RESEARCH *for you*

Delaware State University
SINCE 1891
College of Agriculture and Related Sciences

INSIDE:

RESEARCH *for you*

IN THE NEWSPAPER BUSINESS THEY HAVE WHAT they call a "Hey, Martha." It's a kind of offbeat, amusing story that makes a reader yell to a listener, "Hey, Martha, did you know?"

That's the way I feel about the caliber and quality of work we are doing in Agricultural Research in the College of Agriculture and Related Sciences at Delaware State University. We are doing the kind of work that makes you stand up and take note. It's the kind of work designed to make your lives easier, improve your health and increase your income or earning potential. We are doing the kind of work that is designed to help YOU – the citizens of Delaware, this nation and the world.

AT DELAWARE STATE UNIVERSITY, WE ARE DOING RESEARCH **WITH CITIZENS IN MIND.**

Our researchers are looking to see if a small, peppery-tasting seed popular in West and Central Africa might be a key to preventing cancer, stroke, and cardiovascular disease.

Researchers are working with ways to increase the income or save farmers money by helping them appropriately price heritage breed poultry, and decrease the time it takes to detect fish spoilage. They are looking at how to save the lives of bats, who are capable of eating their weight each night in insects, saving farmers billions of dollars in insecticide and reducing the amount of chemicals in the foods we consume.

Researchers are also looking for a variety of sweet potato that will grow best in the cool Delaware climate. Sweet potatoes are an excellent source of carbohydrates and because they contain natural sugar, they help regulate blood sugar. Yes, we want our sweet potato farmers to compete with farmers in North Carolina and Louisiana, the country's largest sweet-potato-producing states.

And they are also helping to train and interest students of all ages in science, technology, engineering and math. While STEM courses are more rigorous, they are critical to this country being able to meet the needs of an increasing technology-driven economy.

Yes, we are doing all this and we are doing this for you.

But this is why we were created almost 125 years ago. Land-grant universities, and in particular, those land-grant universities historically designed to serve minority communities, have a mandate to do the kind of research with citizens in mind. If you are having problems or if you are interested in how you can become better at what you do, land-grant universities are doing the research to help answer those questions and concerns.

At Delaware State University, we aren't any different.

This document is just a sample of the work we are doing. As we partner with local and state governments, the federal government and public and private industry, we will continue to work on those issues and concerns that make life easier, more profitable and healthier. It's research, but it's research with you in mind.

We are Delaware State University and we are doing all this for YOU.

Dean Marsh

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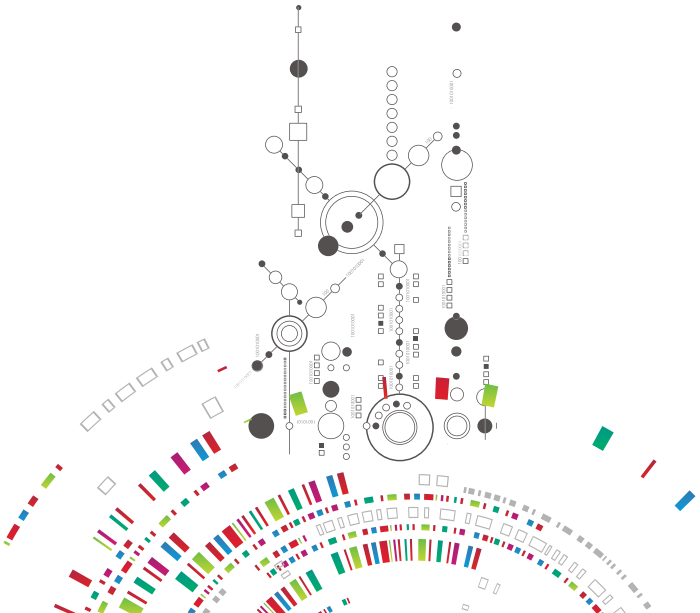
College of Agriculture and Related Sciences
Connecting with you, connecting with the community, connecting with Delaware and connecting you to the world.



West African seed may prevent Western diseases

WHY THIS WORK?

The human and economic tolls of chronic diseases such as cancer, cardiovascular disease and obesity are a grave concern, especially in the western world where diet is a major contributing factor. According to the Centers for Disease Control and Prevention, heart disease and cancer, which are the top two causes of death in the United States, accounted for over half of all deaths in 2011. A report by the American Cancer Society showed that there were 13.7 million Americans living with cancer in 2012, and a total of 1.6 million new cases were diagnosed in 2013, with 580,350 deaths in the same year. The most recent update from the American Heart Association estimates that about 86.1 million Americans are living with some form of cardiovascular disease. Furthermore, the economic cost of cardiovascular diseases and stroke due to health expenditures and loss of productivity totaled more than $315 billion in 2013.

Recent investigations show that a group of fatty acids called conjugated linolenic acids (CLnA), which are concentrated in the seed oils of pomegranate, bitter gourd, pot marigold, and *Ricinodendron heudelotii* (Njangsa), have positive benefits on certain physiological processes, and it may be desirable to include in our diet. These fatty acids possess antitumor properties, improve cardiovascular functions, reduce adiposity and reverse oxidative stress due to heavy metal poisoning. Isomers of

Lumor

PROJECT TITLE: Chemical Characterization of Njangsa *(Ricinodendron Heudelotii)* Seed Oil and Its Oxidative Stability

PRINCIPAL INVESTIGATOR: ***Stephen E. Lumor, Ph.D.,*** *Assistant Professor, Food Science Program, Department of Human Ecology*

FUNDING: This project, funded in 2014, is being supported by the USDA-NIFA Evans-Allen Grant.

CLnA include *a*-eleostearic (c9,t11, t13-octadecatrienoic acid), which accounts for more than 60 percent of the total fatty acids in bitter melon seed, and about 52 percent in *Ricinodendron heudelotii* seed. Other isomers include punicic, calendic and jacaric acids. Of the isomers, *a*-eleostearic (*a*-ESA) is the most potent due to its higher *trans* content, and its activity is about 10-fold higher.

Njangsa, a tropical tree from which the oil seeds are harvested, grows or is cultivated in West and Central Africa, specifically in Cameroon. Njangsa trees reach maturity between 4-5 years before producing fruits. The fruit has a unique aroma, often smelling like over-ripe apples, and the taste is described as peppery and reminiscent of cocoa. Usually, the fruits are manually shelled to collect the seeds, which are hard, round, and dried. The seeds, which are oily, are ground and used for soup and as an ingredient for seasoning baked meats and fish. The oil seed is an economical and valuable agricultural commodity, especially in Cameroon.

The successful characterization of Njangsa seed oil is expected to lead to the incorporation of the oil into a variety of foods as a dietary constituent used for the prevention of cancer, cardiovascular disease, stroke, and obesity.

NJANGSA, A TROPICAL TREE FROM WHICH THE OIL SEEDS ARE HARVESTED, GROWS OR IS CULTIVATED IN WEST AND CENTRAL AFRICA, SPECIFICALLY IN CAMEROON.

WHAT WAS DONE?

Since very little is known of Njangsa seed oil (NSO) with respect to its chemical composition, our first objective was to chemically profile this oil. Our work has shown that unsaturated fatty acids account for about 88 percent of total fatty acids, of which the most prevalent is alpha-eleostearic (44 percent), followed by linoleic (25.8 percent). Modest amounts of two other conjugated linolenic acid isomers were also determined, but their exact identities are yet to be established. Our work has also shown that NSO could be a commercial source of phytosterols since it contains more phytosterols than soybean on a weight-by-weight basis.

Our ongoing investigation is focused on the assessment of the oxidative stability of the oil in a model food system comprising of 50 percent microcrystalline cellulose, 40 percent glycerol, 10 percent NSO with or without 200 parts per million (ppm) antioxidant (oil basis) and iron added to a level of 50 ppm (oil basis). Our aim is to develop a kinetic model that can be used for predicting the shelf life of NSO in a food matrix.

WHAT'S NEXT?

Further research is needed to concentrate alpha-eleostearic acid from NSO for use in dietary supplements. Additionally, we are synthesizing beta-sitosteryl alpha-eleostearate for possible incorporation into reduced-cholesterol dairy products to improve their consistencies.

Setting poultry prices isn't chicken scratch, it's a science

WHY THIS WORK?

Small poultry flock enterprises continue to increase in popularity in the United States. Part of this growth may be due to an increased consumer interest in heritage breeds. Heritage breeds have a slower growth rate and have a reputation of tasting better. As consumers look to non-commercial, slow-growing livestock breeds, they are looking at heritage breeds.

Starting in the 1920's and 1930's, the newly emerging meat chicken industry started by breeding pure lines of several different breeds of chicken. By 1935, there were efforts at crossing Barred Plymouth Rocks males with New Hampshire hens resulting in what was called Barred Cross chicks. The Delaware chicken breed was developed in the 1940's on the Delmarva Peninsula as a result of the specific breeding efforts of George Ellis in Ocean View, DE. Shortly thereafter, the breed fell out of favor as a meat bird and the Cornish cross was further developed by the broiler industry.

The Delaware breed is once again in demand, but good breeding stock for meat production is difficult to locate because the breed has been selected only for show. Little data about the growth performance of the breed is available after 1940's and 1950's as there was greater interest in the breed for its unique plumage genetics. Given the significant changes and improvements to poultry diets, growth performance data is out of date in relation to the Delaware birds that are available for purchase today.

Because heritage meat chickens are very slow growing, farmers do not know how long it takes to grow a flock to a final body weight that is similar to that of a broiler. There has been some research done on fast- versus slow-growing commercial hybrids, but very little research is available to assist growers in deciding which heritage breeds to raise. This lack

McCrea

PROJECT TITLE: Poultry Production Parameters: The Heritage Delaware

PRINCIPAL INVESTIGATOR: ***Brigid McCrea,*** *Associate Professor, Department of Agriculture and Natural Resources, Poultry Specialist, Cooperative Extension*

FUNDING: This project was supported by Purina, Inc.

of information about performance characteristics means that farmers have very little information to use in order to make pricing decisions or to develop business plans.

WHAT WAS DONE?

This study's objective was two-fold. The first objective was to provide farmers with data on performance characteristics, feed efficiency, and carcass yield for Delawares in comparison to fast-growing broilers using modern feeds. The second objective was to determine the additional amount of time it would take to raise the Delawares until they achieved the same live body weight as 6-week-old, fast-growing broilers.

Our research showed that, given the modern feed available, it will take a Delaware 15 weeks to grow to the same live weight as that of a 6-week-old broiler chicken – 2.5 times longer. The overall FCR for broilers and Delawares in this study was 1.75 and 3.46, respectively. That means it took broilers 1.75 pounds of feed to create a pound of meat while it took Delawares 3.46 pounds of feed to make a pound of meat. For a pen of 30 broilers to reach market weight, it took an average of 230 pounds of feed, whereas it took Delawares 460 pounds of feed.

THE LACK OF INFORMATION ABOUT PERFORMANCE CHARACTERISTICS MEANS THAT **FARMERS HAVE VERY LITTLE INFORMATION** TO USE IN ORDER TO MAKE PRICING DECISIONS OR TO DEVELOP BUSINESS PLANS.

Based upon the amount of feed consumed by the two breeds, and the price per bag of feed at the time of the trial, the cost to feed the broilers was $87.58 and the price to feed the Delawares was $170.13. It is estimated that it would cost 1.94 times more to feed the Delawares. Since the cost of production for the Delawares, based on just the price of feed alone, was nearly two times greater, farmers should price their final product accordingly.

In short, it will take farmers twice as long to raise the Delawares and they will also need to feed the Delawares twice as much as the broilers. As such, farmers will need to double the price charged for heritage breeds.

There was a statistically significant difference between the two breeds of chicken with regard to their carcass weight and dressing percentage. The average weight for the broiler carcasses was 3.26 pounds, whereas the average weight for the Delaware carcasses was 3 pounds. The dressing percentage for the broilers was 68.08 percent. The Delaware dressing percentage was lower at 64.61 percent.

WHAT'S NEXT?

Additional research is needed to determine which breed performs best in the living conditions, both indoor and outdoor, in the Mid-Atlantic Region. Since many of the small flock producers in the region also raise their birds on pasture or in organic systems, more information is needed about the performance of these breeds on different types of pasture.

Early detection may mean savings, less spoilage, and safer seafood

WHY THIS WORK?

The United States is the second largest global consumer of fishery products, just behind China. In 2011, U.S. citizens consumed 4.7 billion pounds of seafood and spent $85.9 billion for fishery products. As well, the sushi industry has been growing by 1.6 percent annually from 2008 to 2013 and current numbers of sushi restaurants in the United States total 4,135.

Annually, bacterial spoilage of fishery products results in the loss of one-quarter to one-third of fishery and agricultural products, followed by billions of dollars in direct economic losses. In addition, pathogenic bacteria in spoiled fish represents a risk to public health and can cause foodborne illnesses. In this country, the incidence of Vibrio infections due to seafood consumption increased by 43 percent between 2006 and 2012.

Vibrio parahaemolyticus and *V. vulnificus* are the leading causes of illness from seafood. Vibro infections have the highest mortality rate, greater than 50 percent for primary septicemia, and have led to approximately 40 deaths annually from seafood. Also, *Vibrio anguillarum* causes vibriosis with lethal hemorrhagic septicemia in fish and shellfish that result in substantial economic losses worldwide in aquaculture farming.

Though Vibrionaceae have generally been detected using traditional cultivation methods, this method does not indicate specific Vibrio species. In terms of molecular assay, conventional Polymerase Chain Reaction (PCR) assays cannot make quantitative measurements, but a current real-time PCR method is quantitative, more rapid, and about one hundred times more sensitive than the conventional method.

The development of a rapid method for the detection and quantification of three vibrio pathogens *(V. parahaemolyticus, V. vulnificus, and V. anguillarum)* and total bacteria is crucial in aquaculture for the detection of infected fish and to monitor seafood quality in marine environments. This multipurpose real-time PCR assay could provide rapid and cost-effective microbiological analysis for the routine monitoring and risk assessment of seafood and marine water quality.

WHAT WAS DONE?

This project has a methodological innovation. This method is able to detect and quantify three specific and one non-specific bacterial spp. simultaneously. A four-target multiplex real-time PCR assay was developed using the TaqMan® system. The novel primers and probes were designed from species-specific virulence genes for *V. parahaemolyticus, V. anguillarum*, and *V. vulnificus,* as well as detection of a universal target gene for total bacteria. This approach is the first

Lee

PROJECT TITLE: Development of a Multiplex Real-time PCR Assay for Rapid Quantification of *Vibrio* spp. and Total Bacteria in Seafood and Seawater for Multipurpose Assessment

PRINCIPAL INVESTIGATOR: ***Jung-lim Lee, Ph.D.,*** *Associate Professor in Food Microbiology and Food Safety, Food Science Program, Department of Human Ecology*

FUNDING: This project was supported by the USDA-NIFA, 1890 Capacity Building Grants Program.

attempt for the assessment of fish and marine water safety and quality.

We optimized the multiplex real-time PCR conditions and applied it to detect the total number of bacteria and *Vibrio* spp. from the aquacultured and wild caught fish as well as water samples. Fish fillets were obtained from the aquaculture facility at Delaware State University and local retail sources in Dover, DE. The fillets used in this study were: sea bass *(Centropristis striata)*, cod fish *(Gadus morhua)*, flounder *(Paralichthys)*, haddock *(Melanogrammus aeglefinus)*, hybrid striped bass *(Morone Chrysops x Morone saxatilis)*, mummichog *(Fundulus heteroclitus)*, and tilapia *(Oreochromis mossambicus)*. Seawater samples were collected from different locations and on different days. Estuarine water samples were collected from the Indian River inlet in Delaware. Three Delaware Bay seawater samples were collected from Bowers Beach, and regular seawater samples were collected from the aquaculture facility at DSU.

The total bacterial populations in fish and seawater quantified by a culture method and multiplex real-time PCR assay were similar and indicate that both methods have a close correlation. Therefore, the multiplex real-time PCR assay would be very practical to enumerate total bacteria in fish and seawater. The total numbers of the 3 *Vibrio* spp. by multiplex real-time PCR assay was consistently higher than those of traditional plate counts. Selective media are, usually, used for the traditional isolation of *V. cholerae, V. parahaemolyticus*, and other *Vibrio* spp. but has some limitations. Uncultivable and injured *Vibrio* spp. in environments will not grow on this media because of selective agents. From the results obtained in this study, the quantification of *Vibrio* spp. in fish and seawater by this multiplex real-time PCR assay appears to be more accurate than culture methods.

To the best of our knowledge, our study describes the first multiplex real-time PCR assay for the simultaneous detection of these three species. Furthermore, this assay quantified total bacteria in the seafood and seawater samples at the same time. To prevent pathogenic *Vibrio* infection to humans and fish, their presence in seafood and seawater should be accurately monitored and total bacterial counts could be used as an indicator for measuring the quality of fishery products. This multiplex real-time PCR assay will facilitate the rapid surveillance of fish and seawater for *Vibrio* spp. and total bacteria, and it could be applicable as a diagnostic method in seafood-borne outbreaks.

WHAT'S NEXT?

Aquaculture trials will be required for further study which includes artificial inoculation of *Vibrio* spp. into aquaculture seawater and the inducing of infections in fish cultured in the aquaculture system. In this trial, we will assess the total bacteria and *Vibrio* spp. in fish and their surrounding aquaculture seawater using the multiplex real-time PCR assay and evaluate their correlation between both subjects in the ecosystem.

ANNUALLY, BACTERIAL SPOILAGE OF FISHERY PRODUCTS RESULTS IN THE LOSS OF **ONE-QUARTER TO ONE-THIRD** OF FISHERY AND AGRICULTURAL PRODUCTS.

Fish Rx - Take two probiotics and call me in the morning

WHY THIS WORK?

With the continuing collapse of U.S. commercial fisheries and the escalating disparity between supply and demand for fishery products, aquaculture will increasingly be relied on to meet the national and global demand for seafood. Because disease is a major problem for the fish farming industry, many strategies have been taken to overcome these obstacles, including the addition of antibiotics and chemotherapeutics. While these approaches have met with some success, they have their problems. The presence of high levels of antibiotics in farmed fish and the concern about antibiotic-resistant organisms have led to the understanding that the emphasis in disease management should be on prevention, rather than cure.

Probiotics are one strategy for controlling disease. Probiotics are microorganisms that provide health benefits when consumed. The probiotic acts by either competing with other bacteria for essential resources or nutrients, antagonism, or by producing their own broad-spectrum antibiotics. The application appears to be useful in a wide range of life-history stages, from larvae to adults. In the aquaculture industry,

McIntosh

PROJECT TITLE: Identification and Isolation of Novel Probiotic Bacteria for use in Marine Aquaculture

PRINCIPAL INVESTIGATOR: ***Dennis McIntosh,*** *Associate Professor, Department of Agriculture and Natural Resources and Cooperative Extension Aquaculture Specialist*

FUNDING: This project was supported by a grant from the Northeast Regional Aquaculture Center.

the application of probiotics is not systematically used and little is known about the specific mechanisms used by individual probiotic bacteria for protection.

WHAT WAS DONE?

To optimize their effectiveness, probiotics should be selected from (adapted to) the environment in which they will be eventually used. *Fundulus heteroclitus* lives in habitats with a wide range of salinities and can be cultivated in a similarly wide range in aquaculture. Therefore, the potential probiotics that we derived from this species have the potential to be applied to commercially important species from a range of salinities.

By using *F. heteroclitus* as a source of potential probiotics, the candidate probiotics will similarly be applicable to a range of environmental conditions. Ongoing work with oyster probiotics in conjunction with the NOAA Milford Aquaculture Lab, have laid a solid foundation for the identification and application of novel species of probiotics for use in the Northeast. Collectively, this work will expand our knowledge base in respect to probiotic bacteria, and allow us to improve aquaculture production through cost-effective management, reduce input costs and help improve shellfish and finfish health maintenance and disease control.

To date, we identified seven non-Vibrio bacteria from the intestines of the mummichog *(Fundulus heteroclitus)* that had the ability to inhibit growth of not only the fish pathogens Vibrio harveyi (DNO1) and Vibrio damsela, but also may inhibit growth of Vibrio sp. B183 (a shellfish pathogen) as determined by filter disk assays. Of these, we tested four probiotic bacteria (OY15, Iso5, Iso11 and Iso12) selected by their ability to inhibit pathogen growth and a glycerol-only control (the probiotic storage medium) in a short-term growth trial with our model species, F. heteroclitus, to ascertain the potential effects of the novel probiotic bacterial strains on the larvae.

THE PRESENCE OF HIGH LEVELS OF ANTIBIOTICS IN FARMED FISH AND THE CONCERN ABOUT ANTIBIOTIC-RESISTANT ORGANISMS HAVE LED TO THE UNDERSTANDING THAT **THE EMPHASIS IN DISEASE MANAGEMENT SHOULD BE ON PREVENTION, RATHER THAN CURE.**

WHAT'S NEXT?

Future research will continue to evaluate these potential probiotic strains on the survival and growth of larvae of other commercially important aquaculture species.

Saving bats helps farmers save millions in insect control

WHY THIS WORK?

This research is examining bats on the Delmarva Peninsula and in several countries in Latin America to determine species' diversity, activity levels, habitat preferences, insect control, and fruit seed dispersal by these ecologically important mammals.

Bats are an important keystone species in ecosystems in the Mid-Atlantic due to their consumption of pest insects. It is essential for agriculture and native ecosystems that we conserve bats, which now face critical threats from habitat development, new diseases, and the rapid development of wind energy facilities.

Bat populations have been devastated by the emerging bat disease White-Nose Syndrome, which is estimated to have killed as much as 90 percent of the bat population in areas of the Northeastern United States. Likewise, wind turbines, which kill bats at a higher rate than birds, are a further threat.

Bats ingest enormous quantities of insects, in some cases nearly the bat's entire weight per night. Many of these insects are agricultural pests, which have been estimated to cost farmers in the United States over $30 billion per year, an estimate that includes the cost of pesticides and crop losses from damage by insects. Bats are critical in the biological control of numerous night-flying insect pests, including many that attack economically important Delaware crops, such as corn and soybean. Bats attack Noctuid moth cutworms, turf scarab beetles, Japanese beetles, June bugs, fall armyworms, cabbage loopers, tobacco budworms, corn earworms, and cotton bollworms. In addition, they eat mosquitoes, which spread diseases to humans, horses, and chickens, the latter two being other economically important industries in Delaware.

Researchers have calculated that the annual value of insect suppression by bats is nearly $55 billion in benefit to farmers in the United States. It is also important not to forget the human toll of mosquito-borne diseases that may be reduced through the efforts of bats. In the American tropics, bats also provide ecosystem services through pollination and seed dispersal, which is important for the banana, agave, and mango crop industries and critical to forest regeneration.

WHAT WAS DONE?

Several projects examining bat conservation are on going. One study examines golf courses to determine if there are certain managed habitats that are particularly attractive to bats. Bat activity was monitored through ultrasonic recorders on five Delmarva golf courses to determine what course microhabitat had the greatest bat activity.

Initially, it was expected that forested patches with the least amount of human maintenance

Vulinec

PROJECT TITLE: The Value and Conservation of Bats

PRINCIPAL INVESTIGATOR: ***Kevina Vulinec, PhD.,*** *Professor, Department of Agriculture and Natural Resources, Fulbright Scholar*

FUNDING: These projects were supported by the National Fish and Wildlife Foundation, Maryland Department of Natural Resources, the University of Delaware, First State Marine Wind (Gamesa), and the United States Fish and Wildlife Service.

would have the most bat activity. What was actually found was that the maintained high canopy areas (maintained for golf cart transit) had the most bat activity. This was surprising, but the results show that cover from predators, plus a clear flying corridor for the bats, resulted in increased bat activity. The golf course ponds had the second greatest amount of activity, probably due to emerging insects and a water source for the bats. This limited research shows that golf courses may be a conservation opportunity for bat habitat.

In addition, bat mortality is being examined at a solitary wind turbine on the campus of the University of Delaware's Marine Laboratory in Lewes, DE. Since 2004, bats have been a major focus of the potential environmental impacts of the campus' wind turbines. The 2 megawatt Lewes turbine alone killed an estimated 36.6 bats during 2011. Three years of research showed that bats are eight times more likely than birds to be killed at the Lewes turbine. Lasiurine tree bats *(Lasiurus borealis, Lasiurus cinereus, Lasionycteris noctivagans)* suffered the greatest mortality. And the greatest mortality was during the migration season, from August to October.

From July 1 through October 31, 2013, a weekly alternating curtailment strategy at the UD Lewes wind turbine was implemented to test the new Gamesa Bat Shield, a software program designed specifically to halt the turbine rotation during certain weather conditions. Every other week, the turbine's cut-in speed (the minimum hub height wind speed required for the turbine to start generating electricity) was raised from 3 meters per second (m/s) to 5 m/s from 8 to 10 p.m. At higher wind speeds, bats are less likely to be active, thus reducing mortality chances. We found a significant reduction in bat mortality during the weeks with the higher cut-in speed of 5 m/s.

In addition, expanding on previous work done in the American tropics, bats are studied through a U.S. Fish and Wildlife Faculty Fellowship in Puerto Rico to determine habitat use in coastal zones. These zones are at risk from development and are potential prime locations for wind farms.

In summary, our main findings are:

1. Golf course managers are encouraged to keep a range of habitats available for use by bats, which will help control pests and allow a reduction in the use of pesticides.
2. Wind turbines, while generating green energy, can present a major threat to bats. Curtailing the turbine at wind speeds of 5 m/s or less significantly reduced bat deaths at this solitary turbine.

WHAT'S NEXT?

More research is needed to explore how bats are using farmlands and other anthropogenically-disturbed habitats in the Mid-Atlantic. Our study of golf courses can be expanded to examine maintained parks and even suburban yards for bat-friendly habitats.

In addition, our work with solitary turbines can be expanded to determine how small, privately owned turbines and larger wind turbine facilities can be made safer for bats. Further, our work in the tropics will give us insights into bat conservation in rapidly developing areas.

IT IS ESSENTIAL FOR **AGRICULTURE AND NATIVE ECOSYSTEMS** THAT WE CONSERVE BATS.

Nothing crabby about protecting Blackbird Creek

WHO CARES AND WHY?

Over the past two centuries, there has been a 53 percent reduction of total wetland acreage in the continental United States, with Delaware losing approximately 54 percent of its original wetlands, according to the U.S. Department of Interior and the U.S. Fish and Wildlife Service. Because these lands cannot be reclaimed or fully restored, it is critical that we practice wetland management. Of particular concern, especially over the past several decades, is the enigmatic invasion of common reed, a non-native subspecies of *Phragmites australis*.

Blackbird Creek, a largely forested watershed located in northern Delaware, is characterized by extensive salt marshes and large native populations of saltmarsh cord grass *(Spartina alterniflora)*. Because Blackbird Creek provides multiple recreational activities, it is the victim of varying degrees of human impact, which disturb the ecosystem. Monitoring ecosystem changes and established management practices have been ongoing since the mid-1970s.

Blue crabs and various other species flourish in the Blackbird Creek marsh. The leaves, roots, and stems in the creek provide the crabs a much-needed food source and shelter from predators. Blue crabs are known to selectively choose sites based on habitat quality. Altered marsh structure may provide less value to actively feeding/molting crabs. This may have important implications for adult crabs that use the marsh surface for feeding.

OUR RESEARCH PROVIDES ENHANCED INSIGHT INTO THE IMPORTANCE OF **HOW MARSH SURFACE VEGETATION IS USED BY BLUE CRABS AND RESIDENT FISH.**

The Blue crab, which is a keystone species and one of the most sought-after shellfish in the mid-Atlantic region, is one of the most valuable fisheries in the Chesapeake Bay. The crabs are also a major predator of benthic communities and are prey for many other fish species.

But many of the state's coastal wetlands, including Blackbird Creek, have lost biodiversity over the past several decades, primarily due to the invasion of the common reed and efforts to manage this reed, including herbicide spraying.

This research has allowed us to look at the impacts of land use on aquatic health and marsh habitat. Our research provides enhanced insight into the importance of how marsh surface vegetation is used by blue crabs and resident fish. This will further advance the management and restoration efforts that have been, and are currently, in place for the elimination of the common reed. In addition, we are examining how the various types of marsh grasses affect soil nutrients and thereby influence the micro and macro organisms living in the marsh environment.

WHAT WAS DONE?

Grasses, soil and pore water samples have been collected from Blackbird Creek to better understand microbial load and diversity associated with saltmarsh cord grass and common reed. This research concentrates on

Ozbay

PROJECT TITLE: Land Use Impacts on Marsh and Aquatic Ecosystems

PRINCIPAL INVESTIGATOR: ***Dr. Gulnihal Ozbay,*** *Professor, Department of Agriculture and Natural Resources and Cooperative Extension Natural Resources Specialist*

FUNDING: This project was supported by NSF-EPSCOR Grant, NOAA-ECSC Grant, USDA-NIFA Capacity Building Grant, and USDA Evans-Allen Grant Programs.

the difference in proteobacteria which are considered to be the predominant microbes in marsh ecosystems. Specific proteobacteria primers were designed for molecular analysis to be performed seasonally to identify and compare microbial communities associated with two dominant marsh grasses – saltmarsh cord grass and common reed.

Vesicular arbuscular mycorrhiza are fungi that effectively increase the nutrient availability to the host plants. Microscopic and molecular analysis of plant roots was carried out for the detection of the fungi, and a seasonal study was conducted to determine their presence and abundance during the growing season and the death phase. The percentage of microbial distribution in the soil, roots and leaves has been studied.

Physical and nutrient analyses of soil samples from different seasons were conducted to understand their effect on microbial distribution and vice versa.

After five years of evaluation, research studies have suggested that changes in fish and invertebrate habitat may be the result of the invasion of Phragmites in the mid-Atlantic region, and for the low abundance of both male and female crabs near the mouth of Blackbird Creek, with peak abundances being found at our furthest inland site. Phragmites dominated sites showed a trend toward larger crabs. Spartina dominated sites showed a trend toward smaller crabs, and crabs in the pre-molt stage. A relatively high degree of molting was observed in mixed and Spartina designated sites. Fish abundance appears to be correlated with crab abundance across study sites. The Phragmites site and Spartina site displayed high catch per unit effort values throughout the study period.

Along with the aquatic fauna information, the Principle Component Analysis shows that total phosphorous, nitrate, and total nitrogen are high in areas dominated by Spartina and mixed marsh grass species. The Phragmites dominated area is not rich in any major nutrients. Thus, marsh grass diversity will affect the soil nutrients and microbial community.

Also observed was the association of *(Vesicular Arbuscular Mycorrhiza)* fungi within the roots of *Spartina alterniflora*. These fungi were also observed in the invasive Phragmites when they exist along with Spartina. These fungi help the plants with uptake of nitrogen and phosphorus. Benthic diatom communities differ among the sites in our study and we observed a good correlation between the benthic diatom community and water quality. Sites high in dissolved oxygen and moderate in nutrients provided diverse benthic diatom assemblage.

WHAT'S NEXT?

The Blackbird Creek watershed is sparsely developed and provides an opportunity to study an area that has little anthropogenic impact. The area also has several plots designated as cropland. An understanding of crop rotation in these plots both within and between seasons, coupled with a complete survey of aquatic nekton, can provide insight into whether changes in crops across years can affect trophic interactions and food web dynamics. Additionally, this project will examine the effectiveness of riparian buffers as blockades for fertilizer runoff. The next phase is to examine and evaluate an area with greater development, such as the St. Jones watershed.

Move over North Carolina and Louisiana, Delaware ready for Sweet Potatoes

WHY THIS WORK?

The sweet potato *(Ipomoea batatas)* has become a popular crop for millions of people in Africa, Latin America and Southeast Asia and is known as one of the world's healthiest foods. This root vegetable is a good source of carbohydrates and vitamins including vitamins A, B, and C; contains iron, potassium and magnesium, and because it contains natural sugar that is slowly released in the blood stream, it is good for helping to regulate blood sugar. In addition, the sweet potato is versatile, has a pleasing, dessert-like taste, and is one of the oldest vegetables known to man, with evidence of it being found in Peruvian caves.

The sweet potato is a drought tolerant crop, and captures residual soil nutrients in field rotational

Alvarez

PROJECT TITLE: Sweet Potato as an Alternative Agricultural Enterprise in Delaware

PRINCIPAL INVESTIGATORS: ***Marikis Alvarez, PhD.***, *Associate Dean, Research*, and ***Lekha N. Paudel, PhD.,*** *Cooperative Extension Farm Management Specialist/Risk Management*

FUNDING: This project was supported by research funds available from DSU Experiment Station.

systems, which makes it attractive to small farmers with limited funds to spend on crop insurance.

Louisiana and North Carolina are this country's largest producers of sweet potato. However, it is becoming popular in other parts of the country, including Delaware.

But there is a lack of suitable sweet potato varieties that can adapt to the cooler Delaware climate, since sweet potatoes like it hot. The College of Agriculture and Related Sciences is evaluating a number of varieties, hoping to identify those with the most promise for profitability for the state's small farmers.

THE SWEET POTATO IS A **DROUGHT TOLERANT CROP, AND CAPTURES RESIDUAL SOIL NUTRIENTS IN FIELD ROTATIONAL SYSTEMS,** WHICH MAKES IT ATTRACTIVE TO SMALL FARMERS WITH LIMITED FUNDS TO SPEND ON CROP INSURANCE.

WHAT WAS DONE?

To develop suitable varieties for the Delaware climate and soil, CARS started varietal trials during the 2012 and 2013 growing seasons. There were six varieties planted on sandy loam soil with a pH of 5-6.5 on the tilled bed of three inches wide covered with black plastic.

Of the six, the four lead varieties were: V1 (A-193-217) , which showed the highest average yield (32051 kg ha-1) over the two-year period, followed by cultivar V2 (Birmingham) (31024 kg ha-1), V4 (TI-6008) (31005 kg ha-1) and V6 (TUI-001) (29750 kg ha-1), respectively. However, there was no statistically significant difference among them. All varieties did well during the 120-day growing period in Delaware.

This demonstrates that the sweet potato, including the production of planting material, can be grown as an alternative agricultural enterprise in Delaware. These four varieties are characteristically different in skin color, flesh color, and taste. This allows farmers some levarage in selecting which variety they perfer to enhance diversification of their rotational crops.

WHAT'S NEXT?

Cooperative Extension at DSU will share these results with limited, socially-disadvantaged and minority populations using a variety of avenues, including fact sheets, field days and one-on-one farm visits. It is expected that the sweet potato will become a viable, niche alternative agricultural enterprise for the state's farmers.

In addition, research will be conducted on many other new crops to develop an organic production system to support consumer and market demands.

Chicken litter – How much is too much?

WHY THIS WORK?

Each year, more than 700,000 dry tons of poultry litter are generated in the Delmarva Peninsula. This poultry waste is being disposed of predominantly by applying it to cropland as an organic fertilizer. Poultry litter contains relatively high contents of plant nutrients including nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), and sulfur (S), and serves as a best soil amendment for crop production.

But repeated and excessive applications of poultry litter have resulted in an accumulation of phosphorus in the soil and severe nutrient dissipation via runoff and leaching. These excessive applications can also cause eutrophication (overabundance of nutrients in the water which can mean death to other organisms, like fish) and water quality degradation of both the Chesapeake and Delaware bays. It is estimated that 26.3 million kilograms of nitrogen and 2.0 million kilograms of phosphorus seeped into the Chesapeake Bay as a result of runoff from land-applied animal manures. Another non-point nutrient source to water pollution is land-applied biosolids at 28,000 tons per year in the region.

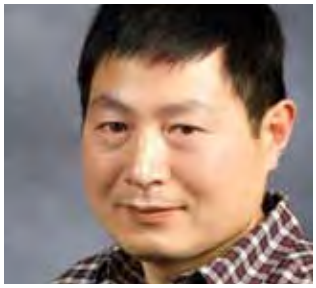
Over and excessive application of poultry litter and biosolids poses a serious threat to the environment and to human health. As such, farmers and environmental managers need scientific guidelines to develop best manure land-disposal programs in terms of application rate, timing, frequency, and mode that promote crop productivity and minimize nutrient water losses.

WHAT WAS DONE?

As part of our research, we measured total and labile nutrient contents of Delmarva poultry litter, biosolids, and their derived products (e.g., biochar, pellets, lime-fortified granules), examined their nutrient release kinetics and plant availability, predicted their nutrient supply capacity, and recommended agronomic application rates for the organic fertilizers.

To protect water quality, Delmarva poultry litter should be incorporated into cropland soil at 6.6 ton/ha (ha: hectare. 1 ha is approximately 2.5 acres) instead of commonly practiced 9-20 ton/ha shortly before planting with supplemental 72.3 kg N/ha chemical fertilization. In repeated annual applications using poultry litter as the sole phosphorus source, the application rate should be further reduced to 5.2 ton/ha. For lime-stabilized biosolids, a nitrogen-based application rate is recommended at 10.4 ton/ha, providing 165 kilograms nitrogen per hectare to plants without phosphorus runoff and leaching risks. The fertilizer value of lime-stabilized biosolids was estimated at $155 per ton at current market prices.

In addition, we also explored the value-added reuse of organic



Guo

PROJECT TITLE: Soil-based Recycling of Organic Waste for Crop Productivity and Environmental Health

PRINCIPAL INVESTIGATOR: ***Mingxin Guo, PhD.,*** *Professor, Department of Agriculture and Natural Resources*

FUNDING: This project was supported by Delaware Department of Agriculture, USDA-NIFA, and NSF-EPSCoR.

residues. Poultry litter was converted to activated carbon for removing heavy metals and organic contaminants from waste water. The optimal activation conditions for producing the best quality activated carbon from poultry litter were determined. Sorption isotherms, kinetics, and capability of poultry litter activated carbon for metal ions and hydrocarbons were investigated.

Poultry litter, crop residues, and forest debris were further used as source materials to produce biochar, bio-oil, and syngas through pyrolysis. A farm-based, pollution-free prototype pyrolysis system was developed. Mass yield and quality of the bio-products from different feedstocks under varied pyrolysis conditions were characterized.

The biochars have been tested in long-term field plot trials as a soil amendment for enhancing soil fertility and promoting crop production. Upgrading procedures were developed to transform pyrolysis bio-oil into a quality liquid fuel. It has shown that at 300°C pyrolysis temperature biochar had the highest mass yield and retained all phosphorus and most nitrogen in poultry litter, but the biochar C was not maximized in stability.

Poultry litter phosphorus was immobilized in biochar as calcium/magnesium precipitates through pyrolysis, remarkably decreasing its water solubility and runoff loss potential upon soil application. Soil amendment with biochar instead of raw poultry litter at 2 mass percent demonstrated improved crop growth and significantly reduced nutrient water losses. Biochar soil amendment also increased soil porosity, organic carbon sequestration, water and nutrient retention, and microbial activity, reduced soil compaction, and improved soil tilth.

OVER AND EXCESSIVE APPLICATION OF POULTRY LITTER AND BIOSOLIDS POSES **A SERIOUS THREAT TO THE ENVIRONMENT AND TO HUMAN HEALTH.**

Our research found the following:

- The land application of Delmarva poultry litter at 6.6 ton/ha instead of commonly practiced 9-20 ton/ha would meet crop phosphorus requirement and minimize nutrient runoff and leaching losses.
- The fertilizer value of lime-stabilized biosolids was $155 per ton at current market prices. Agronomic application of lime-stabilized biosolids should be nitrogen-based at 10.4 ton/ha.
- Poultry litter can also be used to produce activated carbon for removing heavy metals and organic contaminants in wastewater treatment.
- Organic waste materials were converted to biochar as a soil amendment and bio-oil as a renewable liquid fuel through low temperature slow pyrolysis. Soil amendment with poultry litter biochar at 2 mass percent improved crop productivity and soil quality over a long term.

WHAT'S NEXT?

Further research is needed to develop simple and cost-effective pyrolysis units for farm-based production of biochar and bio-oil from agricultural residues. Best land application practices of biochar products from different sources should be identified and disseminated to crop growers.

Switchgrass may keep the switch in the on position

WHY THIS WORK?

The demand for energy is expected to double by 2050. By the same year, food production is also expected to double. With this increase in food demand, biofuel production needs to shift from being derived from edible crops to those that are grown specifically for their high biomass conversion ratios. If the requirement for food and energy doubles and production lags behind, this will undoubtedly cause people to go without. The most affected will be the world's poorest populations.

The use of biofuels derived from grasses addresses the impending energy crisis, food crisis, and greenhouse gas and climate change issues. Switchgrass, a plant native to North America, has become a desirable crop to grow as a renewable source of energy. Switchgrass has been shown to have the capacity for long-term high productivity in a variety of environments. There is high genetic diversity among switchgrass genotypes. The lowland ecotype is generally tetraploid and grows better in non-drought environments while the upland ecotype is composed of tetraploid, hexaploid, and octaploid genomes and are more drought-tolerant. Switchgrass thrives in soils of poor quality and is highly efficient in biomass conversion with minimal nutrient input, making it an

Kalavacharla

PROJECT TITLE: Methylome Sequencing and DNase-seq: Genome-wide Groundwork for Switchgrass *(Panicum virgatum)* for Use as Renewable Biofuel Source

PRINCIPAL INVESTIGATORS: ***Mollee Crampton,*** *Research Technician,* and ***Venu (Kal) Kalavacharla, PhD.,*** *Professor and Director, Center for Integrated Biological and Environmental Research (CIBER) and the Molecular Genetics and EpiGenomics Laboratory*

FUNDING: This project is being supported by the National Science Foundation EPSCoR Grant No. IIA-1301765 and the State of Delaware.

excellent candidate as a source of renewable biofuel.

This research will contribute to feeding and fueling the world as the population increases. Fossil fuels will eventually be depleted and switchgrass can serve as a "greener" energy source. This can help keep other crops, such as corn and sugar cane, in the food industry.

WHAT WAS DONE?

The switchgrass genome has recently been made public and is available online (Phytozome.net). This is a critical step for targeting genes of interest to breed switchgrass for use as an efficient biofuel crop.

Our lab has conducted chromatin immunoprecipitation sequencing (ChIP-seq) to understand how genes are controlled in plant genomes by studying protein-DNA interactions. The current study is concerned with methylome sequencing, as methylation patterns are a determinant of gene expression. Methylation of cytosines in the genome acts as an "off switch" for genes. Methylation patterns will be detected using two methods, including methylated DNA immunoprecipitation sequencing (MeDIP-seq) and whole genome bisulfite sequencing.

To get a better picture of the global control of gene expression, DNase-sequencing (DNase-seq) will also be used. DNase-seq, a technique where nuclear DNA is subjected to enzyme treatment, which degrades DNA (called DNase), will permit us to identify regulatory elements in the switchgrass genome. Comparison of identified regulatory elements and methylated genes among different genotypes of switchgrass allows for identification of genes necessary for selection of more favorable characteristics in crops produced to meet the increasing energy demand.

WHAT'S NEXT?

Further research featuring the comparisons of different genotypes in regard to DNA methylation, DNase-sequencing and the other techniques mentioned above are necessary. Transciptome data would be helpful for breeding purposes to compare differentially expressed genes among different genotypes.

THE USE OF BIOFUELS DERIVED FROM GRASSES ADDRESSES THE IMPENDING ENERGY CRISIS, FOOD CRISIS, AND GREENHOUSE GAS AND CLIMATE CHANGE ISSUES.

DSU-CIBER tries to STEM the tide, and get students interested in the sciences

WHY THIS WORK?

According to the United States Department of Education, only 16 percent of American high school seniors are proficient in mathematics and interested in a STEM (science, technology, engineering and mathematics) career. Even among those who do go on to pursue a college major in STEM fields, only about half choose to work in STEM-related careers. Because a country's sustainable economy depends on innovation and technology, Delaware and the rest of the U.S. need to engage more students in STEM fields so that we can retain more students in these areas and meet our future demands for a skilled workforce.

Several studies revealed that engaging kids at an early age in STEM activities helps them pursue higher education in STEM fields and have careers in those areas. Through CIBER, we are reaching out to provide hands-on research opportunities to undergraduates, K-12 students and teachers. To date, we have provided research opportunities to approximately 200 undergraduate students and approximately 400 K-12 students and teachers.

WHAT WAS DONE?

The DSU Center for Integrated Biological and Environmental Research (CIBER) is providing opportunities to K-12 and undergraduate students in research in an variety of disciplines including, agriculture and natural resources, environmental sciences, bioenergy, water and aquatic sciences, biology, chemistry, climate change and other related areas.

We have conducted the following programs and activities:

- Approximately 70 undergraduate students, from institutions throughout the country, obtained research experience in molecular biology through a National Science Foundation (NSF) grant funded through the Research Experiences for Undergraduates (REU) Program;

Kalavacharla

Melmaiee

PROJECT TITLE: DSU-CIBER: Reaching Out With Research

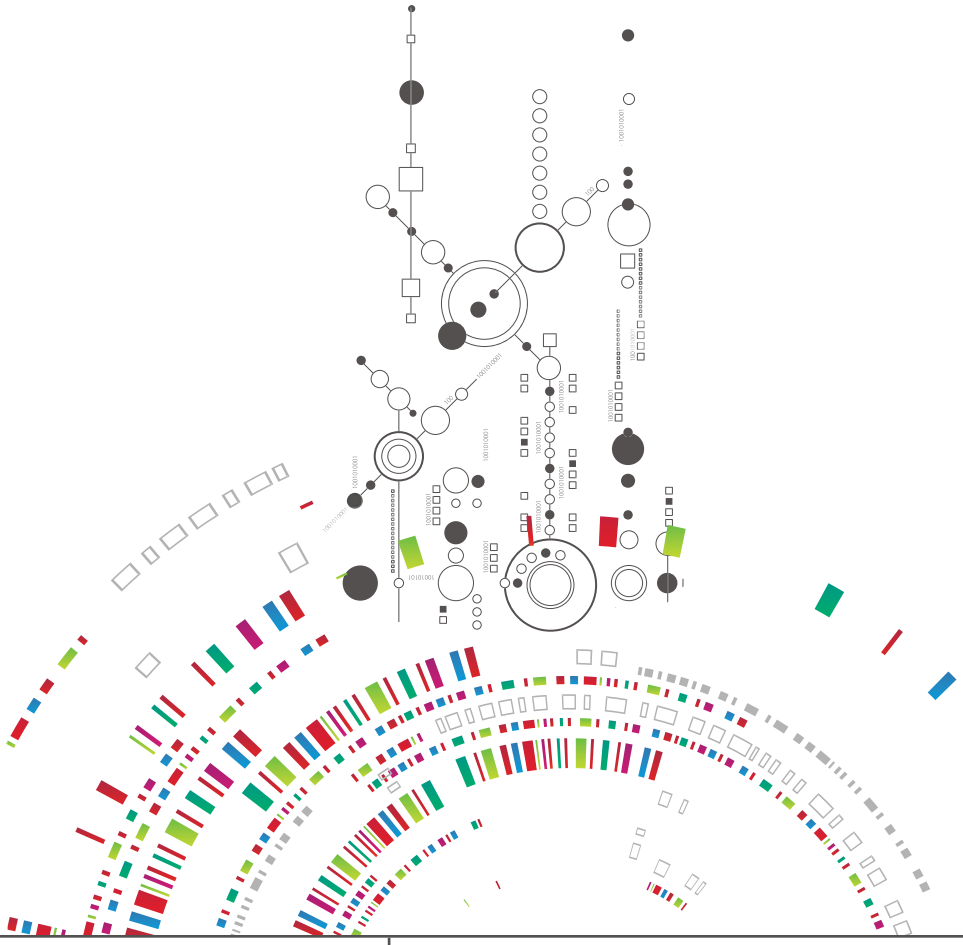
PRINCIPAL INVESTIGATORS: ***Venu (Kal) Kalavacharla, Ph.D.,*** *Professor, College of Agriculture and Related Sciences; Director, Center for Integrated Biological and Environmental Research (CIBER),* and ***Latha Melmaiee, Ph.D.,*** *Research Scientist, CIBER, College of Agriculture and Related Sciences*

FUNDING: This work was made possible by the National Science Foundation EPSCoR Grant No. IIA-1301765 and EPS-0814251 and the State of Delaware, National Science Foundation grant No. DBI-1003917 and USDA awards 2007-38814-18458 and 2008-38814-04735 to VK.

- Through the Delaware Experimental Program to Stimulate Competitive Research (EPSCoR), approximately 60 undergraduate students got research experiences in agriculture and natural resources, environmental sciences, bioenergy, water and aquatic sciences, biology, chemistry, climate change and related areas;
- For the 2013-2014 fiscal year, CIBER helped provide research experiences to approximately 41 students.

SEVERAL STUDIES REVEALED THAT **ENGAGING KIDS AT AN EARLY AGE IN STEM ACTIVITIES HELPS THEM PURSUE HIGHER EDUCATION IN STEM FIELDS** AND HAVE CAREERS IN THOSE AREAS.

Overall, CIBER provided research opportunities to approximately 200 undergraduate students through various programs and since 2007, introduced the research environment to another 200 K-12 students and teachers.



Delaware State University College of Agriculture and Related Sciences

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The charge for the College of Agriculture and Related Sciences at Delaware State University is to implement research, teaching and extension programs that result in an improved quality of life for the residents of Delaware as well as stakeholders at regional and international locations.