these research endeavors would not be possible without the contributions and support of our industry partners, collaborating universities, state and national research labs, and of course, the Georgia Poultry Federation. We are extremely grateful for these collaborative partnerships that allow us to explore novel concepts and push boundaries that we simply could not do on our own. More importantly, we firmly believe that the potential for incredible innovation exists at the intersection of traditional disciplines. So, we have intentionally set out to foster and support these multidisciplinary interactions both internally and externally with the expectation that great new ideas and applications will emerge. Thanks for playing a significant role in helping us drive transformational innovation.

As always, if you have any ideas, questions, or suggestions on how we can have a greater impact, please do not hesitate to contact me.

Doug Britton, Ph.D.
ATRP Program Manager

THANKS TO OUR INDUSTRIAL AND ACADEMIC PARTNERS

Industrial collaborators support research projects by providing industry expertise and access to facilities for data collection and systems testing and contributing in-kind and cash support on an “as needed” basis. Academic partners collaborate with research teams by providing cross-disciplinary expertise and experience as well as access to university research facilities.

American Proteins
Auburn University
    Department of Poultry Science
Case Farms
City of Atlanta
    Department of Watershed Management
Cobb-Vantress
DAR PRO
Enviro Tech Chemical Services
Fieldale Farms
Georgia Institute of Technology
    School of Civil and Environmental Engineering
    School of Electrical and Computer Engineering
Harrison Poultry
Highland Refrigeration

Johns Hopkins University
    Department of Mechanical Engineering
KWJ Engineering
Mar-Jac Poultry
Perdue Farms
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Safe Foods Corporation
TechnoCatch
Tyson Foods
University of Arkansas
    Department of Poultry Science
University of Georgia
    College of Veterinary Medicine
    Department of Poultry Science
USDA-ARS Richard B. Russell Research Center
Wayne Farms
FY 2017 PROGRAM HIGHLIGHTS
[July 1, 2016 - June 30, 2017]

FINANCIAL SUMMARY
Total Funding: $1,813,190
[Annual funding provided by the State of Georgia]

OUTREACH ACTIVITIES

EXHIBITED AT

PRODUCED

CO-HOSTED

WITH THE U.S. POULTRY & EGG ASSOCIATION

COORDINATED

EDUCATIONAL EXHIBIT AT THE GEORGIA NATIONAL FAIR

FINANCIAL SUMMARY

- TECHNOLOGY TRANSFER/OUTREACH/TECHNICAL ASSISTANCE: 20%
- PROGRAM SUPPORT: 10%
- AUTOMATION AND ROBOTICS RESEARCH: 21%
- IMAGING AND SENSING RESEARCH: 17%
- ENVIRONMENTAL AND BIOLOGICAL SYSTEMS RESEARCH: 8%
- FOOD SAFETY RESEARCH: 24%

OUTREACH ACTIVITIES

- EXHIBITED AT INTERNATIONAL PRODUCTION & PROCESSING EXPO
- PRODUCED PoultryTech NEWSLETTER
- CO-HOSTED WITH THE U.S. POULTRY & EGG ASSOCIATION
- COORDINATED EDUCATIONAL EXHIBIT AT THE GEORGIA NATIONAL FAIR

BY THE NUMBERS

- RESEARCH PROTOTYPES IN VARIOUS STAGES OF DEVELOPMENT: 7
- EXPLORATORY RESEARCH PROJECTS FUNDED TO DEVELOP CONCEPTS AND IDEAS FOR LATER TRANSITION INTO FULL-SCALE RESEARCH PROJECTS: 8
- PATENT, 1 PROVISIONAL PATENT, 1 INVENTION DISCLOSURE: 1
- PUBLISHED ARTICLES, PAPERS, AND PRESENTATIONS ON RESEARCH DISCOVERIES: 51
- INDUSTRY AND ACADEMIC PARTNERS PARTICIPATED DIRECTLY IN ONE OR MORE RESEARCH PROJECTS: 23
- TECHNICAL ASSISTANCE SERVICES PROVIDED TO COMPANIES OR INDIVIDUALS THAT HELPED SOLVE A PROBLEM OR PROVIDED USEFUL INFORMATION: 44

PROGRAM SUPPORT

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- 20%

Total Funding: $1,813,190
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FY 2017 RESEARCH SUMMARY

FULL-SCALE RESEARCH PROJECTS
Full-scale projects address critical issues facing poultry processing and production.

ROBOTIC SENSING AND GRASPING
Researchers completed development and testing of a dexterous gripper and associated 3D imaging sensors, which are integrated with a food-grade robotic arm to automatically perform poultry processing bird handling tasks. FY 2017 activities focused on the bin picking and cone loading tasks: specifically, object detection of real bird carcasses that have been lifted out of a random pile and motion control of actual deformable birds with placement on moving cones. Laboratory tests showed the system successful at automating the tasks.

ICE-WATER SLURRY FOR ENHANCED ANTIMICROBIAL ACTIVITY
Researchers continued to investigate the feasibility of using ice-water slurry for pathogen reduction in poultry chillers. Smaller scale experiments were conducted in 15-gallon micro-testers with chicken parts, specifically wings, instead of whole carcasses. The micro-testers are alternatives to the 250-gallon scaled auger chiller previously used. These tests enabled more precision and expedience in exploring different settings, including ice fractions and peracetic acid (antimicrobial aid) concentrations, compared with chilled water. Results showed improved pathogen reduction rates, indicating that slurry provides greater antimicrobial effectiveness than chilled water.

MONITORING BIRD WELL-BEING IN BROILER HOUSING USING AUDIO
Researchers enhanced the data acquisition and analysis capability of the Growout Monitoring System by using an audio characterization technique known as sparse coding. The technique enables the system to characterize the daily cycle or rhythm of the growout house. Researchers can then analyze the resultant data and determine any deviation from normal environmental occurrences that could potentially affect bird well-being. Experiments were conducted in a commercial-size growout house at the University of Arkansas. Initial results indicate that high temperatures and water restriction seem to have more of an effect on the birds than feed or temperature reduction within the limits of the experiments conducted thus far.

REMOVAL OF FREE FATTY ACIDS FROM RENDERED OIL
Researchers developed a novel method for the removal of free fatty acids (FFAs) from various oil systems through the use of functionalized magnetic nanoparticles (MNPs). MNPs of various sizes were produced using a modified thermal decomposition method and were verified using X-ray diffraction and magnetic measurements. The surface of these particles showed a high affinity for FFAs, allowing for a large adsorption capacity of 521 mg/g using size, temperature, and MNP composition optimization. Lab testing also showed 96% removal of MNPs without any separation optimization, and the particles can be reused multiple times to remove problematic FFAs from rendered oil systems.
AUTOMATED CONE LOADING WITH LOW-COST ROBOT BAXTER
Researchers investigated the feasibility of using a Baxter robot (a humanoid robot from Rethink Robotics) to work alone or alongside humans while performing the cone loading task. The team designed custom grippers and developed specialized algorithms that enable Baxter to recognize the orientation and cavity of a bird front half and then place it on a stationary cone. Initial results showed a near 90% success rate. The effort is part of a continuing project aimed at demonstrating the potential use of co-robotics in poultry processing plants.

PHOSPHORUS REMOVAL USING MAGNETIC NANOPARTICLES
Researchers continued testing of their magnetic nanoparticle (MNP)-based treatment method to remove and recover phosphorous from poultry processing wastewater. Wastewater characterization and phosphorus speciation studies were conducted using samples obtained from a local poultry wastewater treatment plant. The samples were characterized with high levels of contaminants, including total phosphorus (TP). Lab results showed that treatment of the samples with the MNP not only reduced TP by more than 90%, but also decreased the levels of other contaminants like suspended solids; chemical oxygen demand; and fats, oils, and grease. Phosphorus speciation analyses on the samples showed that almost all reactive phosphorus (orthophosphate) and organic phosphorus either soluble or particulate forms were removed by the MNPs.

NOVEL SEPARATION TECHNOLOGIES FOR POULTRY PROCESSING LIQUID STREAMS
Researchers demonstrated the throughput, efficiency, and footprint of the existing dynamic filtration prototype using a flat sheet membrane held in a plate-and-frame configuration. The technology targets poultry processing unit operations that employ extended product contact with water, such as the chiller. Experimental tests validated the system as a working prototype for steady-state filtering at 100-micron and provided data useful for validating the business case for dynamic filtration.

ROBOTIC SENSING AND MANIPULATION IN A GROWOUT HOUSE
Researchers tested the ability of their Growout House Robot (GOHBot) to perform broiler and breeder rearing and management tasks in growout houses. Specifically, the team successfully demonstrated an approach for automated removal of floor eggs using a 4 degree-of-freedom robotic arm with a suction cup end effector attached to the GOHBot. Testing yielded a 91.57% accuracy rate. Improvements to the hardware are expected to bring the accuracy to between 99-100%. The team also performed more than 2 hours of entirely safe fully autonomous operation of the robot in a commercial breeder house. In fact, the team found that the robot performed even better in the commercial house than in the smaller research pens.

POULTRY SYSTEM SIMULATION MODEL
Researchers added a labor module to the existing model that simulates a poultry processing plant’s labor requirements and structure based on the plant’s operations and automation level. The module goes beyond a simple assessment of how many workers of a particular type should be employed — it also includes economic analyses associated with changes in workforce composition if plant managers decide to change current practices in favor of new technologies and automation. The labor module is in addition to water use and energy consumption modules, all of which can be used by plant operations to identify areas for usage reductions and process improvements.
EXPLORATORY RESEARCH PROJECTS
Exploratory projects are higher risk, smaller scope efforts that seek to develop concepts and ideas for later transition into full-scale projects.

CORRELATIONS BETWEEN BROILER PROCESSING CHARACTERISTICS AND GENETIC TRAITS
Researchers studied the weight and physical measures of different genetic species of broilers as a precursor for efficient processing machinery design. They found the approach feasible for production settings as there are correlations between various bones on the birds that could be used for the monitoring of flock growth and performance. The derived data can be used to generate statistics for planning and scheduling processing operations as an aid in configuring machinery since the correlations are stronger than bird weight measurements only.

GENERATING 3D MODELS OF CHICKEN IN A DYNAMIC ENVIRONMENT
Researchers explored using cutting edge algorithms to generate a 360-degree model of a chicken using 3D imaging sensors. Several approaches exist for generating high fidelity 3D models of static objects, but these techniques are unable to produce a reasonable output when the target is moving dynamically. The ability to reconstruct 3D models from a moving target is essential to be able to capture models of live animals in their environment. Such models could be used for managing growout, augmenting processing systems, and assisting in equipment design.

GROWOUT SANITATION
Researchers completed data analysis from the previous year’s work. Effects of water chlorination, litter quality, and antibiotic use were examined in relation to poultry growth and mortality among 1,280 chicks raised during an entire growout cycle under varying treatments (new or used litter, with and without chlorine-treated water, and with and without antibiotic feed). Results showed the highest weights (2.87 kg/chicken) were found in chicks raised in the “antibiotic feed and used litter” group closely followed by those raised in the “no antibiotic feed and new litter” group (2.86 kg/chicken). Higher mortality rates were recorded in the groups raised with antibiotic feed. Overall, results showed a cleaner growout environment produces a healthier chicken.

VIRTUAL REALITY APPLICATIONS IN POULTRY PRODUCTION AND PROCESSING
Researchers evaluated the feasibility of using virtual reality (VR) tools to support the manufacture of automation technologies for handling natural products. Specific projects included using VR tools (HTC Vive and Samsung Gear VR) to visualize and assess the trajectories of cutting paths for the deboning shoulder cut task. This allows the team to analyze cutting paths generated by algorithms created in the lab. The tools can also be used to help design robot grippers by studying their interaction with poultry in the VR environment, which eliminates the need to build and test the actual hardware or use real product.
ON-FARM PRODUCTION SYSTEM
Researchers continued to enhance the conceptual design of their On-Farm Production System for on-farm bird harvesting. The system is designed with mobility in mind and is contained within a 53-foot trailer that can be easily moved between houses or farms; it includes modules for catching, shackling, stunning, and slaughtering. A key design concern is the incorporation of an environmentally friendly stunning device. During FY 2017, researchers redesigned the system to incorporate low atmospheric pressure stunning (LAPS) technology. The team believes the LAPS technology is technically feasible. Process flow and mechanical designs are now 90% complete, and the team hopes to begin prototyping parts of the system in the near future.

THE IMPLICATION OF NEW PERFORMANCE STANDARDS FOR CHICKEN PARTS IN PROCESSING
Researchers studied the New Poultry Inspection System (NPIS) and its potential implications on the U.S. Food Safety and Inspection Service (FSIS) pathogen reduction standards for Salmonella and Campylobacter in raw chicken parts to determine what, if any, impact it has on the current chilling process. The rigor mortis effect in bone-in parts does not appear to be significant, allowing the possibility of cutting parts before chilling (hot-processing); thus, cutting chicken parts and then chilling with disinfectant may help to streamline parts processing.

MAGNETIC REFRIGERATION AS ALTERNATIVE COOLING TECHNOLOGY FOR POULTRY INDUSTRY
Researchers evaluated magnetic refrigeration as a more environmentally friendly and efficient cooling technology for poultry processing as compared with current ammonia refrigeration. Specifically, they successfully synthesized nano-sized versions of three commonly used magnetic refrigeration materials through a modified thermal decomposition method. X-ray diffraction and magnetic measurements of the nanoparticles were collected and indicate that the target particles demonstrated acceptable phase purity. Out of the three magnetic refrigeration materials, LSMO (La$_{0.8}$Sr$_{0.2}$MnO$_3$) showed a higher magnetic response than its LCMO (La$_{0.8}$Ca$_{0.2}$MnO$_3$) and PSMO (Pr$_{0.63}$Sr$_{0.37}$MnO$_3$) counterparts, indicating the most potential as an alternative to ammonia refrigeration.

MULTI-FUNCTION SENSORY SYSTEM FOR SMART POULTRY FARMING
Researchers continued optimization of their ammonia micro-sensor system and designed an effective circuit to reduce background noise. Specifically, the 3-Omega technique was combined with a differential electrical circuit in order to enhance the sensor’s sensitivity while eliminating the interfering environmental factors at very low concentrations. An automated test bed was also developed where the sensor was tested for ammonia and a number of gases in a nitrogen environment that mimics testing in air. Initial results were promising, but researchers believe additional design improvements are needed to lower the detection levels, reduce noise, and increase system stability.
ADVISORY COMMITTEE

The Agricultural Technology Research 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.

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