In-ovo Monitoring of Embryonic Development Could Help to Optimize Poultry Hatchery Operations

Each month, more than 700 million “broiler” eggs (eggs from chickens that are bred for meat production) are hatched in the United States. Typically, it takes a total of 21 days for an egg to hatch. This timeframe includes incubation, inoculation, removal of dead eggs, and transfer of viable eggs to the hatcher. A number of factors, ranging from storage time and the age of laying hens, to temperature and humidity levels, to breed type, can have an effect on the developing embryo as well as hatchability.

A collaborative project being conducted by the Georgia Tech Research Institute (GTRI) and Auburn University is investigating whether the status of an avian embryo can be monitored and its hatch time predicted. The team has developed a noninvasive and rapid spectrophotometric technique to track the changing embryo in-ovo or inside the egg. This method allows researchers to predict when individual eggs will hatch, which in turn, should provide insight into a number of practices from animal health and welfare to the inoculation regime.

Hatchability experiments were recently conducted where eggs were taken all the way to hatch and spectral readings were recorded at approximately the same time daily for 21 days (see graph on page 2). Different temperatures, humidity levels, and with/without egg turning were examined. Analysis of the spectral data showed fertile, developing eggs changed at a greater rate than infertile eggs. A number of eggs were removed from the process and placed at a lower temperature to determine if the spectral changes slowed. The previously observed spectral changes slowed significantly for the cooled eggs.

“At a very early point, spectral data indicates the rate of embryonic development for each egg if the hatchery is running consistently,” explains Robert Wallace, a GTRI research chemist who is leading the research.

Perhaps the greatest overall benefit, he says, is spectral data can show whether individual eggs within an incubator are developing at different rates or if an entire incubator is developing outside of the established norm, giving hatchery managers the ability to better manage and thus optimize operations.
In-ovo Monitoring of Embryonic Development Could Help to Optimize Poultry Hatchery Operations

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For example, humidity, air flow, temperature, and other factors may be changed over the course of the incubation process depending on the development of the chicks. In addition, the ability to track mortality may be beneficial as removal of dead eggs may prevent possible contamination of viable eggs that are also present.

Spectral data showing changes in embryo development over incubation time.

ATRP’s Britton Testifies Before Georgia House Science and Technology Committee

Doug Britton, ATRP program manager, testified before the Georgia House Science and Technology Committee on March 14, at the state Capitol in Atlanta.

The Committee is responsible for legislation that promotes the appropriate and safe development, as well as use of science and technological advances in the state. The Committee met to hear testimony about the applications of science and technology to agricultural activities in Georgia. Agribusiness is Georgia’s leading industry, comprising $68 billion of the state’s $727 billion economy and employing 13 percent of Georgia’s workforce.

Britton’s testimony focused on ATRP’s long history of collaborative research and development with the poultry and food processing industries in Georgia, particularly the program’s focus on robotics and automation systems, advanced imaging and sensor concepts, environmental and energy systems, and worker and product safety technologies.

Advances in these areas help poultry and food processors improve productivity, reduce costs, and enhance workplace/product safety and health, all of which benefit the state’s economy. The Committee also heard testimony from Jaymie Forrest, managing director, Georgia Tech Supply Chain & Logistics Institute, and Robert Shulstad, associate dean for Research, College of Agricultural and Environmental Sciences, University of Georgia.

The poultry industry has an excellent history of optimizing existing processes, but to some extent, it has become a victim of its own successes. Over time, it has become increasingly difficult to realize continued gains without more fundamental changes to the overall processes. This realization has ignited an exciting conversation about the future of poultry production and processing within the greater poultry community. By most accounts, if we were to redesign how we do things today, the processes would look quite different. We would most likely seek to optimize the processes against a larger set of criteria that includes food safety, water use, environmental impact, animal welfare, and labor, among others.

The good news is that real transformation is possible, but we must be ready and willing to think “outside-the-box” and innovate. Innovation, in turn, is sparked by great and creative ideas. Rarely does true transformation occur when great ideas are kept in isolation or held only by a small group of individuals. One way to accelerate innovation is to encourage broad collaboration focused on a set of common goals between individuals or communities with diverse professional backgrounds. When one captures a vision of what “could be,” it can be invigorating to participate in pioneering new pathways and trailblazing new ideas.

This is where you come in! Fundamentally reinventing poultry production and processing is a monumental task. If we hope to be successful at this endeavor, it will require participation and expertise from the entire poultry community. Many have already begun to think about future challenges, and I want to encourage you to take the opportunity to participate in industry and professional meetings that focus on innovation and the future of the poultry industry. Share your thoughts with colleagues and friends in industry and academia. But, most importantly, foster those great ideas that have the potential to spark real transformative change. The Agricultural Technology Research Program at the Georgia Tech Research Institute is excited to be a part of this growing initiative focused on the future of poultry production and processing, and together, I am fully confident that we can take on this new grand challenge.

Doug Britton, Ph.D.
ATRP Program Manager

Email any suggestions, comments, or questions to:
poultrytech@gtri.gatech.edu
Rethinking Research Methods for Emerging Technologies

Written by John Pierson

Researchers from the Georgia Tech Research Institute’s (GTRI) Food Processing Technology Division and the University of Georgia’s Poultry Science Department have worked individually, collectively, and jointly to address current and future challenges facing the poultry and allied industries. The universities interact frequently with industry through both advisory boards and established contacts and with each other to ensure research is meeting needs. Recently, Drs. Doug Britton and Mike Lacy began a more formalized dialogue to discuss what the poultry industry might look like in the future and how university researchers in Georgia and nationally might better assist the industry.

One related GTRI initiative underway seeks to better define future research agendas, with researchers examining how emerging technologies that impact poultry processing should be assessed. The project’s initial scope sought to establish analytics associated with food safety, quality, and yield. However, the team quickly realized that identifying systematic design approaches might better identify research, which if undertaken today, could give the best results in the future.

A key consideration is how problems are formed and then solved, particularly when one is looking to the future. The relative maturity of the poultry industry indicates transformational (disruptive) change is imminent; currently, change tends to remain supply/demand-driven and focused primarily on selling propositions. Recent history has shown that disruptive innovations (digital cameras, cell phones) overtake existing customers or markets because established businesses fail to place sufficient value upon or participate in the innovation early on.

One approach, systems theory, looks at the influence of certain factors of the whole (food safety, quality, or yield) as criteria to better improve processing. System types include hard systems (those that can be quantified such as yield) as compared to soft systems (those that are qualified such as quality) versus evolutionary systems (self-regulate using feedback such as certain food safety interventions).

Another approach uses design thinking, where the goal starts with what is meant to be achieved (poultry processing in the future) instead of with a certain problem (food safety, quality, yield). Here, one only needs to define enough of the parameters to optimize a path to the goal.

While many other descriptions exist, when a task or product is defined and clarified into a product proposal, requirements list, and ultimately a detailed design ready for production, it is most often called a mechanical product design.

Work to date has identified similarities between systems theory, design thinking, and mechanical product design, although the path from innovation to invention is still ambiguous. Why? Because scientists tend to focus on systems as abstract concepts needing better quantification, while engineers typically see systems as concrete arrangements that achieve better quantification. Regardless, as global markets and distributed information exchange increases, industry needs scientists and engineers to better align their definitions of systems so that innovation can quickly be converted into a mechanical product design.

Moving forward, researchers plan to discuss results to date with experts associated with Professional Master’s Degree in Applied Systems Engineering and Certificate Programs at the Georgia Institute of Technology. They also will continue to engage other university colleagues and industry to better define research agendas to address future challenges facing the poultry and allied industries.

John Pierson is a principal research engineer in the Georgia Tech Research Institute’s Food Processing Technology Division. His areas of expertise are wastewater pretreatment alternatives, environmental control systems, pollution control, and biofuels. He can be contacted by email at john.pierson@gtri.gatech.edu.

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Industrial Storm Water Permit and Georgia’s Poultry Industry

A variety of activities have been underway since November 2010, preparing for the proposed update to the general permit for storm water discharges from industrial activities. For most facilities, those activities have focused on refining storm water pollution prevention plans (SWP3), sampling, and attending industry-related meetings to discuss storm water management best practices. The result has been a concerted effort by the Georgia poultry industry to develop definitive approaches for ensuring that storm water discharges associated with poultry and allied industrial activities exceed water quality standards.

As part of this effort, researchers with the Georgia Tech Research Institute (GTRI) evaluated the possible statistical correlation between fecal coliform and total suspended solids levels in storm water discharges from poultry processing facilities; this correlation was specific to animal handling facilities. Efforts included education, on-site research, and technology assessments, culminating in a report to be considered by the Director of the Georgia Environmental Protection Division (EPD). The report was prepared sufficiently in advance for consideration during the drafting of the subsequent storm water permit for industrial activities.

The proposed National Pollutant Discharge Elimination System (NPDES) General Permit GAR050000 for storm water discharges associated with industrial activities contains significant additional requirements for animal handling facilities. These requirements are magnified for those locations that discharge into an impaired stream segment within one linear mile upstream of and in the same water shed as any portion of an impaired stream segment. Of particular note are the best management practices (BMPs) included in the language of the permit that are designed to reduce fecal coliform levels in storm water runoff from animal processing facilities that may be potential sources of fecal coliform. While specific to the animal handling industry, the permit notes that these may be beneficial for other industrial sectors.

**Definitions used to establish water quality standards**

- Designated uses of a water body (e.g., recreation, water supply, aquatic life, agriculture) and the difference between designed uses and existing uses. This module touches on options available to states/tribes in defining designated uses.

- Water quality criteria to protect designated uses (numeric pollutant concentrations and narrative requirements). This module addresses the purpose of water quality criteria, the different types, and how they are expressed.

- Antidegradation policy to maintain and protect existing uses and high-quality waters. This module considers requirements in addressing antidegradation questions and what EPA looks for in its review of a state/tribe’s antidegradation policy.

While the industry continues to review the proposed permit and examine the best approaches for continuing its dedication to environmental stewardship, it is interesting to step back and look at the larger national storm water challenge. Here, small, medium, and large municipalities are also developing storm water management programs for their separate storm sewer systems (MS4s); construction sites are facing effluent limit guidelines (ELGs); and state Departments of Transportation (DOTs) are facing general permits similar to those faced by industry. And as of June 2011, federal authorities are soliciting stakeholder input to assess whether existing storm water requirements should be revised, and if so, how and to what extent.

All of these requirements are NPDES-based, as the associated storm water discharges are now considered point sources. This is particularly relevant as urbanization captures many previous nonpoint sources via MS4s. The result for impaired streams is a total maximum daily loading (TMDL) water quality standard even though sources discharging under a general or individual NPDES permit are often meeting an effluent limit guideline or other numeric limit using technology-based standards.

If storm water management is to truly be an integral part of the broader “preservation of water quality” goal, a better understanding is needed regarding the maximum amount of pollutant that a water body can receive and still meet water quality standards, particularly with respect to the desired margin of safety or ambient background loads. Here, defining reference conditions seems reasonable, but that practically puts the process back to the initial definitions used to establish the water quality standards (designated use, water quality criteria, and antidegradation policy—see below). One often cited option is to change the designated use through a Use Attainability Analysis (UAA) if water quality standard targets are unattainable and then establish site-specific criteria. For impaired waters such as those that are headwaters to larger surface drinking water sources, this may not be possible even if the land uses along the stream banks are long-established low-density residential, much less industrial, municipal, or transportation. Yet, concerned citizens are monitoring streams adjacent to processing facilities long since idle, and associating coliform levels that exceed water quality standards with that facility.

Short of site-specific criteria, broader regional watershed management, or strategies based on non-numeric effluent guidelines, iterative BMPs can play a key role toward meeting water quality standards, which brings us back to the proposed, updated permit. The preliminary analysis examining the correlation of TSS and fecal coliform

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How often have you had conversations with colleagues and partners in other sectors of agriculture about how we need to do a better job of telling the amazing story of modern poultry production and agriculture in general? Maybe it was about the need to educate our youth, or perhaps it was about trying to reverse myths among consumers about how poultry and other food products are produced.

There appears to be a revolution happening that could have a dramatic impact on poultry producers and our partners in agricultural food production. I’m not talking about technological advances that will enable farmers and food producers to provide even safer and more healthy foods or ones that will allow us to continue to make efficiency improvements which will make our poultry operations even more sustainable in the future — though these advancements are sure to happen in the coming years. I’m talking about the ways in which farmers and food producers respond to consumers’ insatiable curiosity about the food they purchase and feed to their families.

Conversations are happening at the dinner table, among neighbors and friends and perhaps most significantly online in the social media space. Those who are critical of modern farming practices have been actively engaged in these conversations for some time, in many cases driving the discussions. There are millions of consumers though that simply have questions about the food they eat — where it was produced and how it was raised. As they should be, consumers are curious and are looking for answers. The question remains whether their questions will be answered by those who know the most about agriculture and food production, farmers and food processors, or whether they will be answered by critics with a bias against modern agricultural practices.

Farmers across the nation are stepping up to the challenge. There are farmers speaking out on Twitter with tens of thousands of followers. They are talking about their everyday activities associated with raising food and caring for animals, and at the same time they are demystifying what it means to be a family farmer for millions of those curious consumers.

Organizations such as the AgChat Foundation and the U.S. Farmers and Ranchers Alliance (USFRA) are among those facilitating these online discussions. The Alliance is a coalition of more than 50 national, regional and state agricultural groups and their partners. The poultry industry is an active partner in this coalition through the U.S. Poultry & Egg Association and United Egg Producers. USFRA is billed as the first collaboration of such a wide range of groups gathered to lead a dialogue about how food is raised.

"Consumers have questions about the food they eat … Farmers across the nation are stepping up to the challenge … talking about their everyday activities … demystifying what it means to be a family farmer."

USFRA started by listening to people to learn what questions they have about how food is raised and what is most important to them as consumers. It turns out that some of the messages that we in agriculture have used for years, while true and important, might not be what consumers are most interested in. For example, 64 percent of consumers say that keeping food prices low is very important, but they also want to know that the food they feed their families is safe and healthy for them in the long term. On the other hand, they might be less interested in how U.S. agriculture creates jobs and is poised to feed a hungry world over the coming decades.

The poultry industry has a remarkable story to tell when it comes to providing affordable food. According to Dr. Mike Lacy, head of the Poultry Science Department at the University of Georgia, “Chicken and eggs sell today for about one-eighth of the cost they did in 1950, when you consider the value of the dollar in 1950. Taking into account the change in the value of the dollar, essentially, chicken today is selling for $4.90 less per pound and eggs $13.20 less per dozen. It is almost impossible to find another commodity that sells for the same price now as it did in the 1950s.” At the same time, the wide variety of poultry products available to consumers has never been safer or more beneficial to the long term health of their families. These are two messages that are at the heart of what consumers say is important about the food they purchase and consume.

Environmental sustainability is another topic that consumers want to know more about. Large scale agriculture is often painted as being not sustainable, whatever that means. Some say big is bad, and small or locally produced is good. For poultry producers, what is lost in the comparison are the tremendous gains in efficiencies that have occurred over the recent decades. Breeding programs initiated in the U.S. have provided specialized poultry breeds that produce more eggs and meat with less feed. In 1950, it took 10 weeks and more than 10 pounds of feed to grow a 3.2 pound broiler. Today, broiler growers produce a 5 pound chicken in about six weeks and only need a little more than 9 pounds of feed to do so. The poultry industry has also made strides in other areas such as conserving water and energy. Large scale agricultural production and “sustainable” aren’t mutually exclusive, but acknowledging that this is important to consumers and communicating our achievements in this area is the responsibility of these new agricultural voices. There are lively conversations happening online about how antibiotics are used, how livestock and poultry are cared for and what is the difference between a “family farm” and a “factory farm.” The difference seems to be that agricultural voices are being heard in response to questions from typical consumers who want to know more about how food is raised in our nation.

It is no surprise that hard-working farmers and the innovative people in food processing believe that agriculture is under appreciated and that the positive messages about how food is produced isn’t getting through to consumers. At the same time, we can’t ignore USFRA’s survey result which says that 42 percent of consumers believe that the U.S. is “on the wrong track” in the way we produce food.

Check out the site where USFRA is facilitating this discussion — http://www.fooddialogues.com — you will find the discussions to be interesting, and you might even find yourself diving into the conversation.
Saving Energy Using “Green” Renewable Resources

Written by Gary Floyd

In the Spring 2008 issue of PoultryTech, an article on heat recovery was written to provide information on the potential savings from taking waste heat from refrigeration systems. The last two paragraphs of the article also pointed out the potential reduction in greenhouse gases. Waste heat recovery is still a win-win solution today, but I would like to discuss other opportunities to invest in clean energy technologies that support renewable resources.

Anaerobic digestion is one of those opportunities. This digestion process occurs naturally through which organic matter such as manure, feed spills, poultry wastes, and crop residues are fed, heated, and mixed. During the process, in the absence of oxygen, the anaerobic bacteria thrive by consuming the solid waste resulting in the release of methane and carbon dioxide known as biogas. The biogas can then be used as fuel for boilers, which can offset the cost of natural gas usage.

Sanderson Farms has installed a digester at one of their poultry plants that captures methane gas from the anaerobic lagoon that treats the plant’s wastewater. The captured gas is piped back to the plant and then used to fuel the gas boiler. The plant, according to Sanderson Farms, has reduced their natural gas usage by 80 percent.

Biogas itself is typically composed of 60 percent methane and 40 percent CO₂. Natural gas is 97 percent methane. There are technologies that can remove CO₂ from the biogas and then convert it to renewable natural gas, enabling it to be injected into a natural gas pipeline for resale.

The technology to upgrade biogas is becoming more popular because it does not have the heat loss and emission issues related to an internal combustion engine. And, since the final product is natural gas, it can be moved efficiently using the existing natural gas grid. Finally, unlike natural gas, which contributes gas emissions to the atmosphere, the combustion of upgraded biogas actually reduces greenhouse gas emissions to the atmosphere by displacing natural gas.

Electricity can also be produced from biogas using internal combustion engines and generators. Plants that install these systems may be able to offset their plant electrical energy costs and be eligible to sell back to their electric grid provider. Two types of biogas engines are available: diesel and gas. Gas engines are designed to burn a gaseous fuel instead of liquid. In a diesel biogas engine, 5 percent of the produced energy will come from diesel oil, which will be used as a pilot fuel to ignite during combustion.

Biogas generators are relatively simple systems, but their efficiency is close to 40 percent at best when converting the biogas to electrical energy. The remaining biogas is converted to heat and noise. The heat can be recovered and used for other plant processes.

Gas turbines are used in the electric utility industry to convert natural gas into electricity; however, biogas, which has a lower BTU value than natural gas, is wet and corrosive, and therefore, not the best fuel for the turbine. Also, the biogas would require additional conditioning, which makes it not economically feasible.

Economics should be considered if an anaerobic digester is to be used solely to produce electricity or offset a plant’s electricity usage. Georgia Power, a subsidiary of Southern Company located in the Southeastern United States, will purchase the energy produced from renewable generation that meets the Federal Energy Regulatory Commission (FERC) requirements to be a Qualifying Facility (QF) (greater than 100 KW, less than 80 MW). The payment for energy is calculated on an hourly avoided cost rate.

The avoided cost rate represents the value of the electricity the utility avoids generating or purchasing. When a poultry plant delivers electricity from its generating system, the electric utility will reduce the equivalent amount of electricity generated at its most expensive operating unit. The costs avoided consist of the cost of fuel needed to produce that electricity and unit’s operation and maintenance costs. This is the energy component of the electric utility’s avoided cost.

The electricity supplied by the poultry plant also contributes to the electric utility’s system reliability. As demand (KW) grows in the electric provider’s service area, the reserve margin decreases and at some point the electric utility will need to add capacity to meet demand. The poultry plant’s contribution to the electric utility system allows the utility to defer the addition of capacity.

A component of the avoided energy rate gives credit for the generation and transmission capacity that is avoided. And, when Georgia Power has a capacity need, QFs can bid their capacity into Georgia Power Requests for Proposals (RFPs) and may receive payment for their capacity.

Because avoided cost depends on system operations and needs, the avoided cost for each utility is unique and the amount determined to be a utility’s avoided cost changes over time. Georgia Power purchases energy at the hourly avoided cost rate, currently forecasted to be around 5.6 cents per kWh in 2012.

Anaerobic digesters are complex biological systems requiring careful planning and operation. Well-designed systems require considerable capital investment and operational costs, but there are tax credits and incentives available.

Incentives in the form of federal and state tax credits, accelerated depreciation, and low-interest financing may be available. The Energy Policy Act of 2005 increased the business renewable investment tax credit to 30 percent and is not set to expire until 2016. Another incentive available is Georgia’s Clean Energy Property Tax Credit that provides up to a 35 percent tax credit for renewable generation assets. This tax incentive is reaching its upper limit, so contact the Georgia Environmental Finance Authority (GEFA) to find out if funds are still available (www.gefa.org/
Gary Floyd is an alumnus of Georgia Tech and an industrial segment manager for Georgia Power Company. He serves as a member of the Georgia Tech Research Institute's Agricultural Technology Research Program Advisory Board.

index.aspx?page=423). The Database of State Incentives for Renewables and Efficiency web site provides all current state and federal incentives available.

Finally, electricity through "Green" energy programs may be another investment opportunity for poultry plants. Georgia Power’s Green Energy Program enables industrial customers to support the growth of renewable energy resources in Georgia. The Large Volume Purchase Option offers customers the opportunity to buy Green Energy at a lower, customer-specific price. This option is available to businesses that wish to purchase a minimum of 90,000 kWh (900 blocks) of renewable energy per month.

Customers must purchase at least 400 blocks of either Standard Green Energy ($3.50 plus tax per block) or Premium Green Energy ($5.00 plus tax per block). In addition, they must purchase at least an additional 500 blocks of renewable energy under the Large Volume Purchase Option at a reduced price.

Georgia Power will contract with customers to determine the price, quantity, term, and source of the additional certified Green Energy. Also, customers who act as a single brand under common ownership or under common control via a written franchise agreement with a single controlling entity may aggregate their load for the purposes of participating under the Large Volume Purchase Option.

More information on Green Energy’s Large Volume Purchase Option can be obtained by emailing at G2GESALES@southernco.com or by visiting http://www.georgiapower.com/greeen/large_volume.asp.

Investing in “Green” renewable technologies and resources is a win-win to energy efficiency, strengthening the economy, and protecting the environment.

ATRP Advisory Board Reviews Research Progress

On April 17, ATRP held its annual Advisory Board Meeting. Project directors provided board members with an update on program research projects as well as technology transfer and outreach activities. A round-table session was also held where board members provided feedback and discussed future research opportunities, challenges, and directions with researchers. The annual meeting serves as the first step in ATRP’s efforts to identify and conduct research projects that best address priority industry needs. ATRP extends its appreciation to the Georgia Poultry Federation and the individual board members who give of their time and experience to help review and focus ATRP’s research program.

2012-2013 ATRP Advisory Board

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Abit Massey Receives Lifetime Achievement Award

ATRP wishes to congratulate longtime supporter Abit Massey, president emeritus of the Georgia Poultry Federation, on his being honored by the U.S. Poultry & Egg Association (USPOULTRY) with the Harold E. Ford Lifetime Achievement Award. The award is presented to an individual whose dedication and leadership over the years have far exceeded the ordinary and impacted both the poultry industry and USPOULTRY in an exemplary manner.

“In addition to being recognized as a Georgia poultry industry icon, Abit is recognized as a leader in several fields, including the lobbying profession, association management field, and among collegiate supporters,” remarked Gary Cooper, immediate past chairman of USPOULTRY, during the award ceremony at the 2012 International Poultry Expo. “Abit is well respected and highly regarded within the industry; his legacy will be acknowledged for many years to come.”

Abit Massey, president emeritus of the Georgia Poultry Federation (left), was honored by USPOULTRY with the Harold E. Ford Lifetime Achievement Award at the 2012 International Poultry Expo in Atlanta. He was presented with the award by Harold E. Ford, past president of USPOULTRY and for whom the award was named.
coliform for storm water outfalls at poultry processing facilities in Georgia indicated that the TSS benchmark has been broadly achieved through the use of iteratively implemented BMPs. However, the original correlation between TSS and fecal coliform \( r^2 = 0.6066 \) was not consistently replicated over the entire set of data pairs.

Thus, moving forward, the industry must remain vigilant with regard to BMPs included in SWP3. It is also important to continue supporting on-site research, educational seminars to better understand technology assessments, and industry activities where information can be shared. The industry should also communicate poultry facility stewardship initiatives and engage the active participation of community groups truly interested in preserving water quality. This type of outreach can build the relationships needed to find technology-based solutions and drive water quality standard effluent limits needed to manage storm water in a cost-effective manner.

Communicating poultry facility stewardship initiatives and engaging the active participation of community groups truly interested in preserving water quality, can build the relationships needed to find technology-based solutions and derive water quality standard effluent limits needed to manage storm water in a cost-effective manner. Future university efforts include seminars, workshops, and other outreach activities related to the permit as well as research initiatives that include working with industry during the life of this next permit.

This regulatory update was contributed by John Pierson, principal research engineer in the Georgia Tech Research Institute’s Food Processing Technology Division. He leads the division’s environmental technical assistance program and can be contacted by email at john.pierson@gtri.gatech.edu.

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