COMMUNITY RESEARCH SERVICE

AgKnowledge

College of Agriculture, Food Science, and Sustainable Systems and Land Grant Program

SPRING 2017

YOUR NEW LAND GRANT PROGRAM

Building on excellence with new research in poultry, plant breeding, urban ag, and food science

Kentucky State University®

Animal Science | Beekeeping | Organic Farming | Aquaculture | Health & Nutrition | GIS | Horticulture

Welcome to the third edition of AgKnowledge

Dear Reader,

It is with great pleasure that we present the third edition of the College of Agriculture, Food Science, and Sustainable Systems' (CAFSSS) and KSU Land Grant Program AgKnowledge magazine. This publication is designed to highlight the research and extension activities that the CAFSSS scientists are currently conducting at Kentucky State University.

In the past year, our faculty, staff and students have concentrated on research and extension programing to serve the stakeholders of the Commonwealth, with an emphasis on serving the underserved in rural and urban settings. We have held local and national workshops to help further our efforts to support agriculture in Kentucky communities, and we have been awarded many hard-earned grants to help us with that mission. We will continue to build valuable partnerships with community and government organizations, and promote our mission to prospective students and collaborators.

The KSU CAFSSS faculty, staff and students have continued to make great strides as a leading institution for teaching, research and extension. We are here to help our stakeholders. Please give us your feedback on how we can help you solve your problems. If you do not currently receive a newsletter or literature, please call our office and subscribe to future publications. You can receive these by postal mail or by email. Thanks again for reading, and we hope you can use the information provided in the magazine.

Dr. Kirk Pomper
Land Grant Director
College of Agriculture, Food Science, and Sustainable Systems
and Land Grant Program

AgKnowledge

2017 Edition, Volume 3

Project Manager BLAIR HESS
Graphic Designer
WYVETTE WILLIAMS
Contributing Photographers
CHET WHITE, CHARLES WEIBEL, ELLIOTT HESS

Interim President
DR. AARON THOMPSON
Land Grant Director
DR. KIRK POMPER
Associate Extension Administrator
DR. JOHNNIE WESTBROOK
Interim Assistant Extension Administrator
DR. COURTNEY OWENS
Interim Assistant Research Director DR. BOB DURBOROW
Chair, Division of Aquaculture
DR. JAMES TIDWELL
Interim Chair, Division of Agriculture and Natural Resources
DR. JOHN SEDLACEK

AgKnowledge magazine publishes annually by Kentucky State University's College of Agriculture, Food Science, and Sustainable Systems and aims to promote the research and extension work of the 1890 Land Grant Institution.

CONTENTS

THE ORGANIC APPROACH 3

33

37

The Organic Approach

Research aims to establish best management practices for Kentucky farmers

In organic agriculture there is a great deal of anecdotal and empirical evidence that certain practices work well for producers. There is a need for more scientific evidence to support the researchers and producers who are trying to develop site-specific best management practices for many unique, diversified organic operations.

At Kentucky State University, Dr. Shawn Lucas and his research team conduct studies on diversified organic farming systems that will ultimately help producers answer questions about developing best management practices for their operations. The Organic Research Program in the College of Agriculture, Food Science, and Sustainable Systems is currently developing a research project that examines the effects of integrating pastured livestock into crop rotations. Such rotations are increasingly being adopted on small- and medium-sized organic farms across the state. Researchers plan on examining impacts on soil and water quality in response to this integrated rotation system. Results from this study may help producers make important management decisions.

Dr. Lucas also coordinates research on industrial hemp. Kentucky State University has participated in the Kentucky Industrial Hemp Research Pilot Program since 2014. Current research efforts include examination of the impacts of field retting of fiber hemp on soil quality, examination of impacts of several biofertilization products on crop biomass, grain yields, and soil enzyme activity, and aquaponic production of hemp. Results from these studies may provide useful information to producers, processors and marketers participating in the growing hemp industry in Kentucky.

Dr. Lucas is a trained soil scientist and agronomist. "I have long had an interest in helping farmers develop best management practices that will enhance their soil resource and enhance ecosystem services in production operations that are ultimately profitable and socially acceptable for producers and communities," Dr. Lucas says.

The organic research team is made up of research assistant Erica Thompson, technician Rose Johnson, graduate students Ellyn Anthony and Krystal Conway-Cunningham, student employee Gabe Stone, and co-investigator Anthony Silvernail.

"This team provides unwavering help in the field and laboratory," Dr. Lucas says. "I could not coordinate the Organic Research Program without the input and efforts of co-investigator Tony Silvernail."

Dr. Shawn Lucas, Assistant Professor of Organic Agriculture

Cultivating Growth

New Land Grant Director leads program and pawpaw research into the future

Small and limited-resource farmers in Kentucky and the Southeastern region continue to look for low-input agricultural crops and for economic support. The North American pawpaw is a native tree fruit in the expanding commercial fruit production in Kentucky and the surrounding region. Trees bear fruit in August-September and produce a unique tropical-like flavored fruit with a blend of mango, pineapple and banana, with some cultivars displaying a melon flavor.

Pawpaw has great potential for fresh market sales at farmers' markets, on-farm sales, and CSAs, as well as the processing market. Pawpaw production information and new high-yielding varieties would help jump-start the pawpaw industry.

Since 1994, Kentucky State University has served as the U.S. Department of Agriculture National Clonal Germplasm Repository, or gene bank, for pawpaw, as a satellite site of the repository at Corvallis, Ore. The function of the repository is fourfold: (1.) germplasm acquisition; (2.) germplasm preservation; (3.) germplasm evaluation; and (4.) germplasm distribution. The current pawpaw repository collection is in the form of trees planted in orchards, those growing in the greenhouse, and seeds in refrigerated storage. The Repository collection includes over 2,000 accessions (trees) from 16 different states including Arkansas, Illinois, Indiana, Kentucky, Louisiana, Maryland, Mississippi, Missouri, Nebraska, New York, Ohio, Oklahoma, Pennsylvania, Tennessee, Virginia, and West Virginia. These trees are planted on approximately 12 acres at KSU's Harold R. Benson Research and Demonstration Farm in Frankfort, Ky. This is the largest collection of pawpaw anywhere in the world. It is a tremendously valuable resource for scientific research and new variety development.

Pawpaw research in the College of Agriculture, Food Science, and Sustainable Systems is lead by Dr. Kirk Pomper, director of the Land Grant Program and professor in Agriculture and Natural Resources and supported by research and extension associate Sheri Crabtree, research associate Jerimiah Lowe, and graduate students Srijana Thapa Magar and Brian Edgar. Research focuses on increasing the production of pawpaw orchards, finding new ways to propagate pawpaw, and selecting new high-yielding pawpaw fruit varieties with enhanced fruit quality.

Dr. Kirk Pomper, Director of KSU Land Grant Programs, Director-KSU Agricultural Research Station, Professor

(Top): Jerimiah Lowe, Research Associate, and (Bottom): Sheri Crabtree, Research and Extension Associate

KSU-Atwood™ and KSU-Benson™ are new high-yielding pawpaw varieties that have been released to the public by the Kentucky State University pawpaw research team.

KSU-Benson™ was released at the end of 2016 at the 4th International Pawpaw Conference held at Kentucky State University. The fruit is named for Dr. Harold R. Benson, director of the Land Grant Program for 36 years.

"Pawpaw is in the early stages of commercial production and is being planted around the world," Dr. Pomper says. "I expect KSU-Benson™ will be widely planted around the country with its excellent tasting, round fruit."

KSU provides seeds and budwood of pawpaw varieties to over 300 people each year.

Dr. Pomper was named Land Grant Director in early 2017 after serving as the interim director for over a year. He is working to expand on successful research and Cooperative Extension programs by increasing focus in poultry, plant breeding, urban ag, and food science. KSU's Cooperative Extension Program will also be extending its commitment to rural urban communities in the areas of 4-H, community development, family and consumer science, and agriculture.

KENTUCKY STATE UNIVERSITY HAS THE ONLY FULL-TIME PAWPAW RESEARCH PROGRAM IN THE WORLD.

THERE ARE OVER

2,000

ACCESSIONS (TREES) FROM 17 STATES THAT ARE PLANTED ON 12 ACRES AT THE KSU FARM.

Kentucky State University has released two new pawpaw varieties:

- KSU-Atwood™, is named for Rufus B. Atwood, former president of Kentucky State College (now University) from 1929-1962 who led efforts to desegregated education in Kentucky in the 1940s.
- KSU-Benson™ is named in honor of Dr. Harold R. Benson who served as director of the Land Grant Program for more than 36 years. Dr. Benson supported the KSU pawpaw research program from its beginning.

Pawpaw research efforts are directed at improving propagation methods, developing orchard management recommendations, conducting regional variety trials, understanding fruit ripening and storage techniques, and germplasm collection and characterization of genetic diversity.

The Benefits of Bugs

Research works to attract beneficial insects to improve biological control of crops

Dr. John D. Sedlacek, Associate Professor and Interim Chair, Division of Agriculture and Natural Resources

Insect pests are a major concern for sweet corn and blackberry growers. Producers and vegetable/fruit processors have very low tolerance for presence of insects or damage to meet consumer demand for damage and insect-free food. Sweet corn and blackberries, especially the fresh market products, are sprayed intensely with insecticides to minimize the presence of insects and to ensure that little insect damage occurs to the ears or fruit. Sustainable farming practices offer ways to potentially lower input costs, decrease reliance on nonrenewable resources, and obtain premium prices for agricultural commodities compared to those conventionally produced. However, a major constraint to adoption of sustainable insect management and control practices is the lack of research-based information concerning more ecological methods.

Dr. John Sedlacek, associate professor in the Division of Agriculture and Natural Resources and chair of the college's undergraduate and graduate degree programs, conducts research on conservation biological control using native perennial plants and synthetic insect attractants to increase biodiversity of insect predators and parasitoids to manage pest insects in annual and perennial crops.

"Specifically we are attracting several species of lady beetles, lacewings, big eyed bugs, minute pirate bugs, ground beetles and other predators and parasitoids of sweet corn and blackberry pests to these crops," Sedlacek says.

Conservation Biological Control (CBC) seeks to preserve and increase abundance and activity of beneficial insect populations in a crop setting. The overall goal of this research is to develop CBC pest management options and strategies for sweet corn and blackberries. Investigating methods of manipulating crop habitats will help growers improve biological control of pest insects in annual row and perennial bramble crops. As a result, all growers will have more sustainable methods to manage insect pests. Improvement in efficacy of natural controls could also lead to reductions in synthetic pesticide applications, which would decrease costs for pest control, improve environmental health and ultimately be more profitable for all growers.

Dr. Sedlacek is assisted by research associate Karen Friley, graduate research assistants Kyle Slusher and Mamata Bashyal, as well as graduate student Denita Brown, undergraduate research assistant Sathya Govindasamy, and Practicum II research student Amanda Keeling.

All the Buzz

Research aims to protect honeybees from harmful pathogens

Dr. Tom Webster, associate professor in the College of Agriculture, Food Science, and Sustainable Systems, leads a research team investigating a pathogen that infects the honeybee digestive system called *Nosema ceranae*. This microscopic pathogen infects many honeybee colonies in Kentucky and other parts of the world. It weakens bees by interfering with their ability to digest food. Kentucky State University researchers evaluate treatments to see whether they allow the bees to recover from this pathogen.

The most promising treatment to date is based on a material that stimulates the honeybee immune system. This treatment is being developed and tested in collaboration with researchers at a U.S. Department of Agriculture honeybee research lab in Beltsville, Md., and at Pennsylvania State University.

Honeybees are the most important insect pollinator and are responsible for the pollination of 1/3 of agricultural food crops in the world, with an estimated value of

$216

billion per year.

Worker bees each have 8 tiny wax glands on their abdomens. These glands secrete bits of wax. The worker bees then mold these bits of beeswax into a sheet of interlocking hexagons to make honeycomb.

Dr. Tom Webster, Associate Professor and State Extension Specialist for Apiculture

"I am particularly proud of our improvements in understanding the honeybee midgut and the effects of pathogens on this organ," Dr. Webster says. "Food (honey and pollen) is digested in this organ, and it is vulnerable to many diseases. We have developed new methods to understand and evaluate its development, health and pathology."

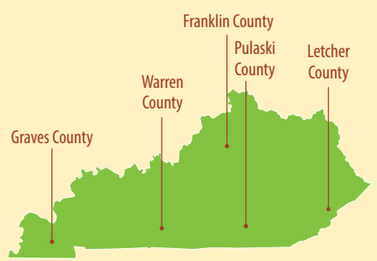
This research is more important than ever as pollinator numbers have drastically decreased over the past decade. Pollinators, including some 20,000 species of wild bees, contribute to the growth of fruit, vegetables and many nuts, as well as flowering plants. Plants that depend on pollination make up 35 percent of global crop production volume with a value of as much as $577 billion a year.

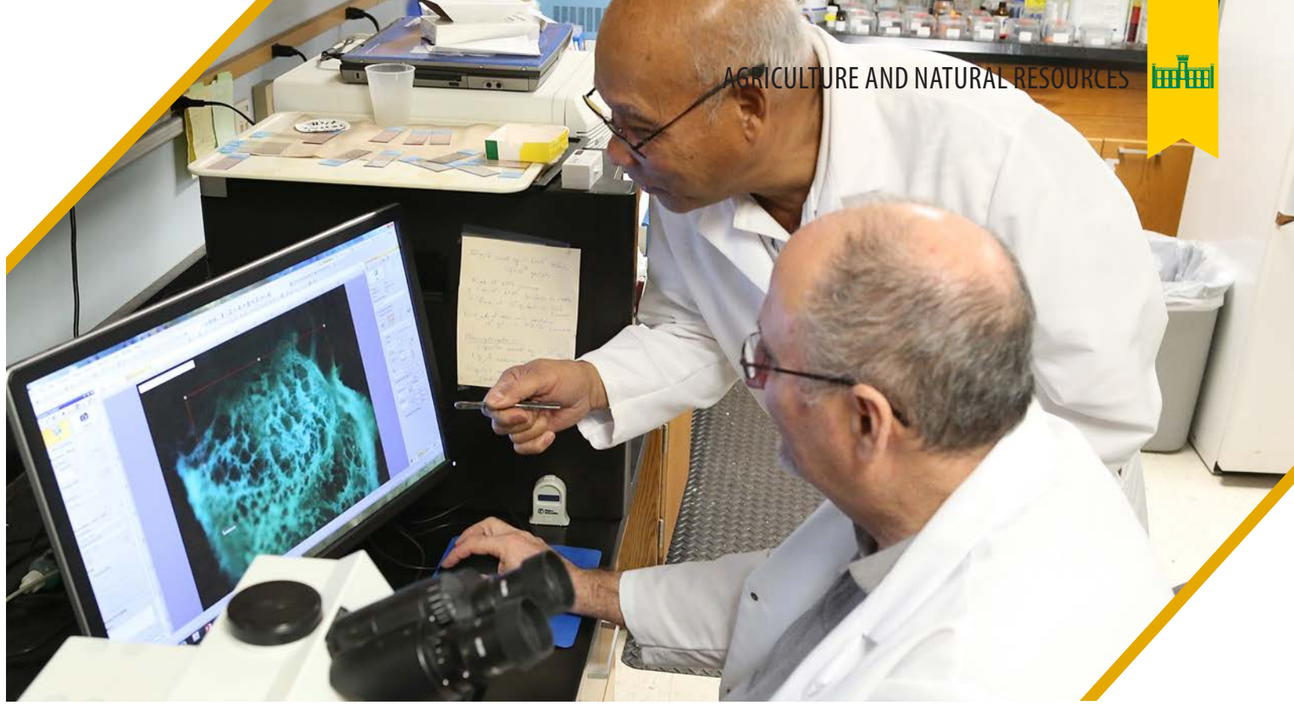
Throughout his career, Dr. Webster has studied the effects of an insecticide on honeybees pollinating alfalfa and non-chemical control of the parasitic varroa mite. He has also worked with beekeepers in Belize and Ecuador to help resolve beekeeping concerns in those countries. Other research projects include studying problems in successful wintering of bee colonies in Kentucky.

Dr. Webster's research team includes research assistant Martin Matisoff, postdoctoral research scientist Dr. Katherin Kamminga, and graduate student Jacob Vincent.

Find a beekeeping organization near you at www.ksbabeekeeping.org/local-beekeeping-organizations

1. Lake Barkley Beekeepers Association
   Meets first Monday of the month at 6:30 p.m. at the Graves County Extension Office.
2. Warren County Beekeepers Association
   Meets fourth Tuesday of the month at the Warren County Extension Office.
3. Lake Cumberland Beekeepers
   Meets third Monday of the month at 7 p.m. at the Pulaski County Extension Office.
4. Capital City Beekeepers Association
   Meets fourth Tuesday of the month at 6 p.m. at the Franklin County Extension Office.
5. Mountain Beekeepers Association
   Meets second Tuesday of the month at the Letcher County Extension Office.





Securing the Hive

Researchers study midgut to explain honeybee decline

The world is facing a decline in honeybee populations that could threaten a variety of crops including apples, cranberries, melons, broccoli, blueberries, avocadoes, almonds, and more. Kentucky State University researchers Cecil Butler and Martin Matisoff are focusing on pathogens related to this decline.

Over the past three years, Butler and Matisoff created methods for studying the honeybee midgut. They developed successful methods for extracting and dissecting honeybee midguts and used that tissue for studying the morphology of the midgut and the effects of Nosema spp. on midgut physiology and anatomy. Butler and Matisoff hypothesized that Nosema spp. infects the bee's midgut changing the physiology thus leading to anatomical changes and declining bee populations.

They observed that the spores were able to circumvent the peritrophic membrane (PM) and infect the delicate epithelial tissue. The PM consists of several layers of chitin and protein that form an impermeable matrix that blocks the passage of viruses, bacteria, fungi, and protozoa. What is not known is how spores, which are significantly larger than these other pathogens, are able to get through the PM.

Their work corroborated earlier electron microscopy studies conducted in the United Kingdom and Brazil. Butler and Matisoff were the first team to use routine and special staining methods to identify anatomical changes in the underlying structures. They also used special stains to identify the valves that control the passage of food into and out of the midgut.

Research Assistants Martin Matisoff and Cecil Butler

Dr. Farida Olden, Assistant Research Professor of Molecular Genetics & Genomics

Protecting Our Pollinators

Investigator studies effects of environmental stressors on honeybees

Dr. Farida Olden, assistant professor in the College of Agriculture, Food Science, and Sustainable Systems, is leading the KSU Land Grant Program's initiative to develop capabilities in the field of genomics and establish a cutting-edge AgBio genomics laboratory.

Dr. Olden aims to expand the honeybee research program to study the repercussions of environmental stressors, such as diseases and pesticides, on the honeybee. As a pollinator, honeybees perform a vital ecosystem service, however, this beneficial insect has been facing an alarming trend of population decline over the last decade. For this reason, Dr. Olden has a keen interest in investigating the impact of environmental stressors on the honeybee, especially a the molecular level.

One of the approaches she implements is RNA-seq, a remarkable emerging new technology for transcriptome profiling. In the framework of Dr. Olden's research, she is also interested in honeybee nutrition as a means to quell the effect of environmental insults. For all living beings, nutritive diets are crucial for an optimal homeostasis, such that nutrition deficiency could negatively impact the development of suitable immune and stress responses. This correlation between fitness and nutrition has led to the advent of Nutrigenomics Science that investigates nutrition effects on the organism, using high-throughput genomics tools. Two of Dr. Olden's current projects pertain to the field of nutrigenomics: honeybee transcriptome profiling under differential diet quality—in the presence of fungal infection—and pesticide contamination.

Dr. Olden works closely with the University of Kentucky, the U.S. Department of Agriculture's Honey Bee Research Center, and Kentucky beekeepers on her research.

A Blooming Industry

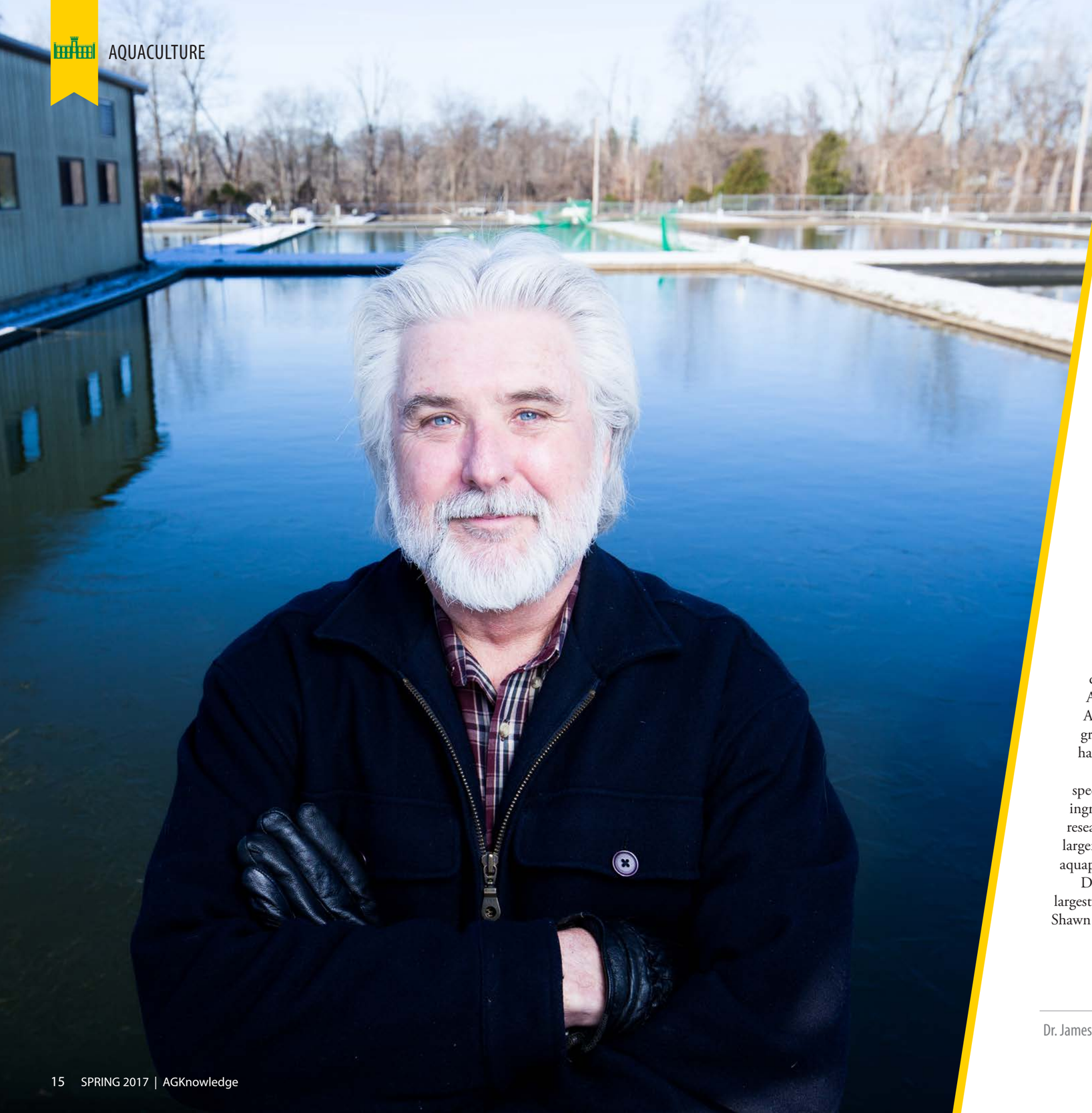
Research introduces temperature tolerance in orchids for growth in Kentucky

Kentucky has a relatively small industry for the production of nursery, greenhouse, and floriculture crops. One way to increase profitability for Kentucky greenhouses and nurseries is to specialize in a niche crop with a high value.

Orchids have been considered a niche crop in the past, but are rapidly gaining popularity. Despite this increase in interest, some of the once-prominent orchid production areas have decimated. As orchids require a considerable amount of heat for optimum growth, the rising heat costs are a major concern for orchid growers. Development of orchids that not only require less heat for production, but also can be potentially grown in high tunnels or even gardens located in the U.S. Department of Agriculture Plant Cold Hardiness Zones 6 or 7 will create opportunities for nurserymen and limited-resource farmers as well as hobbyists and consumers.

Dr. Hideka Kobayashi, assistant professor in the College of Agriculture, Food Science, and Sustainable Systems, is working on the introduction of cold hardiness and temperature tolerance in orchids and *Begonia* and perenniality into common annual bedding plants such as sunflower and *Zinnia*.

Dr. Hideka Kobayashi, Assistant Professor, Division of Agriculture and Natural Resources



Making Waves

KSU Aquaculture leads the country in research and Extension

Kentucky State University's Division of Aquaculture is one of the top aquaculture programs in the U.S. Known for its innovative research, KSU supports aquaculture initiatives across Kentucky. The program, which is housed in the College of Agriculture, Food Science, and Sustainable Systems, is the university's Program of Distinction and the region's only full-service aquaculture program offering opportunities in teaching, research, and extension.

Dr. James Tidwell directs the aquaculture program at KSU and has dedicated most of his 30-year professional career to the university. Dr. Tidwell has been instrumental in developing the academic program within the division and fostering the growth of aquaculture research and extension at Kentucky State. He devoted many years to the development of academic offerings in aquaculture including the Masters Degree in Aquaculture/Aquatic Sciences and the wide variety of online classes. Today, the Division of Aquaculture has the largest offering of online aquaculture courses in the U.S. at both the graduate and undergraduate levels. More than 700 students from 40 states and 27 countries have taken online classes through the program.

Dr. Tidwell's research directions include the development of alternative aquaculture species, the evaluation of different production systems, and the evaluation of alternative feed ingredients. He has also worked on practical fish and shrimp nutrition. Most recently, his research has involved largemouth bass as a culture species, insect meal as a protein source in largemouth bass diets, and the food safety aspects of products (fish and vegetables) produced in aquaponics systems.

Dr. Tidwell has served as President of the World Aquaculture Society, which is aquaculture's largest professional society with membership in over 90 countries. His staff includes Karla Johnson, Shawn Coyle, Leigh Anne Bright, Janelle Hager, Chelsea Walling, Doug Blair, and Fred Gonzales.

Dr. James Tidwell, Professor and Chair, Division of Aquaculture

KSU Increases Research and Development

Aquaculture efforts in fish diseases is one program helping to put university on the forefront

Kentucky State University is defying a national trend and climbing its way up the national rankings in higher education research and development. According to the recently published National Science Foundation (NSF) Higher Education Research and Development Survey, KSU ranks 375th out of 640 institutions reporting research expenditures. KSU's ranking has climbed eight positions from the previous year when it ranked 383rd.

The NSF survey shows funding for research and development in higher education has declined by 1.7 percent between the fiscal year 2014 and fiscal year 2015. KSU research and development expenditures increased six percent in the same period. Among 1890 Land Grant institutions, KSU was one of six schools to see an increase in research and development expenditures. It ranked 66th out of 202 reporting institutions for expenditures in agricultural science.

Dr. Robert Durborow, professor and state Extension specialist for aquaculture who also serves as interim assistant research director for the Land Grant Program, is proud of the work of the university's research community.

Dr. Robert Durborow, Interim Assistant Research Director, Professor, State Extension Specialist in Aquaculture

Dr. Durborow is a fish pathologist and the director of KSU's Fish Disease Diagnostic Laboratory. In addition to teaching online and on-campus classes in fish diseases and water quality management at the undergraduate and graduate levels, Dr. Durborow and his students diagnose about 50 cases a year and advise fish farmers on how to treat and prevent the diseases identified in the lab. These treatments include feeding medicated feed and administering legal chemical treatments to the water.

Dr. Durborow and his team also test water samples and advise pond owners on how to treat their water for best management. Water treatments include pulverized agricultural limestone, salt, gypsum, potassium permanganate, copper sulfate, and formalin. He also performs fish health inspections required by the U.S. Department of Agriculture/APHIS, state veterinary services in states where Kentucky fish producers sell their crop, and/or private hatcheries in order to prevent the transport of diseases across state lines.

Increasing Fish Production for Small Farmers

Research investigates integrating aquaculture and water reuse

The London Utility Commission and Kentucky State University's Division of Aquaculture are collaborating on a project to integrate aquaculture and water reuse at the Water Resource Recovery Facility in London, Ky. This project takes advantage of decommissioned facilities, a secure location, treated water discharged from the plant, and other components of the facility to grow fish. It will develop management practices and serve as a demonstration providing a focus for educational programs on aquaculture for the next three years.

This is part of the research work of Dr. Ken Semmens, assistant professor in aquaculture in KSU's College of Agriculture, Food Science, and Sustainable Systems. Dr. Semmens seeks to address production and marketing issues facing the aquaculture industry, especially for small farmers in Kentucky and the surrounding region. He conducts research on the use of domestic wastewater for aquaculture production, response of fish in holding systems associated with the sale of live food fish, floating raceways, and the culture of paddlefish.

"As the value of water is recognized, it makes sense to develop methods that take greater advantage of existing resources to grow fish for food and recreation," Semmens says.

KSU aquaculture investigators have conducted research across central Kentucky on fish grown in water discharged from wastewater treatment plants in Winchester, Frankfort, Midway, and London. Paddlefish, hybrid striped bass, channel catfish, colorful koi carp, tilapia, and largemouth bass survive and grow well in these systems.

By using decommissioned water treatment facilities and retrofitting them for aquaculture, municipalities may avoid demolition costs, create new jobs, and generate revenue for their communities. Most of the new water resource recovery facilities are being built adjacent to the old and would conveniently allow reclaimed water to be used for aquaculture. Using reclaimed water can be considered a non-consumptive way to reuse water because the aquaculture effluent is returned to the treatment process.

Dr. Ken Semmens, Assistant Professor in Aquaculture

Production Sciences Group works to improve efficiency of recirculating aquaculture systems

Innovative Aquaculture Production

The Production Sciences lab in Kentucky State University's Division of Aquaculture produces meaningful research results that directly contribute to the betterment of the aquaculture industry in Kentucky and around the world.

"It is my proudest professional accomplishment," says Dr. Andrew Ray, assistant professor of aquaculture production who established funding for and created the lab. It is funded with over $1.2 million in external, competitive grants.

Dr. Ray's research focuses on finding ways to make aquaculture systems more sustainable, efficient, and more profitable for farmers. He leads the Aquaculture Production Sciences Group at the university, which works to improve indoor and greenhouse-based recirculating aquaculture systems that use very little water. Because of very low water use, the production sciences group works with systems to grow marine shrimp year-round in Kentucky, allowing farmers to provide fresh, never frozen, jumbo shrimp to local markets. In addition, some aquaculture systems recycle nutrients, leading to lower food costs.

He also works with tilapia, largemouth bass, koi, and other freshwater species. More broadly, his research interests include systems refinement, waste and contaminant remediation, polyculture, nutrient cycling, terrestrial-aquatic food systems integration, and aquaponics.

Dr. Ray has worked with industry and academia across the U.S. and in many parts of the world. He designed and managed large-scale aquaculture operations in Mississippi and in South Africa, and he has helped to design barn-scale systems in California and Kentucky. His research group includes Adam Cecil, Leo Fleckenstein, John Barksdale, Josh Finley, Elizabeth Gamez, Tom Tierney, and Nathan Kring.

Dr. Andrew Ray, Assistant Professor in Aquaculture

The Case for Koi

Breeding koi for weed control and ornamental value

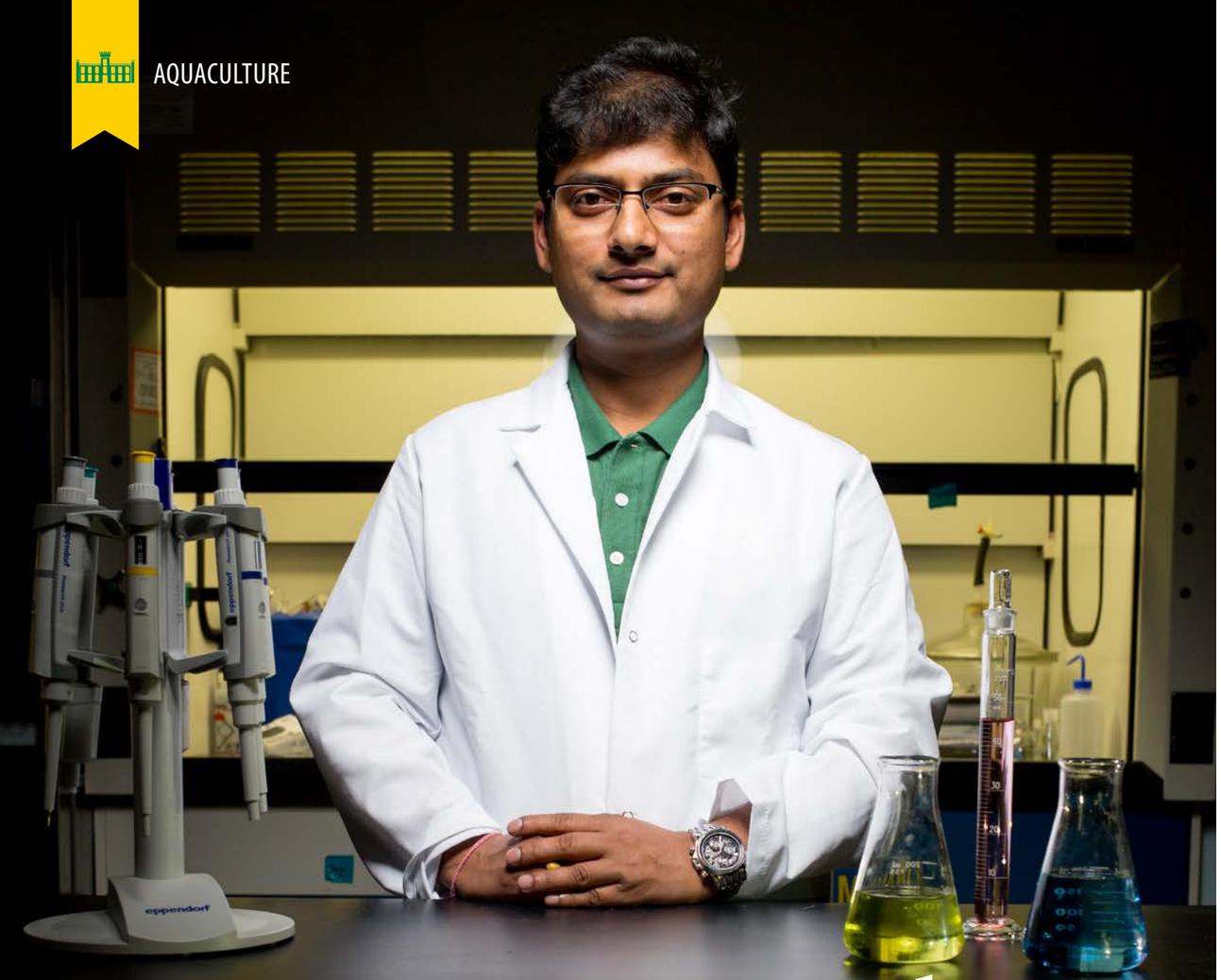
In Kentucky State University's Division of Aquaculture, Dr. Boris Gomelsky studies fish genetics and reproduction. He has nearly 40 years of experience in this area, conducting research in the U.S., Israel, and Russia. He has worked with koi, goldfish, tilapia, crappie, paddlefish, and striped bass. In recent years, his research has focused on cyprinid fish (carp family) including ornamental koi carp to be stocked in water bodies to prevent the growth of algae and submerged weeds. Currently, working with Dr. Noel Novelo and graduate student Jeffrey Warner, Dr. Gomelsky performs studies on fish genetics in the following areas:

First, Dr. Gomelsky develops methods for production of sterile fish, or fish that are unable to reproduce. It is known that the stocking of some cyprinid fish, for example ornamental koi carp or goldfish, to ponds or other water bodies can prevent development of filamentous algae and submerged weeds. The mechanism of this positive influence is that cyprinid fish make water more turbid and less transparent for sunlight. These conditions stimulate development of desirable microscopic algae (phytoplankton) but not the expansion of annoying filamentous algae and submerged weeds.

In order to be successfully used for weed control, stocked fish should be genetically sterile for prevention of uncontrolled reproduction and overcrowding. Dr. Gomelsky investigates using two different genetic methods for production of sterile fish. The first method is induced triploidy. Triploid fish have an additional set of chromosomes in their genomes. The presence of this extra chromosome set makes it impossible for fish to develop eggs and spermatozoa and therefore the fish are sterile. Induced triploidy is used not only for producing sterile fish but also for plants. For example, seedless watermelons, which we buy in grocery stores, originate from sterile triploid plants. Another genetic method, which he applies in his studies for obtaining sterile fish, is interspecies hybridization or production of hybrids between two different fish species. Distant hybridization is a common method for production of sterile animals. The most well-known example is sterility of mule, which is hybrid between a donkey and a horse. In Dr. Gomelsky's studies, he produces and investigates hybrids between two common ornamental fish: koi and goldfish.

A second focus of genetic studies that Dr. Gomelsky explores is the investigation of inheritance of color and other traits in ornamental koi carp. Koi is a very popular decorative fish in many countries including the United States. Koi were developed in Japan approximately two centuries ago. In spite of relatively long history of koi, the inheritance of many traits is not yet understood. As a result of our studies performed at Kentucky State University, Dr. Gomelsky obtains data on inheritance of different traits in koi including long fins, sparkling scales and red eyes. Currently he is investigating inheritance of trait "transparent scales" in koi. Available information on koi genetics will help to improve quality of fish produced by U.S. koi culturists.

Dr. Boris Gomelsky, Professor in Aquaculture Genetics and Reproduction



Preparing Aquaculture to Feed the World

Nutrition research works to alleviate food scarcity for growing populations through improved fish feed

Dr. Vikas Kumar, Assistant Professor in Aquaculture Nutrition

Dr. Waldemar Rossi, Research Assistant

The world's population is expected to grow from today's 7.4 billion to about 9.1 billion by 2040. Feeding these people and eliminating hunger will require advancement in feed and food production systems. Aquaculture is one of the best measures that provides a high-quality, inexpensive, and healthy source of animal protein.

Aquaculture holds great promise for alleviating food scarcity and poverty. With an aim to produce healthy seafood by using alternative feed ingredients and different aquaculture technology, Dr. Vikas Kumar is working on a series of projects primarily focusing on developing nutritionally balanced, environmentally sound, and cost-effective diet for commercial fish and shellfish culture.

Dr. Kumar, who is an assistant professor in the College of Agriculture, Food Science, and Sustainable Systems Division of Aquaculture, has more than 10 years of research experience in fish nutrition as well as fish physiology and biochemistry. He has developed a number of international collaborative projects and completed research work with Germany, Belgium, Norway, India, Brazil, Mexico, China, and Malaysia.

Most recently, Dr. Kumar has worked on several projects including research to boost aquaculture sustainability and profitability by enhancing soybean meal utilization in aquafeeds by assessing the nutritive value and optimization of soybean meal-based diets for hybrid catfish and largemouth bass. Other research includes optimizing the use of algal meal (Schizochytrium sp.) as a fish oil replacer in the practical diets of Pacific white shrimp (Litopenaeus vannamei).

Internationally, Dr. Kumar is working on a collaborative project with Nofima, a Norwegian food research institute located in Sunndalsora, Norway that operates industry-oriented research and development in aquaculture, fisheries, and food. Dr. Kumar and Nofima are ealuating Enzomeal for largemouth bass (Micropterus salmoides) and Atlantic salmon (Salmo salar) feed.

Dr. Kumar's other research interests include fish and shellfish nutrition, alternative protein sources and development of novel protein ingredients for aquafeed, feed processing and manufacturing technology for aquatic and farm animal feed, biological and chemical effects of feed and ingredient processing, and improvement, standardization, and documentation of methods in fish nutrition.

Sharing the Harvest

KSU pushes ahead in aquaponics research and partners with the community

Interest in aquaponics has grown considerably in recent years. Kentucky State University's Division of Aquaculture in the College of Agriculture, Food Science, and Sustainable Systems keeps up with the expanding industry by increasing infrastructure for research at the Aquaculture Research Center. The center now houses a production technologies building containing recirculating systems including six replicated aquaponics systems, as well as an aquaponics greenhouse.

Aquaponics combines recirculating aquaculture systems with soilless plant production, essentially using fish waste as liquid fertilizer for the plants. In its most basic form, aquaponics systems include an area for fish production, a space for solids/waste removal, and a hydroponic production unit.

At Kentucky State University, aquaponics research has mainly focused on leafy greens because they grow quickly, leading to higher profit turnover for producers than fruiting plants like tomatoes and cucumbers. KSU researchers lead by Janelle Hager, research associate in aquaponics, have evaluated the growth of basil, Romaine lettuce, Bibb lettuce, kale, and Swiss chard under different types of indoor lighting technologies as well as using outdoor light in the greenhouse. Hager has also conducted sunflower growing trials in the aquaponics green house.

Recently, Hager teamed up with ACCESS Soup Kitchen and Men's Shelter in Frankfort to provide fresh produce to the soup kitchen. Funding for the project is provided by a grant that requires the focus of the research to be directed toward providing fresh produce to underserved communities, minorities, and food deserts. KSU has provided tilapia about every three to four months, and heads of lettuce are donated to the organization weekly.

"I think part of being at KSU, our goals are serving," Hager says. "Using aquaponics, a growing field, to reach community members and be engaged that way is cool. This opportunity has been really special."

Janelle Hager, Research Associate in Aquaculture

Technology of the Future

KSU uses drones to study farm and land management activities

The drone is just one of the many geospatial tools researchers and Extension staff at Kentucky State University employ in order to understand the world and around us, both in terms of the differences between places and how that may be changing over time. This is especially important when considering how dependent agriculture is on local environmental change, so being able to quantify change and track it over time can be helpful for planning purposes and more.

While the technology provides an invaluable service towards research objectives, people are often more interested in the drone as a piece of "cool" technology rather than the scientific role it plays. Jeremy Sandifer, STEM project coordinator, capitalizes on that fascination when creating educational content and working with young people. He works with assistant professor Dr. Buddhi Gyawali to teach undergraduate- and graduate-level courses in Earth and Environmental Systems and Geosciences, Geographic Information Systems, and Remote Sensing.

"Whatever it takes to keep them interested," Sandifer says.

Dating back to the 1960s and the days of The Space Race, the type of digital imagery produced by the drone has been used in the evaluation of environmental conditions. This technology has allowed witnessing whole scale changes on Earth's surface including massive deforestation in the Amazon, as well as the slow but steady decline of sea ice extent in the Arctic.

"Recently, thanks to super high spatial resolution satellite imagery and emergence of low cost 'drone' technology, we are witnessing an explosion in the utilization of this data for farm and land management activities, especially agriculture," Sandifer says. "At the farm level, this imagery can be used to estimate the distribution of such parameters as nitrogen or moisture content in the soil and can also be coupled with crop production level to build yield prediction models."

Sandifer and Dr. Gyawali have implemented several projects that are helping us understand to what degree the tried and true traditional geospatial methods can

be adapted to extract useable information. Sandifer also hopes to better understand how that extracted information then relates to the hard data KSU soil and crop scientists are collecting as part of their work.

"Applying expert knowledge as a ground truth to our imagery is much more meaningful in terms of the information that can be extracted from it, and whether that information is actionable or not," Sandifer says. "Without that ground validation data, the imagery is only useful for documentation and marketing. Helpful, but not in terms of our research questions."

At Bernheim Arboretum and Research Florest in Clermont, Ky., Sandifer and the GIS staff and students are working with the forest management staff to use geospatial data and methods to document conditions of the edible garden and to understand the distribution of invasive species throughout the park.

ARE YOU INTERESTED IN GATHERING DATA ON YOUR FARM?

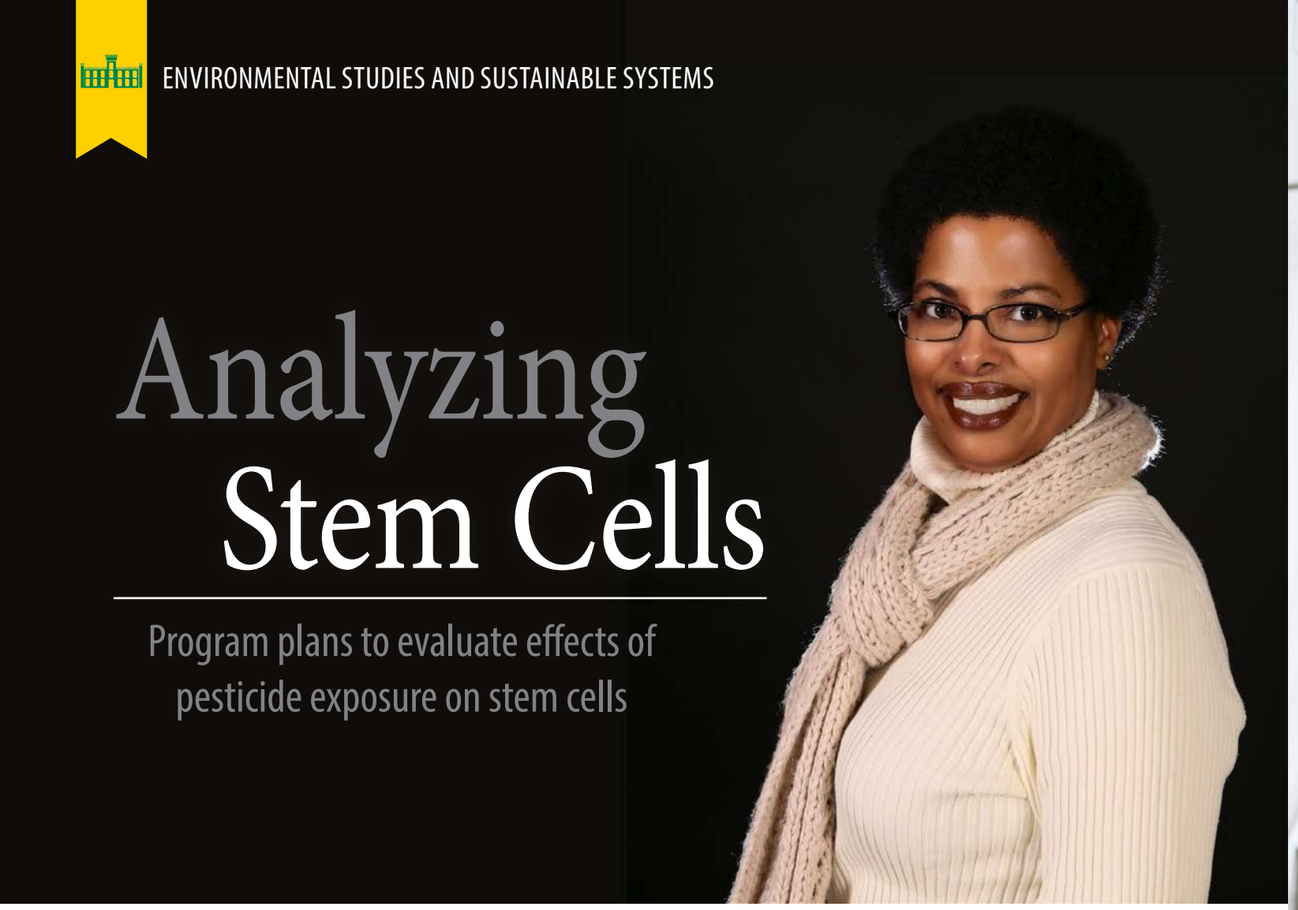
Sandifer is looking for local farmers and land managers who have been collecting detailed data on their crops, either in terms of production yields, quality, or changes in the local environmental conditions. The College of Agriculture, Food Science, and Sustainable Systems wants to work with these producers to help them leverage the power of this technology for improving their bottom line.

Contact Jeremy Sandifer at jeremy.sandifer@kysu.edu.

Opposite page: Jeremy Sandifer, STEM Project Coordinator; This page: Sandifer and Dr. Buddhi Gyawali (right), Assistant Professor of Geospatial Applications and Human Dimensions of Natural Resources

Analyzing Stem Cells

Program plans to evaluate effects of pesticide exposure on stem cells



A stem cell is an undifferentiated cell of a multicellular organism that is capable of giving rise to indefinitely more cells of the same type and from which certain other kinds of cell arise by differentiation. At Kentucky State University's College of Agriculture, Food Science, and Sustainable Systems, Dr. Tyra Dunn-Thomas is conducting research that focuses on the effects of pesticide exposure on stem cells as a model for human health. Specifically, Dr. Dunn-Thomas is interested in the mortality rate and differentiation of cells once exposed to pesticides.

Stem cells have the potential to develop into many different cell types in the body during early life and growth. Additionally, in many tissues these cells serve as a sort of internal repair system, dividing essentially without limit to replenish other cells as long as the person or animal is alive. When a stem cell divides, each new cell has the potential either to remain a stem cell or become another type of cell with a more specialized function.

Dr. Dunn-Thomas has a background in biology, computer science, and clinical research. She has more than 12 years of research experience working in academia, industry, and government, and her research has included Parkinson's disease, cancer, retinal development and diseases, women's health, post-traumatic stress disorder, genomics, and proteomics.

Dr. Tyra Dunn-Thomas, Assistant Research Professor

The Impact of Soil

Research investigates livestock emission using eddy flux covariance

Agricultural soils are ecologically complex systems and their management could impact rate and magnitude of gas and energy exchange between the surface and the atmosphere. Dr. Maheteme Gebremedhin, assistant professor of soil science in the College of Agriculture, Food Science, and Sustainable Systems employs the micrometeorological technique of eddy flux covariance to understand the temporal variation of carbon dioxide and methane gases exchanges on grazing pasture and forest landscape.

Measurement of livestock emission is central to projections and uncertainties related to studies of animal methane emission in responses to grazing pattern and management. The goal of Dr. Gebremedhin's project is to estimate methane emission rate from a goat pasture, developing a fuller understanding of the variables controlling the temporal dynamics of methane fluxes across temporal scales ranging from seconds to seasons and beyond. Measurements also include high frequency 3-D wind speed and direction, air pressure, temperature and humidity, precipitation and photosynthetically active radiation (PAR) and incoming and net radiation.

Dr. Gebremedhin is also working in soil science to understand the effects of farming practices and soil management on soil health and productivity. His research aims to understand innovative conservation practices such as minimum tillage, cover crop, and crop rotation on physical, biological, and chemical properties of soils.

He and his research team work closely with farmers, particularly small-scale land owners, and provide relevant findings of their research in key crop production restraints that Kentucky farmers are confronted with: excessive nutrient runoff, organic carbon content, and altered composition of soil biota.

Currently, Dr. Gebremedhin and his research team are working on a project funded by the U.S. Department of Agriculture Natural Resources Conservation Service aimed at understanding the effects of manure application and cover crop on soil physical, chemical, and biological properties.

Dr. Maheteme Gebremedhin, Assistant Professor of Soil Science

Managing our Soil

Research analyzes soil composition to improve upon growth

The escalating production costs associated with the increasing costs to U.S. farmers of energy and synthetic fertilizers and the problems of soil deterioration and erosion associated with intensive farming systems have generated considerable interest in less expensive and more environmentally compatible production alternatives such as recycling wastes from several processing operations and developing new organic products for use in land farming. New soil management practices are needed to develop and expand our knowledge and technical means of agricultural production systems related to recycling waste, soil enzyme activity, and crop yield.

Glucosinolates are present in varying amounts in members of the Brassicaceae family (i.e., mustard and arugula). They suppress soil-borne pests due to the biofumigant properties of the highly toxic isothiocyanates present in Brassica vegetables.

Dr. George Antonious, professor in the College of Agriculture, Food Science, and Sustainable Systems, is working on research with the U.S. Department of Agriculture to assess variation in glucosinolate concentrations among mustard, arugula, kale, and collard plants grown under four soil management practices: sewage sludge, horse manure, chicken manure, and no-mulch native soil; assess enzyme activity in soil amended with sewage sludge, horse manure, chicken manure, and no-mulch native soil; monitor crop yield and quality as affected by soil amendments; and enhance minority student learning in agricultural and environmental sciences by increasing students' hands-on training in field and laboratory plant and soil sciences.

Dr. Antonious is also working on research screening the USDA Capsicum Collection for antioxidants and metal accumulation. Peppers, a significant component of the human diet in many regions of the world, provide vitamins A and C and are a sources of many other antioxidants such as capsaicin, dihydrocapsaicin, and phenols. Enhancing the concentration of antioxidants in fruits of pepper plants grown in soil amended with recycled waste such as sewage sludge, yard waste, and chicken manure has not been completely investigated. Dr. Antonious analyzed changes in pepper antioxidant content in relation to soil amendments and fruit development. Total marketable pepper yield was increased by 34% and 15% in soil amended with sewage sludge and chicken manure amendments, respectively, compared to no-mulch bare soil; whereas, the number of culls (fruits that fail to meet the requirements of foregoing grades) was lower in yard waste compared to sewage sludge and chicken manure treatments.

Other research projects include exploring wild tomato leaf extracts in pesticide formulations.

Dr. George Antonious, Professor, Division of Environmental Studies and Sustainable Systems

HELPING THE HERD

Goat research at KSU focuses on forage-based production and breed selection

Kentucky has millions of acres of grasslands most of which are suitable for forages production, which is a critical resource for profitability and sustainability of small-scale goat production. The last decade has seen tremendous growth in goat production, especially in meat goats. Kentucky State University is uniquely positioned to assist in this area, and has dedicated itself to developing a sustainable meat goat production system for small scale producers through its research and extension activities.

Assistant professor Dr. Ken Andries heads up research efforts related to the production of meat goats for the College of Agriculture, Food Science, and Sustainable Systems with the help of co-investigator Frederick Bebe. In recent years, goat research at Kentucky State University has focused on forage based production and breed selection.

Currently, Dr. Andries and his team are looking at the estimation of genetic parameters of birth to weaning traits in meat goats involving collection and analysis of data for correlation and heritability estimates, and the analysis of weaning and post-weaning fecal samples to determine breed and sex differences in parasite resistance. Their research also analyzes the effectiveness of grazing management practices (e.g. rotational grazing/animal and soil health) to reduce parasite exposure.

Research looks at alternative forages and breed comparisons as well. Current results show that the Spanish goat is a hardier breed of goat than the Boer breed, but they are slower growing resulting in more kids surviving to weaning but at lighter weights. The Savanna breed appears to be between the Boer and Spanish for survival but has good growth and muscle traits similar to the Boer. This research indicates that use of the Savanna genetics should be able to help improve survival traits and maintain growth and muscle that is desired for market.

Dr. Ken Andries, Assistant Professor

Food Safety First

KSU research helps small scale farmers produce safe food for consumers

Food safety matters to everyone every day and is a priority research area for the U.S. Department of Agriculture. According to estimates from the Centers for Disease Control and Prevention, about 48 million people (1 in 6 Americans) get sick, 128,000 are hospitalized, and 3,000 die each year as a result of foodborne illnesses.

In recent years, the number of foodborne outbreaks associated with contaminated produce has increased substantially. Consequently, there is a need for a systematic study on how and at what stages of cultivation and/or distribution there are possibilities for contamination, niches for survival, and dynamics of successful transmission of foodborne pathogens in fresh produce.

In the region's $3 billion food economy, Louisville-area residents alone spend an estimated $100 million annually on local foods and express interest in purchasing as much as $158 million more. While most produce-related outbreaks are associated with conventionally grown commodities, given the wide range of organic production practices and with more small farmers transitioning to organic production, there is a vulnerable segment of produce that demands microbial safety assessment. Animal and plant wastes are the major sources of organic fertilizers. These practices can result in a higher risk of contamination by microbial pathogens on organic vegetables.

Dr. Avinash Topè, assistant professor in the College of Agriculture, Food Science, and Sustainable Systems, is working on research funded by U.S. Department of Agriculture National Institute of Food and Agriculture to investigate food safety and assess gaps in knowledge, attitudes, and practices among small and limited-resource produce growers in Kentucky in accordance with Good Agricultural Practice (GAP) recommendations.

Dr. Topè has isolated microorganisms including coliforms, Escherichia coli, E. coli O157:H7, Salmonella, and Listeria from produce from small organic and conventional farms in the Bluegrass region of Kentucky to profile their antibiotic resistance. In addition, he is working to offer food safety training to small and minority organic producers.

Dr. Avinash Topè, Assistant Professor and Principal Investigator, Division of Food and Animal Science

Expanding the Market

Research investigates value-added potential for Asian carp

Dr. Changzheng Wang conducts research in the development of value-added products from Asian carp, an invasive fish species, and the storage stability of such products. Developing value-added products from Asian carp will increase the value of and expand the market for this fish species in the United States and foreign markets. Even though fish mince made from Asian carp through deboning can be processed into surimi products, repeated washing of fish mince that is necessary for surimi production generates large volumes of waste water, which is too costly for land-based fish processors.

It is highly desirable to develop value-added products directly from Asian carp mince. However, Asian carp mince is susceptible to quality deterioration, limiting the time available for its distribution and marketing. Incorporation of cryoprotectants such as sucrose and sorbitol, and natural antioxidants may improve the storage stability of Asian carp mince by reducing lipid oxidation and protein degradation. Dr.Wang's research will help to expand the market for Asian carp, create economic opportunities for Kentucky processors and fishermen to generate income, and expedite the elimination of Asian carp from Kentucky lakes and rivers.

During his time at KSU, Dr. Wang's research has focused on the potential effects of dietary components such as calcium, magnesium, sodium bicarbonate, soy protein, vegetables powders such as onion, tomato, broccoli, and purple sweet potatoes on bone metabolism, acid base balance and antioxidant status, using laboratory animals as experimental models for human diseases. His work in this area is aimed at finding novel preventive strategies against osteoporosis, obesity and other chronic diseases.

More recently, Dr. Wang has studied the use of acidic electrolyzed water as an alternative sanitizer for fish processing and vegetable processing, since there are growing concerns about the potential hazards associated with the use of other chemical sanitizers. His research team includes co-investigator Dr. Lingyu Huang and research assistant Cecil Butler.

Dr.Changzheng Wang, Associate Professor, and Dr. Lingyu Huang, Research Associate, with a student.

KENTUCKY STATE UNIVERSITY®

LAND GRANT PROGRAM