

THE POWER OF PRODUCE

Researchers unlock secrets 'From Crops to the Clinic to the Consumer'

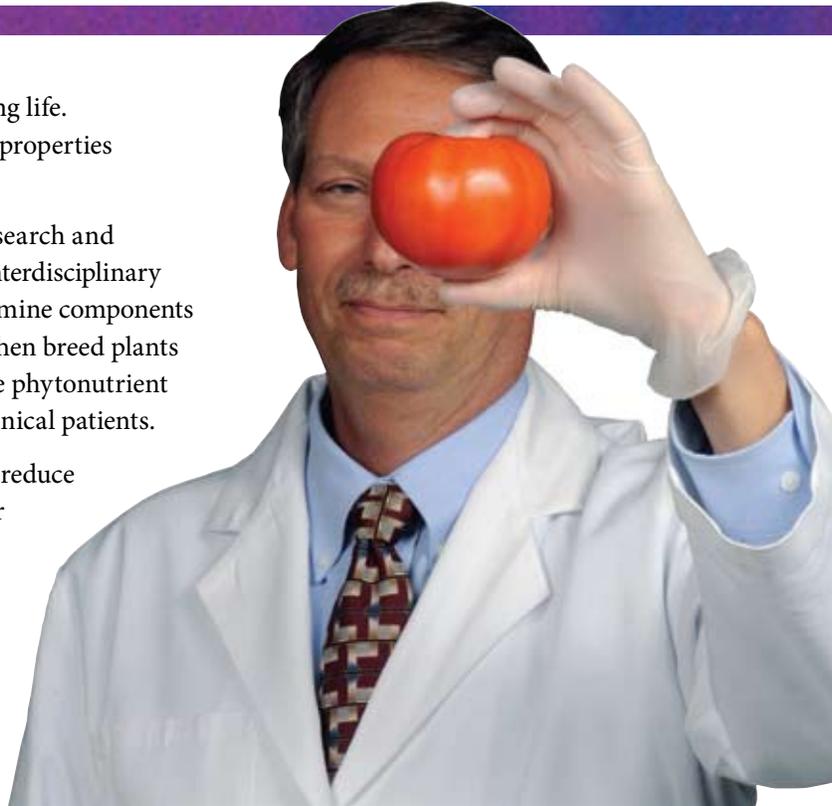
Steve Schwartz believes the right foods can enhance and prolong life. Tomatoes, berries, soy — these foods and more have beneficial properties that researchers are just beginning to discover.

Schwartz leads the Center for Advanced Functional Foods Research and Entrepreneurship (CAFFRE), an umbrella organization for an interdisciplinary group of Ohio State University researchers. The researchers examine components of plants that promote health — called phytonutrients — and then breed plants to boost the phytonutrient content; create products to promote phytonutrient effectiveness; then test the products in the laboratory and in clinical patients.

"If we're successful, people could actually change their diet and reduce their risk of developing chronic illnesses over their lifetimes, or perhaps slow the development of a disease after it strikes," Schwartz said.

More information: <http://fst.osu.edu/caffre/>

Steve Schwartz, Food Science and Technology ▶



"If we can develop a tomato product that, when consumed in modest amounts, reduces prostate-cancer risk by even 10 percent, we are talking about preventing 22,000 cases per year in the United States."

— Dr. Steve Clinton, medical oncologist with the James Cancer Hospital and CAFFRE partner

CAFFRE scientists have uncovered disease-fighting properties in soy (heart disease), tomatoes (prostate cancer), broccoli (bladder cancer), and black raspberries (colon, esophageal, and oral cancer). CAFFRE-designed products being tested in clinical settings include:

- Soy-tomato juice, rich in lycopene and other phytochemicals that improved participants' blood lipid levels and antioxidant status in pilot clinical trials
- Black raspberry lozenges, being tested for effectiveness against tumors in patients diagnosed with oral cancer
- High-protein soy bread, examined for its role in promoting heart health



As a young scientist, Steve Schwartz was fascinated by how food can affect health — good and bad. But, while food toxicology held some interest, "I decided that I'd rather look at the positive." It turned out to be a good choice. Schwartz, along with Mark Failla in human nutrition and Steve Clinton in the College of Medicine, have assembled a unique team of food scientists, plant breeders, nutritionists, oncologists, and other researchers to unlock the secrets of health-promoting food components. In 2007, Schwartz was named a fellow in the American Association for the Advancement of Science for his contributions in food chemistry and health, particularly antioxidants and other components related to chronic disease, oxidative stress, bioavailability, and cancer.

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CLEAN WATER MAKES ECONOMIC SENSE

OARDC program helps the environment while stimulating the economy

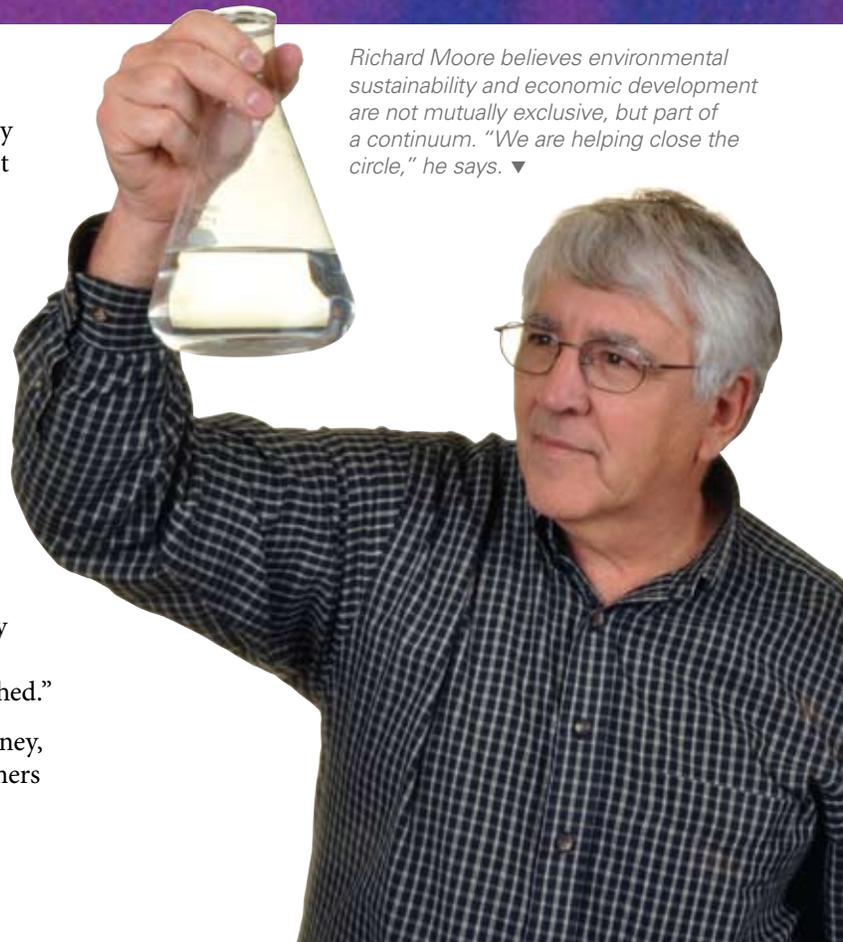
An Ohio Agricultural Research and Development Center water-quality effort aims to boost environmental sustainability and economic development in some of Ohio's largest and most critical watersheds: Upper Scioto, which includes the city of Columbus and 20 central Ohio counties, and the Muskingum watershed with 27 counties.

Led by Richard Moore, a researcher in the Department of Human and Community Resource Development, the program uses "nutrient-trading" (a market-based approach for protecting and improving water quality by setting caps on the total quantity of nutrients such as nitrogen and phosphorus entering the water) agreements to help municipalities and businesses meet water-quality mandates without expensive wastewater-treatment facility upgrades.

Nutrient-trading gives companies credits, Moore explains. "They get credits from the Environmental Protection Agency by paying farmers to implement conservation measures that help reduce the level of pollutants, or 'nutrients', in an entire watershed."

In the end, everybody benefits — cities and taxpayers save money, businesses increase production, jobs are created or saved, farmers strengthen their operations, and water is safer for all.

More information: <http://sugarcreekmethod.osu.edu>



Richard Moore believes environmental sustainability and economic development are not mutually exclusive, but part of a continuum. "We are helping close the circle," he says. ▼



"We are very interested in this effort. It could save us money in infrastructure, reduce drinking-water costs, and have many other impacts on water quality."

— Robert Ashton, Department of Public Utilities, City of Columbus

TRADING ON THE BENEFITS

The Alpine cheese factory in Holmes County faced a dilemma: it wanted to increase production of its Jarlsberg specialty cheese, but new regulations meant it would have to spend a prohibitive sum of money in equipment to reduce phosphorous emissions from its plant.

Alpine partnered with OARDC and local conservation agencies to draft a nutrient-trading program that would allow it to expand its business while improving water quality in the Sugar Creek watershed. The result:

- 12 new jobs
- 40 percent increase in cheese production to 50,000 pounds per day at just one plant, worth \$500,000 retail/day
- 250,000 additional pounds of milk per day bought from local Amish farmers
- Funding for the local Soil and Water Conservation District

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PLETHORA OF ECOSYSTEMS SERVICES EXIST TO CONTROL CLIMATE CHANGE

Several carbon collection options have value to environment/economy

Practice no-till corn, capture carbon, and turn that carbon in for cash. That's one way to stave off global warming. For farmers, however, that practice may be too costly in the current market, one Ohio State University economic study has found. "We wanted to know what farmers could get for carbon on the trading market under continuous no-till," said Brent Sohngen, an agricultural economist at the Ohio Agricultural Research and Development Center. His work challenges commonly held thoughts about carbon credits and may lead to new approaches to climate change issues. "We found that they (farmers) would get about 50 cents per acre per year above their farm expenditures." That may not be enough to overcome a 17 percent yield loss.

Plowing to recover those yields results in a loss of about 6 tons of soil carbon per acre. Thus, until such time that the cash value for carbon in trading markets is substantially increased, no-till will continue to be justified for its other benefits such as erosion control, soil carbon enhancement, and prevention of water pollution from agricultural runoff. One solution to the conundrum: don't rule out other alternatives of carbon collection and storage, such as reforestation and methane recovery.

More information: <http://ohiowatersheds.osu.edu/climate/> and <http://aede.osu.edu/people/sohngen.1/>



*Brent Sohngen,
OARDC ag economist ▶*



"The Ohio State University plays an important role in research and outreach by providing sound science to monitor, measure, and place a quantifiable value on the types of emission reduction opportunities that are available."

— Mark Wilson,
Land Stewards, LLC

METHODS OF CARBON SEQUESTRATION

- **Continuous no-till:** On average, Ohio soils can sequester about a half-ton of carbon per 2.5 acres, which is equivalent to 500 pounds per acre.
- **Reforestation:** One acre of newly planted trees can accumulate carbon at rates of 4–10 tons of CO₂ per acre per year, accumulating a total amount over time of 200–250 tons CO₂.
- **Wetlands:** A 140-acre temperate Ohio wetland can sequester 80 tons of carbon per year. A tropical wetland, covering nearly 290 acres, can store 300 tons of carbon each year.
- **Methane recovery:** Methane is estimated to be 21 times as intense a greenhouse gas as carbon dioxide.

If methane were used in transportation as fuel, greenhouse gas production would be reduced by 580 million tons of CO₂ per year.
- **Conserve** the land and grow grass. One acre of new grass equals 1.0 carbon credit per year.
- **Better manage** your fertilizer applications. Nitrous oxide is 300 times more intense a greenhouse gas than carbon dioxide.

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FOSTERING ENTREPRENEURSHIP

Public-private partnerships advance green energy, bioproducts

The Ohio Agricultural Research and Development Center is partnering with businesses to bring knowledge to the marketplace and put Ohio on the forefront of the emerging bioeconomy.

One example is the collaboration with **quasar energy group** (formerly Schmack BioEnergy), which produces biogas from municipal and agricultural waste and turns it into electricity. The Cleveland-based company has set up a laboratory and engineering office on OARDC's Wooster campus, and is working with researchers to optimize methane-production technologies.

In addition, **quasar** is interested in commercializing an OARDC-patented process for converting solid wastes, such as yard trimmings and crop residue, to methane. This innovation can produce double the biogas as conventional liquid biodigesters and recycle the effluent coming out of those systems, reducing the cost of disposal and benefiting the environment.

More information:

<http://www.quasarenergygroup.com/pages/oardc.html>

"OARDC has the brain power, the talent, and the facilities to help us get a jump-start on these technologies," said Clemens Halene, quasar energy group's vice president of engineering. ▶



"Ohio has enough biomass to set up more than 7,700 biogas plants, which could create more than 100,000 jobs."

— Clemens Halene,
Vice President
of Engineering,
quasar energy group

FROM LABORATORY TO MARKET

OARDC's Ohio BioProducts Innovation Center (OBIC) partnered with Natural Fiber Composites Corporation (NFCC) to create the new generation of composite materials from plant-derived fibers — for use in transportation, construction, consumer, and industrial products. Results:

- A \$3 million Third Frontier award, matched by another \$3 million from private partners
- A pilot plant in Wooster, producing 6 million pounds of fiber materials a year and employing eight people
- Expected to generate \$12 million in revenue and 37 jobs in Ohio by 2012

Show and Tell

In order to showcase its technology, **quasar** is planning to build a biogas facility on the OARDC campus. Among its features:

- 500,000-gallon digester capable of processing 40–50 wet tons of waste per day
- Capacity to produce 400 kW of electricity
- Ability to supply one-third of the Wooster campus's energy needs, providing a green energy source for the BioHio Research Park and the campus

OARDC has worked closely with over 100 companies on sponsored research projects during the past five years.



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MANUFACTURING GROWTH

Research may save U.S. foundry industry \$30 million a year and jump-start new green businesses, too

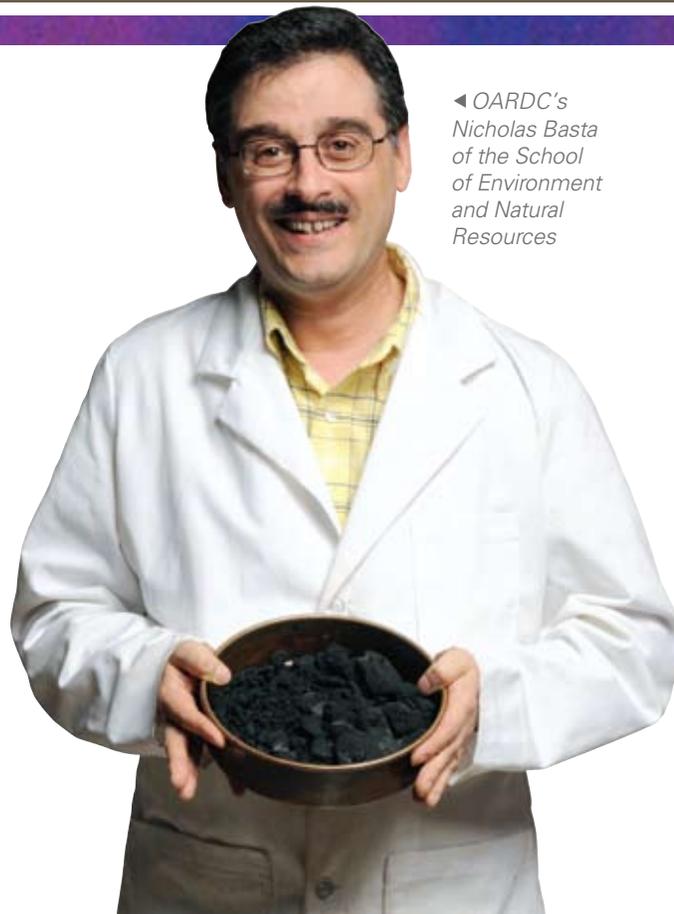
What to do with 10 million tons of spent foundry sand, a byproduct of the U.S. foundry industry, every year? Until now, the answer has been to throw much of it out and to pay the cost of landfill disposal.

But a recent study offers an option, one that may not only save that industry millions of dollars a year — key in a time of pressure from cheap imports — but also help plants and green businesses grow.

For the first time, scientists from the Ohio Agricultural Research and Development Center, the U.S. Department of Agriculture, and the U.S. Environmental Protection Agency conducted a risk assessment of using spent foundry sand as a beneficial material in soils. Based on the findings, EPA is now developing the first regulatory guidelines for the practice.

Study co-leader Nicholas Basta, an OARDC professor of soil and environmental chemistry, said the work opens the door to safely reusing spent foundry sand, not dumping it. The practice will “increase the global competitiveness of our foundry industry,” Basta said, “and create start-up businesses and jobs focused on the production and marketing of spent foundry sand as a soil substitute and in soil blends.”

More information: <http://www.foundryrecycling.org/> and <http://senr.osu.edu/facview.asp?id=3251>



◀ OARDC's
Nicholas Basta
of the School
of Environment
and Natural
Resources

“This [research] could transform the metal casting industry in the United States. It has demonstrated beyond any reasonable doubt that spent, non-toxic foundry sand is environmentally benign and can be a valuable industry byproduct.”

— Russ Murray, director,
Ohio Cast Metals Association

IMPACTS

- Recycling just 10 percent of spent foundry sand in soils instead of dumping it in landfills would save the U.S. foundry industry **\$30 million a year** BASED ON PRODUCING 10 MILLION TONS A YEAR AND LANDFILL DISPOSAL COSTS OF \$30 A TON.
- The U.S. foundry industry centers in the Midwest and East, with Ohio's 400 foundries — 13 percent of the nation's total, with 150 in Cleveland/Akron alone — providing 38,000 jobs. SOURCE: OHIO CAST METALS ASSOCIATION.
- The foundry industry “forms the basic underpinning of an industrial society,” says trade journal *Manufacturing & Technology News*. Yet “hundreds of (U.S.) foundries have gone out of business in recent years due to unrelenting pressure from cheap imports, the departure of large manufacturers, and skyrocketing costs of raw materials.”

More About the Project

- Conducted the first risk assessment of using spent foundry sand in soils — looking, for example, at the effects on plant growth, trace elements, trace organic chemicals, and potential toxicity
- Determined the practice to be safe for people, plants, and the environment, including on crops, in soils, and in food chains

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MAKING CROP INSECT AND DISEASE MANAGEMENT MORE RELIABLE, SAFER

OARDC collaborates with industry in \$5 million bioproduct initiative

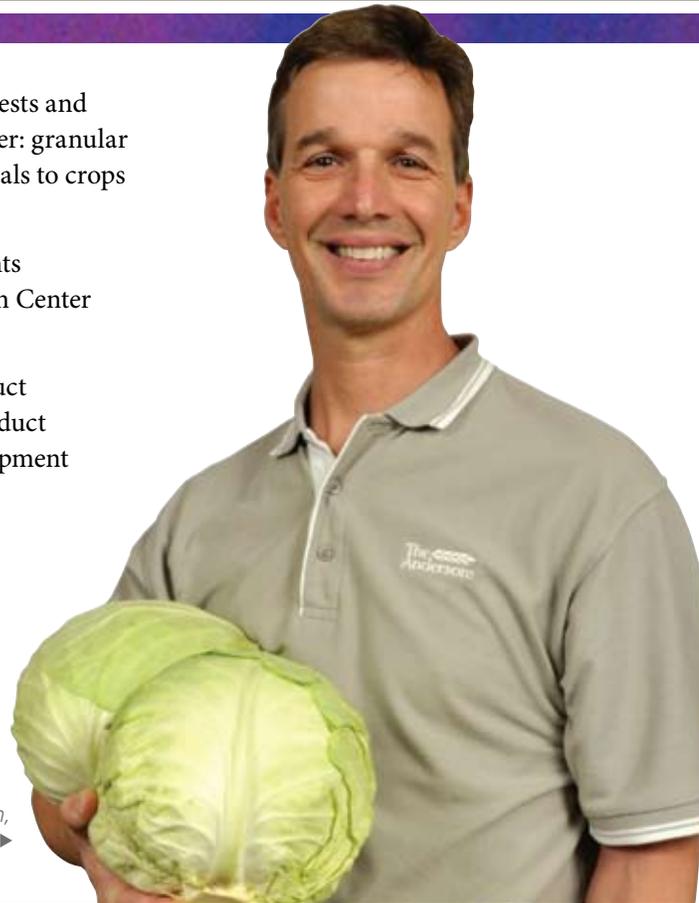
Imagine a more reliable, environmentally friendly way of ridding food of pests and diseases. The Andersons, Inc., based in Maumee, Ohio, may have the answer: granular technology. The dry application is a more effective method to apply chemicals to crops and the granules are only activated with exposed to water.

Granular products work in the turf industry. Now the company has its sights on agriculture, and it's collaborating with the Ohio BioProducts Innovation Center to expand that success.

"If we are successful with the proper application equipment and if the product works, it will mean a safer alternative to liquid pesticides and a reliable product for farmers," said Erdal Ozkan, an Ohio Agricultural Research and Development Center agricultural engineer.

Researchers are developing better application equipment and evaluating how well the product does its job in the field.

More information: <http://www.granuletechnology.com>



Chuck Anderson,
The Andersons ▶



"The collaboration has brought us to a powerhouse in technical capabilities with OARDC and encouraged us to expand our market research, see opportunities, and build our thinking into a seven-year commercialization strategy. The process took a lot of discipline to get everything to happen, but the collaboration created value. It literally changed our business plan."

— Chuck Anderson, Director, Technical and Marketing Development, The Andersons

MORE ABOUT THE PROJECT

- The research to develop and commercialize granular technology is supported by a \$5 million Third Frontier Grant.
- The Andersons, Inc., is the first company in Ohio to win an award of such magnitude to advance bioproduct initiatives.
- Granular technology more effectively contains, transports, and delivers fertilizer and pesticides, or other biologically active ingredients, to specific areas.
- It eliminates spray drift common in liquid chemical applications, reduces spills, and is safer for the environment.

How OARDC Is Involved

- Researchers are developing equipment that will apply the dry product where it's needed and keep it on the plant.
- Researchers are identifying the right nozzle type, droplet size, and most uniform distribution of water sprayed to apply to the dry product.
- Entomologist Celeste Welty is using cabbage as the crop of choice for evaluating the granular product and comparing its efficacy to conventional liquid applications.

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GETTING A JUMP ON INFLUENZA OUTBREAKS

Animal virus studies help advance human H1N1 flu research

When the H1N1 pandemic flu virus reared its ugly head in the spring of 2009, the Ohio Agricultural Research and Development Center was already hard at work studying similar viruses in animals — generating information crucial to better understanding human disease.

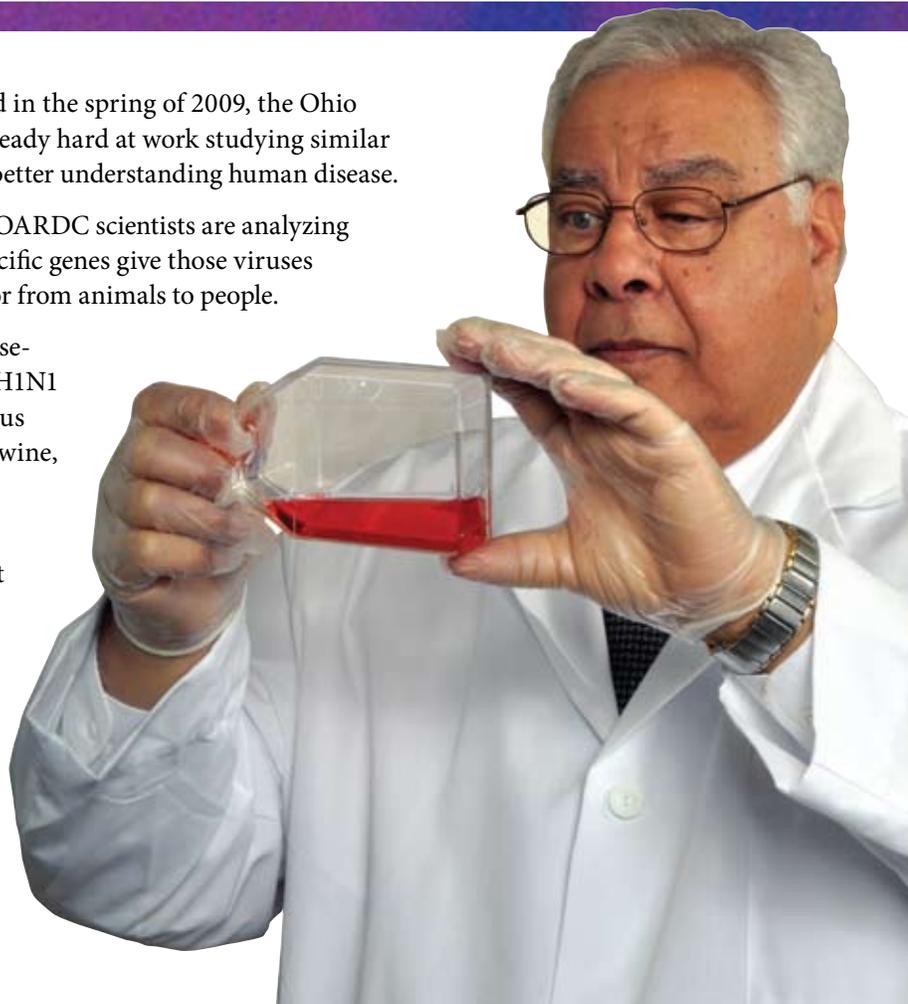
By using a molecular technique called reverse genetics, OARDC scientists are analyzing avian and swine influenza viruses to pinpoint which specific genes give those viruses the ability to jump from one animal species to another, or from animals to people.

Researchers are also studying the genetic makeup, disease-causing mechanisms, and processes of immunity of an H1N1 virus found at an Ohio county fair — which, like the virus responsible for the 2009 pandemic, contained genes of swine, avian, and human influenza viruses.

Outcomes of this research: identifying the mechanism of cross-species infection by influenza viruses will result in diagnostic tools to identify new viruses capable of jumping from animals to people and information for the development of more effective vaccines.

More information:
<http://phpid.osu.edu/phpid>

Mo Saif leads a team seeking to discover what makes an influenza virus, such as H1N1, capable of jumping between species. This knowledge will be vital for the poultry and livestock industries — and also for human health. ►



New Facilities for New Research

OARDC is beginning construction on a new \$22.2 million Plant and Animal Agrosecurity Research Facility — the only one in Ohio and one of only five nationally with the capacity for research on infectious diseases of plants and animals that require special safety features, such as avian and H1N1 influenza.



MAKING A DIFFERENCE IN ANIMAL AND HUMAN HEALTH

Mo Saif knows a thing or two about flu viruses. The head of OARDC's Food Animal Health Research Program, Saif is an international expert on viral diseases of poultry. But his scientific involvement goes beyond farm animals. Because some viruses can infect both animals and humans — the H5N1 bird flu and the most recent H1N1 flu pandemic viruses among them — Saif's expertise is often sought by researchers working in the field of human virology. To that extent, Saif is also a member of Ohio State's Public Health Preparedness for Infectious Diseases program.

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LAND OF OPPORTUNITY

Project will build local food systems — and with them, northeast Ohio's economy

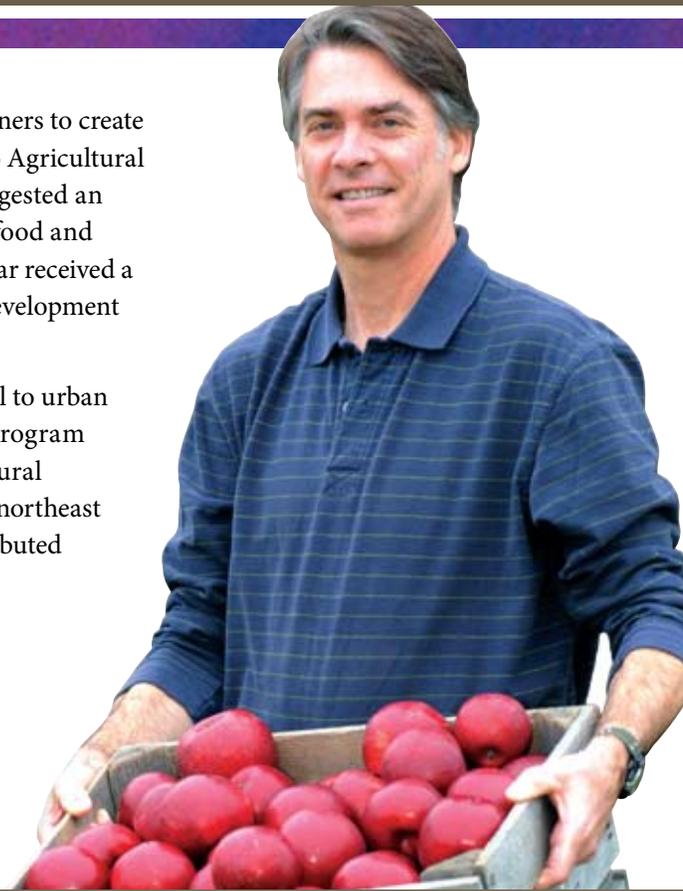
Advance Northeast Ohio — a regional economic action plan by 90-plus partners to create jobs, increase incomes, and reduce poverty — launched in 2007. But the Ohio Agricultural Research and Development Center's Casey Hoy and colleagues recently suggested an addition to it, one that tapped a local strength: partnerships in sustainable food and bioproduct production. Their proposal fell on attentive ears. The team this year received a \$250,000 grant from the Fund for Our Economic Future to accelerate the development of an AgBiosciences Industry Cluster to include in the plan.

The project “builds a partnership throughout the region, and across the rural to urban continuum,” said Hoy, who leads OARDC's Agroecosystems Management Program and holds Ohio State's W.K. Kellogg Foundation-endowed chair in agricultural ecosystems management. “We share a vision for building local economies in northeast Ohio starting with local food systems, leading to renewable energy and distributed manufacturing from the region's agricultural lands.”

More information:

<http://localfoodsystems.org/advance-northeast-ohio-partners>

*Casey Hoy, OARDC project leader,
Catalyzing an AgBiosciences
Industry Cluster Initiative ▶*



“This project focuses on building the local and regional economy in northeast Ohio, with local ownership of many businesses that produce what the region needs.” — Casey Hoy

The \$250,000 Fund for Our Economic Future-funded project will:

- Develop a comprehensive inventory of northeast Ohio's agricultural resources
- Create an investment portfolio of at least 10 business cases to serve as models; the project's second phase will add cases and move them toward businesses
- Establish an online infrastructure for networking and collaborating on opportunities in AgBiosciences across the region
- Convene a region-wide leadership council to guide further development
- Leverage an existing \$2.26 million U.S. Department of Agriculture Regional Partnerships for Innovation grant to OARDC, also led by Hoy and AMP

IMPACTS

- Increasing the amount of food sourced locally to 10 percent — the project's goal — would keep at least \$1.3 billion more each year in northeast Ohio BASED ON ANNUAL FOOD EXPENDITURES OF \$14.4 BILLION A YEAR AND 1 PERCENT OF THAT NOW LOCALLY SOURCED.
- Increasing the amount of food sourced locally by just 1 percent would keep \$144 million more each year in northeast Ohio BASED ON ANNUAL FOOD EXPENDITURES OF \$14.4 BILLION A YEAR AND ONLY 1 PERCENT OF THAT NOW LOCAL.
- Increasing northeast Ohio's annual agbioscience revenues by just 1 percent would earn the region \$82 million more each year BASED ON CURRENT REVENUES OF \$8.2 BILLION.

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MAKING MONEY OUT OF WASTE

OARDC helps bring bioproduct innovations to market

If there's a way to make something usable out of what others call "waste," Ohio Agricultural Research and Development Center's Yebo Li can find it.

A researcher in the Department of Food, Agricultural and Biological Engineering, Li is working with the Ohio Soybean Council and Mansfield, Ohio-based Arlington Energy (a biodiesel plant) to turn soybean straw and various soybean-processing byproducts into polyurethane foam — used to make products such as insulation and packing material.

"I discovered a way to use crude glycerol (a biodiesel byproduct with very little commercial value) and soybean straw to make polyurethane foam that is biodegradable and heat resistant, and performs as well as petroleum-based foam," Li says. A patent of his process is pending.

"This product has great commercialization potential," adds Mike Schultheis, Arlington Energy's general manager. "We expect this partnership with OARDC to be very productive."

More information:

<http://www.oardc.osu.edu/bioenergy>

Finding ways to turn waste-streams into usable products such as polyurethane foam fuels Yebo Li's scientific drive. But it doesn't end there. "I'm also interested in how to commercialize these inventions," he says. ▶



Economic Impact

The North American market alone has a demand for 2.8 million tons of polyurethane foam. The partnership between OARDC and Arlington Energy has resulted in a new Ohio enterprise, Arlington Bioproducts, which aims to tap into that market by offering a green alternative. The anticipated outcome:

- 20–30 new jobs
- Revenue in the millions of dollars
- Helping to solidify Ohio's position as a leader in renewable industrial products

A NEW WAY TO ETHANOL

Another one of Li's projects focuses on cellulosic ethanol, a renewable fuel made not from corn but from crop residues and other lignocellulosic biomass. With three grants totaling \$660,000 from the U.S. Departments of Agriculture and Energy, Li is evaluating concurrent wet storage and microbial pretreatment of corn stover to reduce production cost and increase sugar yield — crucial processes for the efficient production of ethanol.

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UNLOCKING THE MYSTERIES OF PLANTS AND HUMAN HEALTH

Multi-year, multi-disciplinary projects exploring benefits of plant compounds

Plants hold secrets, many of which can have benefits in agriculture and human health. Ohio Agricultural Research and Development Center researchers are discovering some of those unknowns.

Terrence Graham, an OARDC plant pathologist, is taking a peek at the molecular level of plants. He has found natural products that play a dual role as ag chemicals and pharmaceuticals.

“Most of the active chemicals we have discovered are from allelopathic plants. They produce natural herbicidal chemicals that can also protect plants from diseases,” said Graham. “Moreover some of these allelopathic chemicals have shown some promise as anti-cancer compounds.”

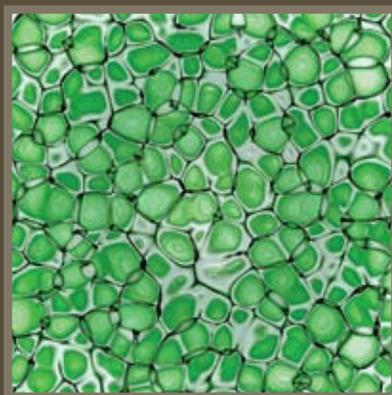
Researchers are finding such relationships in a whole host of plants; about 400 have been tested so far. The findings could mean growing a stronger crop, while fighting off human diseases.



Terrence Graham,
OARDC plant pathologist ▶

“The plant cell is more complex than any chemical that humans have manufactured. The research of Dr. Gary Stoner and his colleagues not only has a benefit to human health, but also to agriculture. It’s an example of all of the wonderful things that can happen at Ohio State. Ohioans can be proud of the people at Ohio State.”

— Dale Stokes, of Stokes Berry Farm in Wilmington, Ohio. Stokes has been collaborating with The Ohio State University on a food-based approach to cancer research since 1986. He is the sole supplier of black raspberries for Ohio State research, and to date, he has been instrumental in securing \$14 million in state and federal monies to support Ohio State’s efforts.



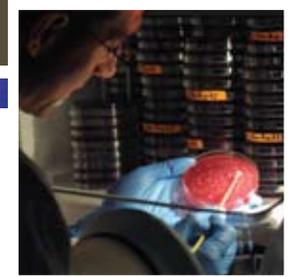
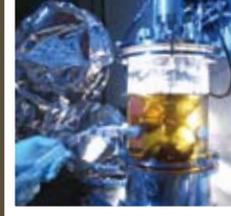
IMPACTS

- Our findings have demonstrated allelopathic plants as a particularly rich source of agriculturally and pharmaceutically active chemicals. This will greatly amplify the discovery process for active natural products.
- The finding that allelopathic natural products can activate plant defense will greatly speed up our discovery of key plant resistance mechanisms and genes.

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OHIO AGRICULTURAL RESEARCH AND DEVELOPMENT CENTER

As the research arm of The Ohio State University's College of Food, Agricultural, and Environmental Sciences, the Ohio Agricultural Research and Development Center (OARDC) employs nearly 650 scientists and staff members throughout the state, conducting research that benefits all Ohioans. OARDC's 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 and Public Health, Veterinary Medicine, Biological Sciences, and Engineering. Research support is provided in three signature areas:

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

For more information, see the CFAES Strategic Plan at <http://cfaes.osu.edu/about-us/>.

At any given time, OARDC scientists are engaged in more than 400 research projects in the areas of agricultural, environmental, and development economics; food, agricultural, and biological engineering; animal sciences; entomology; food animal health; food science and technology; horticulture and crop science; human and community resource development; human ecology; natural resources; and plant pathology. OARDC also trains graduate students in each of these areas.

The Ohio General Assembly established OARDC as the Ohio Agricultural Experiment Station in 1882. Since its founding, OARDC has been a leader in research that makes a difference for Ohioans and for the world.

OARDC 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 \$90+ billion agbioscience industry. OARDC is not funded by student tuition or any other general funds of The Ohio State University.

OARDC is...

- **Nationally ranked in the top 10 in terms of research cited.**
- **The largest and most comprehensive agbioscience research facility in the United States.**
- **Credited with more than 30% of all royalty income for The Ohio State University.**
- **Involved in annual collaborations with more than 130 businesses throughout the world.**
- **Credited with a 110% increase in grants and industry support for its scientists since 2001.**
- **Some 230 scientists conducting more than 400 research projects annually.**
- **A generator of more than \$1 billion of annual economic impact and cost savings to Ohio and the United States.**

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