

“Dr. Li and his students have been very motivated to try new things and perfect the formula for the biopolyol. They have been very cooperative, accessible, and quick to respond to the things we need to commercialize this invention in a very short period of time. We will owe our success to this great partnership we have with Ohio State.”

—Jeff Schultheis, vice president, Bio100 Technologies



## Innovation Yields **Green Polyurethane Foam** and a **New Industry**



OARDC's patented biopolyol can be made into polyurethane foam for automobile seat cushions. This industry sector is targeted by Jeff Schultheis of Bio100 Technologies, which makes and sells the biopolyol.

When Jeff Schultheis was looking for a way to take advantage of the biodiesel industry's crude glycerin byproducts, he found the help he needed with the Ohio Agricultural Research and Development Center.

Today, Schultheis is vice president of Bio100 Technologies, a Mansfield-based company created to commercialize a new, renewable source of polyurethane foam made from low-value glycerin mixed with crop residue.

Developed and patented by OARDC biosystems engineer Yebo Li, the compound is known as a biopolyol and becomes the foundation for a variety of soft and hard foam products such as home insulation, automobile seat cushions, and packaging materials. This biopolyol can also be used to make hard plastics.

Bio100 is now gearing up for commercial-size production, having purchased equipment—including 500-gallon reactors—to scale up manufacturing from small batches used for testing. The company is also negotiating with buyers for its biopolyol, including a global leader in the auto interiors industry.

More: <http://go.osu.edu/polyurethane>

### The Essentials

- **OARDC's patented biopolyol adds value to glycerin byproducts.** With 70 million gallons of crude glycerin produced annually by the U.S. biodiesel industry, there is plenty of raw material supply to grow this green foam industry.
- **The biopolyol is 5–10 percent cheaper than petroleum-based or natural oil-based foams.** Depending on the application, it can replace up to 100 percent of a petroleum-based polyol in the foaming formula.
- **The innovation will help diversify the \$13 billion-a-year U.S. foam industry,** which heavily depends on petroleum-based sources.
- **The biopolyol will create up to 60 jobs within the next five years in Mansfield, Ohio.**
- **OARDC's biopolyol can help make Ohio's biodiesel industry more profitable and sustainable.**
- **This research got its start from Ohio Soybean Council funding.**



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“This technology will allow quasar to accept and process a wider range of high-solids feedstocks, including high-volume off-spec and major market recall material—expanding our business to offer customers a full-service solution to their waste management challenges. The partnership with OARDC applies research to improving the way we do business.”

—Mel Kurtz, president, quasar energy group



## More Energy from More Waste: Innovation Fuels Business Expansion



Biodigesting technology developed by OARDC is helping quasar energy group expand its business and produce more biogas for electricity and vehicle fuel, said Mel Kurtz, president of the company.

What is better than producing clean energy from waste? Producing even more clean energy from more types of waste. This has been made possible thanks to a patent-pending technology developed by the Ohio Agricultural Research and Development Center.

The integrated anaerobic digestion technology, known as **iADs**, is being commercialized by Cleveland-based quasar energy group, which operates several anaerobic digesters in Ohio and Massachusetts. These biodigesters turn agricultural and food-processing waste into biogas, which can generate electricity or be used as automotive fuel.

The novel system is called “integrated” because it adds a solid-state or “dry” biodigester to quasar’s current liquid biodigester, allowing for the production of additional biogas from a number of organic materials with high-solids content—such as yard trimmings and crop residue. These materials cannot be used in liquid biodigesters.

Because of the higher amount of solids that the dry biodigester can process, this system also generates a compost-like residue that can be used as fertilizer—adding another renewable product to quasar’s portfolio.

More: <http://go.osu.edu/iADs> and <http://quasarenergygroup.com>

### The Essentials

- **The first iADs was built by quasar energy group in Zanesville in 2012, with capacity for 8,000 tons of waste annually.**
- **The system can treat and recover energy from organic materials with up to 85 percent solids content.** Liquid biodigesters can process only up to 14 percent solids content.
- **The iADs technology can also increase the amount of waste available for anaerobic digestion** within a specific area, thus reducing transportation costs.
- **This technology received a \$2 million grant from the State of Ohio’s Third Frontier Advanced Energy Program** in 2009. Funding has also been provided by the Ohio Department of Development’s American Recovery and Reinvestment Act (ARRA) State Energy Program.
- **The iADs project was awarded a \$6.5 million grant in 2012 from the U.S. Department of Agriculture** to optimize this technology for production of energy and fuel from lignocellulosic biomass, including corn stover and the perennial grass miscanthus.



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“Water quality is a top concern in Ohio, and farmers want to be part of the solution. Ohio State’s research to validate and update the Phosphorus Risk Index will help us determine what the next best management practices are when it comes to phosphorus use on the farm.”

—Tom Fontana, director, New Use Development, Ohio Soybean Council



## Rewriting Ohio’s Phosphorus Risk Index Initiative



Tom Fontana credits research from OARDC’s Elizabeth Dayton with helping farmers statewide to reduce the risk of phosphorus runoff, which in turn, better protects Ohio surface water quality.

Grand Lake St. Marys has lost an estimated \$60–80 million in tourism due to harmful algal blooms. In 2011, algal blooms covered 990 square miles of Lake Erie’s surface area, the largest in the lake’s history. Those blooms are traced, in part, back to phosphorus.

Researcher Elizabeth Dayton of the Ohio Agricultural Research and Development Center has launched a major research initiative to evaluate and, as necessary, revise Ohio’s current Phosphorus (P) Risk Index to better predict the risk of phosphorus moving off land in order to protect Ohio surface water quality.

Her goals are to make the P Index more accurate, add best management practice options for farmers, create an interactive web-based tool so farmers can calculate their P Index scores, and evaluate options and make informed decisions to better manage phosphorus.

Dayton’s research aligns with a U.S. Department of Agriculture effort calling for states to help producers better manage the application of nutrients on agricultural land.

More: <http://go.osu.edu/phosphorusindex>

### The Essentials

- **Phosphorus is** the pollutant most often **implicated in the degradation of Ohio fresh surface water.**
- **Phosphorus is** one factor contributing to **harmful algal blooms.**
- **Degradation of Ohio waters is harmful to the state’s economy** in terms of fishing, recreation, and drinking water sources.
- **The research for the revised P Index focuses on,** but is not limited to, **Grand Lake St. Marys and the Western Lake Erie Basin,** two of the most problematic watersheds.
- **Ohio’s agricultural industry is concerned about the phosphorus problem in Ohio and wants to be part of the solution.** The industry’s commitment to this project demonstrates its commitment to good stewardship.



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"Many of the trees that the Asian longhorned beetle and thousand cankers disease affect are staple landscape trees in our area. If we lose them, it will devastate Ohio's nursery and landscape industry. The research that Dan Herms and his colleagues are doing is paramount in preventing another loss like that of the ash tree."

—Wm. Kyle Natorp, president and CEO, Natorp's Inc. and Wm. A. Natorp Company, Mason, Ohio

## Program Serves to **Defend Ohio from "Staggering" Assault by New Tree Pests**



OARDC scientists protect companies such as Kyle Natorp's. "OARDC provides this industry with much-needed research into pests and diseases that are attacking our livelihood," Natorp said.

Imagine the Hocking Hills area without any hemlock trees, northeast Ohio without any sugar maples, and Ohio without any buckeyes. All this might happen if a growing foreign threat has its way. From the emerald ash borer (EAB) to the Asian longhorned beetle to the hemlock woolly adelgid and others, "Ohio is under assault from invasive tree pests," said Dan Herms, a scientist with the Ohio Agricultural Research and Development Center. "Their potential impact is staggering." His mission and that of his colleagues is to track the new pests, which have come here by accident from Asia, Europe, and elsewhere, and to try to find ways to control them.

OARDC is specially suited to the task, Herms said. As Ohio's agricultural experiment station, "There's a critical mass of expertise, resources, and facilities here, including new tools in molecular biology, that is unique and allows this work to be done," he said.

More: <http://go.osu.edu/DanHerms> and [www.ashalert.osu.edu/](http://www.ashalert.osu.edu/)

### The Essentials

- For every 1 million board feet of ash and walnut sawtimber destroyed by invasive tree pests, Ohio loses 5.5 jobs and \$550,000 in total economic impact.
- The EAB has cost Ohio communities \$7 billion (to remove and replace dead ashes) and Ohio businesses \$1 billion (in destroyed timber and nursery stock).
- Natorp's Inc., a greater Cincinnati horticultural company, alone has lost \$1 million due to the EAB.
- At risk are 358,000 jobs in Ohio's nursery, landscape, and forest industries, with an economic impact of \$26 billion.
- The latest major concerns are the Asian longhorned beetle (now in southwest Ohio; attacks and kills many tree species including maples, poplars, and buckeyes); the hemlock woolly adelgid (now in southern Ohio; could kill every hemlock tree in the state); and thousand cankers disease (not yet in Ohio but in Pennsylvania; kills walnut trees, which would devastate nut and timber production).



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"The OARDC/quasar CNG conversion pilot project is a great example of university research institutions and industry working together to develop real-world solutions to meet our energy challenges. OARDC and quasar were already well out in front on the issue of utilizing CNG as an alternative transportation fuel and have emerged as clear leaders in this market—a market that promises significant economic growth potential for our region."

—Dave Karpinski, vice president, NorTech, Cleveland



## OARDC's New **Alt-Fuel Cars**: Testing Whether **Biogas** Can Break Us Free from **Foreign Oil**



Dave Karpinski fuels up: "The OARDC/quasar project of converting waste into CNG is an innovative approach to developing renewable energy at an economical price point."

Jim Currie, part of the Ohio Agricultural Research and Development Center's technology commercialization effort, is pumped. Thanks to the \$46,000 Clean Fuels Ohio grant he secured, OARDC has started a demonstration project to test the benefits of running cars and trucks on compressed natural gas, or CNG. This isn't just any CNG. This is renewable CNG biogas produced locally by one of OARDC's industry partners, quasar energy group, which has a waste-converting biogas plant and CNG fueling station in OARDC's BioHio Research Park in Wooster.

"It's not just that it's an alternative fuel," said Currie. "It's bioderived. It takes a waste stream and turns it into a useful product."

The new fuel costs 25 percent less than gasoline, emits one-third less greenhouse gas, and comes from a domestic, renewable resource—food-processing waste and similar abundant materials—rather than from foreign fossil fuels.

More: <http://go.osu.edu/OARDCtech> and <http://go.osu.edu/OARDCquasar>

### The Essentials

- **Three high-use passenger cars and a pickup truck in OARDC's fleet have been converted to run on CNG** for this project.
- **Much of that CNG is renewable biogas produced by quasar energy group's waste-processing plant in OARDC's BioHio Research Park** in Wooster. The plant also currently generates about 30 percent of the electricity needs of the main part of OARDC's campus.
- **The biogas costs the equivalent of \$2.25 a gallon and, at a gasoline price of \$4 a gallon, will save nearly \$1,000 per vehicle per year.**
- **Running a vehicle on natural gas instead of gasoline reduces greenhouse gas emissions by 30–40 percent,** including 25 percent less carbon dioxide, 65 percent less nitrogen oxide, and 90 percent less carbon monoxide.



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“Good stewards of the public trust bring their expertise and resources to protect and restore natural resources, and work to find sustainable solutions to threats to our environment; this is what Warren Dick, his OARDC colleagues, and their many partners have been doing for years. Their research informs best agricultural practices with sound science.”

—John A. Anderson Jr., president, Greenleaf Advisors, Chicago, and former director of The Nature Conservancy’s Great Lakes Project

## A New Way to Fight Lake Erie Algal Blooms



Warren Dick, right, visits a coal-fired power plant, where gypsum is a byproduct of air pollution scrubbers. Through Dick’s research, this gypsum could improve farming while stopping algal blooms in our lakes.

You can see Lake Erie’s toxic algal blooms from outer space, but their impact hits home right under your nose. Once-blue water turns green and smells. It is unsafe for drinking and for water sports. It scares away visitors who otherwise drive Ohio’s \$11 billion-a-year Lake Erie tourism industry. But a scientist with the Ohio Agricultural Research and Development Center may have a solution that helps both the lake and our farmers.

Warren Dick is testing synthetic gypsum, a byproduct of scrubbing air emissions from Ohio’s coal-fired power plants, as a soil amendment. He said the gypsum not only significantly cuts phosphorus runoff from crop fields, which is a major cause of the lake’s algal blooms, but it also cost-effectively increases yields, and with it, farm income.

John A. Anderson Jr., president of the Chicago-based sustainability firm Greenleaf Advisors and a project partner, said the research “suggests a practice that can simultaneously enhance livelihoods, quality of life, and the environment.”

More: <http://go.osu.edu/gypsum>

### The Essentials

- In Ohio, **Lake Erie tourism generates nearly \$11 billion a year and supports about 120,000 jobs.**
- **A 5 percent decline in Lake Erie tourism could cost Ohio more than \$500 million and about 6,000 jobs.**
- **Gypsum reduces soluble phosphorus, the form that can run off into rivers and lakes, by 40–70 percent, “which is a big reduction,” Warren Dick said.**
- **Synthetic gypsum costs farmers \$25–45 a ton and can boost corn yields by 5 bushels an acre. At a rate of 1 ton per acre every two or three years and a conservative corn price of \$5 a bushel, the gypsum “almost pays for itself the first year,” Dick said.**
- **Based on those figures, a 1,000-acre farm using gypsum could net an extra \$25,000 every other year.**



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**“Joe’s research provides useful information for urban farming, container gardening, and year-round produce production. His work has been groundbreaking in demonstrating how small-scale farmers can integrate tree crops, fruits, and vegetables. The state dollars invested in this project will continue to guide innovative farmers for years to come.”**

**—Meagan Tehua, program director, Goodness Grows, Youngstown**



## **Innovative “Parking Lot Farm” Grows Hope and New Options for People in Cities**



Meagan Tehua reaps the bounty of an urban garden—and of OARDC research to improve urban gardens. Projects like Joe Kovach’s, she said, “provide an agricultural legitimacy to management-intensive farming.”

Meagan Tehua sees vacant homes, overgrown lots, and hungry people in her work with the Youngstown area nonprofit called Goodness Grows. But she also sees hope—in the growing number of urban farms in Youngstown, Cleveland, and other Ohio cities, and in the research that supports them. For example, scientist Joe Kovach of the Ohio Agricultural Research and Development Center is testing the best ways to grow food on all-too-common abandoned asphalt parking lots. Through this and related research, Kovach is documenting “the potential for many new kinds of commercial farming” in cities, said Tehua, whose organization works on sustainable farming and food justice in the Mahoning Valley. “Joe’s plots are designed to include diversity, sequence, and perennial crops in a farm portfolio and provide local produce to people in all settings.”

“If this research is successful,” Kovach said, “land that was paved and considered unusable for food can become productive again.”

*More:* <http://go.osu.edu/parkinglotfarm> and <http://go.osu.edu/JoeKovach>

### **The Essentials**

- **According to another recent OARDC study also related to urban farming, Cleveland and other postindustrial cities such as Youngstown, could produce almost all the fresh fruits and vegetables needed by their residents.**
- **Ramping up local food production, that same study determined, would keep millions of dollars in local economies—up to \$115 million a year in Cleveland alone—create new jobs, and provide health, social, and environmental benefits.**
- **Kovach said his test plots, which cover about 48 former parking spaces, or one-eighth of an acre, produced enough fruits and vegetables last year to feed 30–40 people.**



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“It is important that Bridgestone diversifies its sources of natural rubber to assure business sustainability in the tire industry. The TKS plant offers the opportunity to grow natural rubber in temperate climates like Ohio. Our recent studies continue to indicate that TKS has the potential to produce similar properties to Asia-produced rubber.”

—Hiroshi Mouri, president, Bridgestone Americas Center for Research and Technology

## Natural Rubber Made in Ohio: New Crops and Bioproducts Industry Take Root



Hiroshi Mouri, president, Bridgestone Americas Center for Research and Technology, sees a not-so-distant future in which tires will be made from Ohio-grown natural rubber sources being developed by OARDC.

A 6,000-square foot processing pilot plant in Wooster makes gloves and other latex and rubber products. Established in 2012 and run by the Ohio Agricultural Research and Development Center, the plant produces and tests products made from sources of natural rubber grown right here in Ohio.

Funded by a \$3 million Third Frontier grant, the facility is a crucial step in the process of commercializing alternative rubber-producing plants such as Buckeye Gold, a relative of common dandelion, and guayule, a shrub native to the southwestern United States. OARDC scientists are developing Buckeye Gold into a crop that can be grown and processed commercially in Ohio, while trials are underway in southern Ohio to test the adaptability of guayule to the region.

The pilot plant is vital because it produces samples large enough for industry testing, said Katrina Cornish, project leader and OARDC's Ohio Research Scholar in bioemergent materials. They include dipped and compression-molded products; macro, micro, and nano fillers; and filled latex and rubber test samples.

More: <http://www.oardc.osu.edu/penra/>

### The Essentials

- **Natural rubber** is essential for national security and the U.S. economy because it **provides performance characteristics not available from synthetic, petroleum-derived rubber.**
- **North America consumes 2.7 billion pounds of natural rubber**, most of which comes from southeast Asia. **There is a threat of supply shortages** because of increased global demand.
- **If Buckeye Gold rubber were to reach an 8.4 percent share of the North American natural rubber market, it would generate more than 3,000 new jobs.**
- **Project industry partners include Bridgestone, Cooper Tire & Rubber, Veyance Technologies, and Ford Motor Company. Academic and government partners include The University of Akron, Oregon State University, and the U.S. Department of Agriculture.**



# Ohio Agricultural Research and Development Center

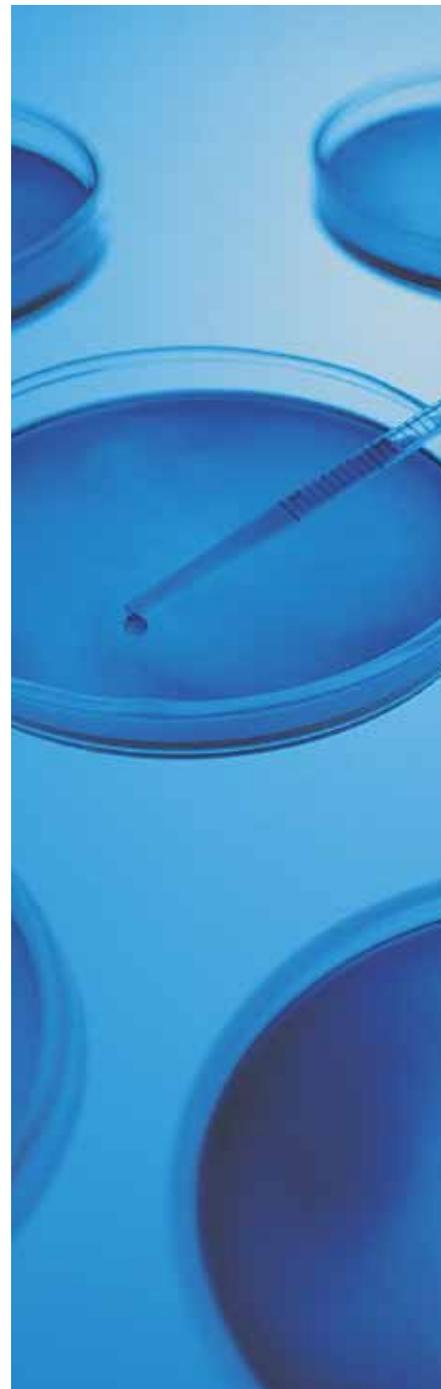
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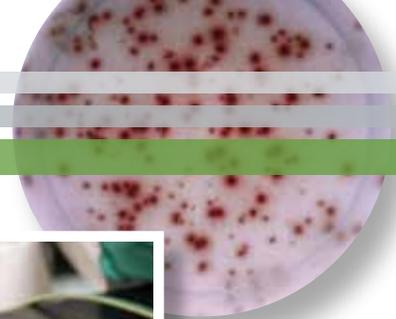
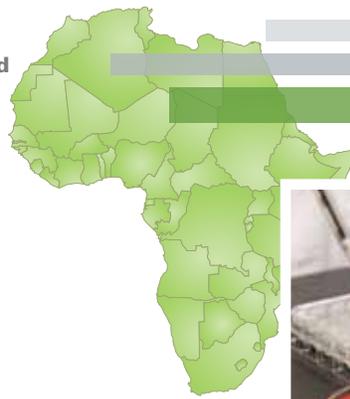
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**“A complex relationship exists between diet, gut microbial communities, and the immune system in severely malnourished children. We now have a way to tease apart these influences. The work that Dr. Saif’s lab is doing is helping to set the stage for future clinical trials in malnourished infants and children.”**

**—Jeffrey I. Gordon, MD, director of Washington University’s Center for Genome Sciences & Systems Biology**



## Getting to the Gut of Malnutrition



The work Linda Saif, center right, and her researchers are doing could help save 50 million children from illness related to rotavirus, a severe illness particularly in the world’s poorest countries.

Severe malnutrition does not stem simply from a lack of food. Scientists now believe it involves a breakdown in how microbes in the human gut process various components of the diet. With support from an \$8.3 million grant from the Bill & Melinda Gates Foundation, an international team is working to find answers. Linda Saif, an OARDC internationally recognized virologist and immunologist, is leading the portion of the project that will evaluate how to improve the effectiveness of vaccines against rotavirus—the leading cause of childhood diarrhea.

Malnourished children may not have acquired important gut microbes that help process nutrients, Saif said. Specially formulated nutritional or probiotic supplements might promote a healthy gut, but there’s no precise way to test their effectiveness in humans.

“The germ-free piglets we raise here at OARDC are ideal for research like this,” Saif said. “We will transplant representative human gut microbiomes into the piglets and examine how supplements might promote a healthy gut, alleviating malnutrition as well as rotavirus diarrhea and deaths.”

More: <http://go.osu.edu/malnutr>

### The Essentials

- According to the International Vaccines Access Center at the Johns Hopkins Bloomberg School of Public Health, **delivering a rotavirus vaccine that works to children in the world’s 73 poorest countries could save 50 million from illness and more than 800,000 from death—and save \$12 billion in costs associated with rotavirus.**
- **In Linda Saif’s lab, OARDC researchers Anastasia Vlasova, Gireesh Rajashekara, and Kuldeep Chattha work to unravel the complex associations between childhood malnutrition, its impact on intestinal microflora, and how that affects vaccines’ effectiveness against rotavirus.**
- **The project is being led by Jeffrey I. Gordon, MD, at Washington University School of Medicine and involves researchers from University of Tampere School of Medicine in Finland; University of California, Davis; Foundation for the National Institutes of Health; University of Colorado, Boulder; University of Malawi College of Medicine; and Imperial College, London.**



# Ohio Agricultural Research and Development Center

As the research arm of The Ohio State University's College of Food, Agricultural, and Environmental Sciences (CFAES), the Ohio Agricultural Research and Development Center (OARDC) employs nearly 650 scientists and staff members throughout the state.

Its Wooster campus is the largest agbioscience research facility in the United States, and OARDC scientists work closely with researchers in Ohio State's Colleges of Education and Human Ecology, Medicine, Public Health, Veterinary Medicine, Biological Sciences, and Engineering.

At any given time, OARDC researchers are engaged in more than 400 research projects. Primary focus is in three signature areas:

- Advanced Bioenergy and Biobased Products
- Environmental Quality and Sustainability
- Food Security, Production, and Human Health

The Ohio General Assembly established OARDC as the Ohio Agricultural Experiment Station in 1882. It is supported by a line-item appropriation from the Ohio General Assembly, competitive grants, gifts, contracts, federal grants, and other sources. OARDC uses these funds to provide direct research support and economic development for Ohio's annual \$100+ billion agbioscience industry. OARDC is not funded by student tuition or any other general funds of The Ohio State University.



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"Jeff LeJeune's work has helped me identify the causes of some of the problems I have on my dairy farm and helped us put together a vaccine program to try to counteract some of the diseases that he's identified."

—Kurt Steiner, a sixth generation farmer who partners with his brother, Eric Steiner, and his uncle, John Steiner, to run Steinhurst Farms in Creston, Ohio

## Control of Euro Starlings to Improve Food Safety in Ohio



Kurt Steiner credits OARDC research for helping Steinhurst Farms devise a vaccine program to protect livestock from diseases spread by wild birds and raccoons.

Antimicrobial-resistant (AMR) bacteria cost the American public an estimated \$4 billion in health care annually. Controlling small birds on farms may be the answer to lowering those costs and preventing the transmission of bacteria and viruses among food-producing animals.

That is part of the discovery from work conducted by Ohio Agricultural Research and Development Center researchers who obtained a pair of food safety grants totaling \$2.3 million from the U.S. Department of Agriculture. The OARDC scientists are studying how European starlings and raccoons can spread *E. coli* O157:H7 to farm animals.

Researchers including Jeff LeJeune, a microbiologist and veterinary scientist with OARDC, have determined that European starlings play an important role in transmitting several diseases to livestock and poultry among farms.

They recommend that farmers take measures to prevent wild birds from contaminating livestock feeds, which will decrease the contamination of the food supply and may reduce the number of people that become ill from contaminated foods.

More: <http://go.osu.edu/starlings>

### The Essentials

- Each year there are about **63,000 cases of *E. coli* O157:H7** nationwide, **resulting in about a \$630 million burden to the public health system**, which translates to about \$10,000 per case.
- In Ohio, **this translates to about 2,331 cases annually, costing the state \$23 million a year.**
- **Reducing the infection rate in cattle**, even marginally, and thereby reducing food, water, and direct contact transmission, **will save lives, prevent illnesses, and lower costs** related to *E. coli* infections.
- **Findings from this project can potentially help control other zoonotic diseases** in livestock and poultry **and further improve food safety.**



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“The research that Dr. Wang has done on rice blast in the last 10 years has been extremely significant in helping to better understand how the disease works, which has been a strong benefit to helping rice breeders create new rice varieties and in helping chemical companies to develop better fungicides to combat the devastating disease.”

—Yulin Jia, a rice molecular pathologist with the U.S. Department of Agriculture’s National Rice Research Center

## Research Blasts Rice Disease



Guo-Liang Wang’s research on rice blast, a devastating fungal disease of rice, can potentially help feed 60 million people annually and help control diseases in other crops such as wheat and corn.

More than half of the world turns to rice for food. Of the 2 billion new people expected by 2050, about 70 percent will eat rice. But the world’s rice crops are threatened continuously by rice blast, a fungal disease that destroys enough rice each year to feed 60 million people.

Guo-Liang Wang, an Ohio Agricultural Research and Development Center researcher and professor of plant pathology, has worked on rice diseases for more than 20 years. Because rice is a model plant for cereal crops, information from Wang’s research could be applied to controlling diseases in other important crops such as wheat and corn.

Internationally known for studying host resistance to fungal and bacterial pathogens, Wang’s goal is to engineer new varieties of rice plants with stronger defensive proteins to fight rice blast and to develop long-term resistance. He uses cutting-edge genomic technologies to reveal important pathways contributing to disease and resistance responses in plants, and to provide critical resources to the cereal research community.

More: <http://plantpath.osu.edu/wang>

### The Essentials

- Rice blast can cause up to a 30 percent yield loss.
- The Wang Laboratory for Plant Disease Resistance and Functional Genomics has obtained more than \$6.5 million to support the rice blast project from various international, federal, and industry, funding agencies.
- The Wang Laboratory has been involved in the mapping and cloning of 15 resistance genes in the past decade. Among them, 4 were cloned and characterized at the molecular level.
- Most of the resistance genes have been used in rice breeding programs worldwide. The molecular markers linked to the genes have facilitated selection of resistant rice varieties.
- Use of the new varieties with the resistance genes in rice production has significantly reduced the application of fungicides and increased yield.



# Ohio Agricultural Research and Development Center

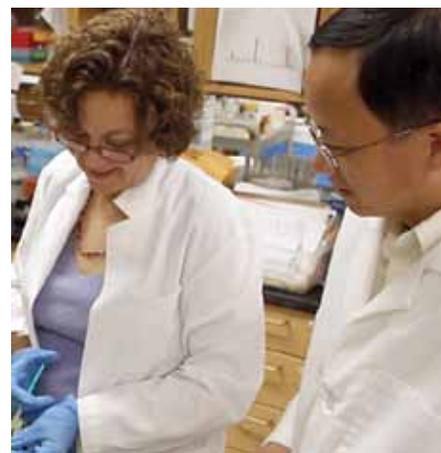
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