"BioHio is a truly unique asset. It brings economy-shifting potential to our county and our region. We are truly fortunate to have OARDC here, as it is demonstrating how R&D activity can be leveraged to drive economic growth, job creation, and the generation of income."

— Rod Crider, President, Wayne Economic Development Council

THE ESSENTIALS

BioHio saw key developments take place during 2010:

- Water, sewer, gas, electric, and road improvements were made on the park's main 95-acre site, thanks to a $3.1 million grant from the Ohio Department of Development and $3.4 million in matching funds from utilities and the City of Wooster.
- Funded by a U.S. Department of Commerce $744,000 grant and $1.2 million in local matches, Pounden Hall was renovated to provide space for businesses right on campus.
- Cleveland-based **quasar energy group** established its engineering office at Pounden Hall and built a biogas plant with 450 kW of electrical output on the park's main site.
- The project became an Ohio State University affiliate.

More than $8 Million in Grants, Matching Funds Makes BioHio Research Park a Reality

Companies moving in; Economic development in northeast Ohio has a new engine

Located on the Wooster campus of the Ohio Agricultural Research and Development Center, BioHio Research Park has moved from a plan on paper to a reality on the ground — with the main site enhanced with an improved access road, job-ready site preparation, and utilities. Tenants are moving into a newly remodeled building, and a company is already operating a clean energy plant on the premises.

A unique project in the Buckeye State, BioHio is a business and technology center, with business and industry partners moving ideas and products from the OARDC labs to the marketplace in the agbiosciences — areas such as food safety, renewable energy and materials, and environmental remediation.

The park will provide space and support for companies and startup businesses. In turn, these businesses will link with OARDC researchers to promote economic development and create jobs.

More information: http://go.osu.edu/6j *and* http://www.quasarenergygroup.com

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"From an industry perspective, it's good to know that the deeper organic matter is placed in the soil, the less likely it is to be oxidized and released into the atmosphere as carbon dioxide."

— Mark Wilson, Land Stewards, LLC

THE ESSENTIALS

- With continuous no-till, Ohio soils can sequester 500 pounds of carbon per acre.
- No-till is practiced on 35% of Ohio's available cropland. Approximately 20% of the state's corn and 80% of its soybeans and wheat is in no-till.
- The Intergovernmental Panel on Climate Change estimates that roughly 100 billion metric tons of carbon over the next 50 years could be sequestered with beneficial land management practices. This sequestration would offset 10–20% of the world's projected carbon emissions from fossil fuels.

New Ways to Store Soil Carbon Positive for Environment/Farmers

Researchers at the Ohio Agricultural Research and Development Center are finding that carbon stored on the soil surface (first 8 inches) degrades more rapidly than carbon at deeper depths (up to 3 feet). Some reasons: higher microbial biomass, more soil surface activity, and fewer soil minerals. "Lignin and cellulosic plant materials are not stable in the soil, so carbon will be lost when plant litter decomposes. But organic carbon associated with soil minerals at deeper depths will last a long time, maybe thousands of years," said OARDC research scientist Klaus Lorenz.

Ways to promote deep carbon storage include: manure application, which supports earthworm activity; practices that support a stable soil structure with conduits that move carbon deeper; and growing plants with deep, extended roots.

Maintaining healthy soil carbon levels is critical to supporting Ohio's more than $100 billion agbioscience industry. Likewise, sequestering carbon in the soil helps to slow climate change. The research focuses on the impacts that changes in climate and carbon have on the environment, and how we can respond through scientific and policy-oriented solutions.

What is carbon sequestration?
Storing or sequestering carbon in the soil is one way to mitigate climate change. No-till farming aids in carbon sequestration by minimizing soil disturbance and slowing the release of carbon dioxide into the atmosphere. Carbon dioxide has been linked to climate variability.

More information: http://go.osu.edu/6u

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"Several existing synchronization protocols that are used today by the beef industry, not only nationally but globally, were initiated through research efforts with OARDC. The results of this research benefit thousands of beef producers, allowing them to be more profitable with their operations." *— Brian House, Select Sires Inc., a cattle genetics company based in Plain City, Ohio*

THE ESSENTIALS

If OARDC's reproduction protocol were implemented with just 10% of Ohio's 500,000 beef and dairy cows, the total economic benefit for the state would easily surpass $5 million. Here's the breakdown:

- $400,000 saved in overhead costs as a result of cows becoming pregnant 21 days earlier.
- $500,000 saved in costs associated with the development of replacement cows due to low fertility rates.
- More than $4 million in multiplier effect from savings and increased production.

In Synch: Better Cow Reproduction Means Higher Profits for Beef Industry

There's no way around it: getting the highest possible number of cows pregnant at the same time is crucial for the profitability and efficiency of Ohio's beef cattle industry, which has an annual value of $1.3 billion.

Working closely with the industry, Ohio Agricultural Research and Development Center animal scientist Mike Day is making that possible. Day and his team pioneered a new fixed-time artificial insemination (AI) protocol — known as "5-day CO-Synch + CIDR" — that better synchronizes a cow's estrus (heat) cycle so that AI can be administered when cows are at their maximum fertility.

Now a recommended practice within the cattle industry nationwide, this protocol has been tested on more than 1,700 cows, resulting in 68% of the animals getting pregnant within one day — a 17.5% increase compared to industry standards.

Investments by OARDC, private industry, and public funding agencies have provided beef cattle producers throughout the world with a method to improve fertility and increase profits.

More information: http://www.selectsiresbeef.com

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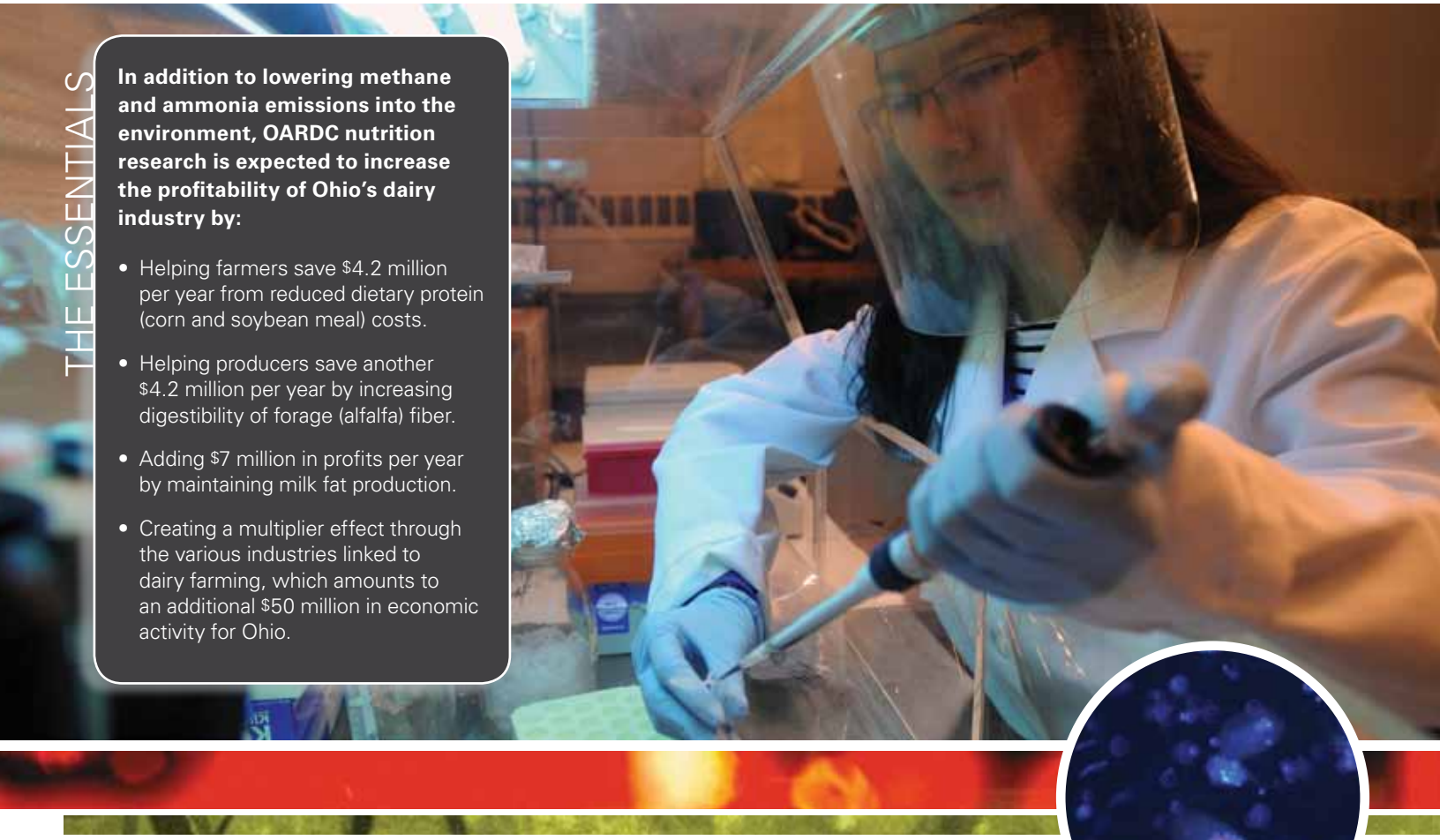
"The techniques developed by Ohio State have allowed us to better elucidate the role of protozoa in ruminal fermentation. We believe that Dr. Firkins' work can assist us in predicting when different interventions will impact practical nutrition of dairy cattle on farms."

— Gale Bateman II, Ruminant Nutritionist, Provimi North America, Lewisburg, Ohio



THE ESSENTIALS

In addition to lowering methane and ammonia emissions into the environment, OARDC nutrition research is expected to increase the profitability of Ohio's dairy industry by:

- Helping farmers save $4.2 million per year from reduced dietary protein (corn and soybean meal) costs.
- Helping producers save another $4.2 million per year by increasing digestibility of forage (alfalfa) fiber.
- Adding $7 million in profits per year by maintaining milk fat production.
- Creating a multiplier effect through the various industries linked to dairy farming, which amounts to an additional $50 million in economic activity for Ohio.

A Winning Formula: Reducing Dairy Cows' Environmental Impact, Farmers' Feed Costs

From cows we get dairy products, meat, and many other products. But cows also release lots of methane and ammonia into the environment. Methane is 25 times more potent than carbon dioxide as a greenhouse gas. And ammonia can contaminate surface waters and soils.

Animal scientist Jeff Firkins at the Ohio Agricultural Research and Development Center has developed novel techniques to manipulate rumen protozoa — microbes inside the cow's stomach that promote the reduced emission of methane and ammonia. By integrating these techniques with evaluation of dairy cattle diets typical in Ohio, this research is expected to help reduce the environmental impact of livestock operations in the state and the world.

Because rumen protozoa also waste dietary protein and energy, representing up to 90% of feed expenses by cattle producers, Firkins' work can also slash production costs by boosting feed efficiency — all without compromising milk quality. This research holds great promise in helping Ohio's animal industry remain a strong contributor to the state's economic portfolio.

More information: http://go.osu.edu/6s

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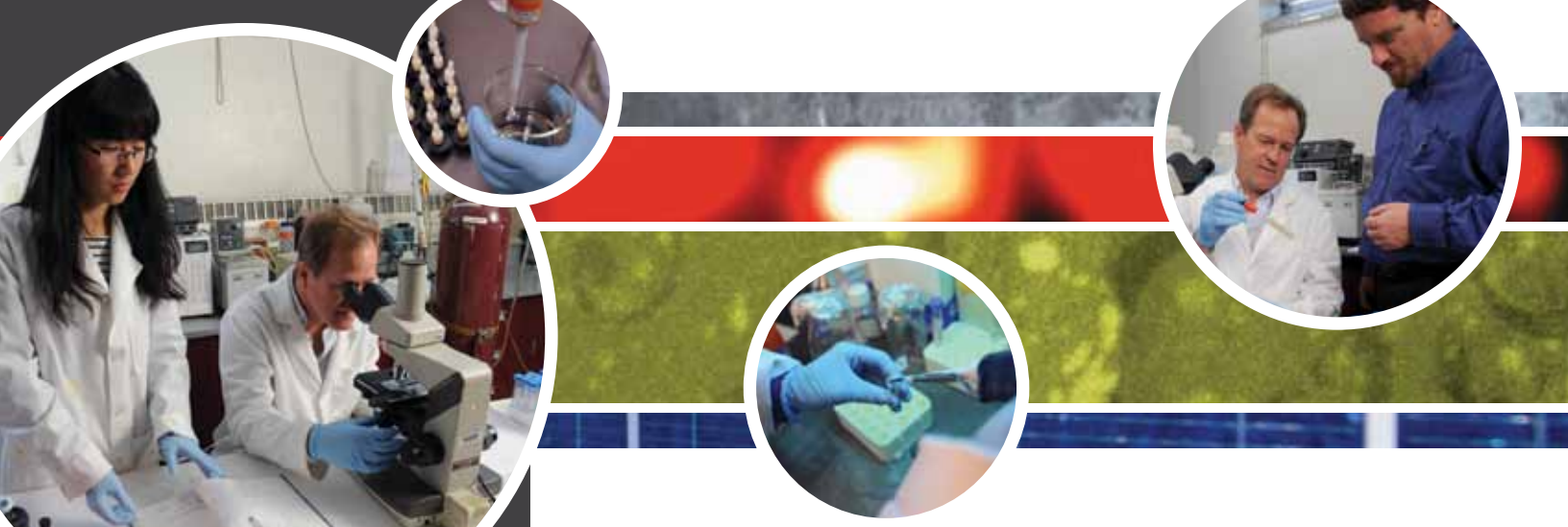

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"As tight as profit margins are right now, we can't afford not to use distiller's grains to reduce our feeding costs and remain in business. Ohio State's research is helping us do that."

— Stan Smith, Smith Simmental Farm, Canal Winchester, Ohio, and OSU Extension Program Assistant

THE ESSENTIALS

Made possible by OARDC research, increased use of the 1.2 million tons of distiller's grains generated by Ohio's ethanol industry can:

- Reduce feeding costs by 20–50% compared to using corn and hay.
- Decrease manure output by 50%, contributing to improved environmental quality.
- Nearly eliminate the need to treat grazing lambs for internal parasites, greatly enhancing profitability of the sheep industry.
- Save Ohio cattle producers over $100 annually per cow — for a total of $20 million.
- Support continued ethanol and corn production in Ohio, create new jobs, and enhance economic stability in multiple sectors of agriculture.

A Different Brew: Use of Distiller's Grains Benefits Livestock, Corn, Biofuels Industries

Thirty percent of the 146 million bushels of Ohio-grown corn used by the state's growing ethanol industry ends up in a byproduct called distiller's grains (DGS). DGS is a great feed for cattle and sheep and is also cheaper than corn and hay.

In the past, nutritional requirements limited the use of DGS to 25% per ration. This reduced potential savings, employment opportunities, and profitability for ethanol plants.

That's where animal scientists Steve Loerch and Francis Fluharty at the Ohio Agricultural Research and Development Center come into the picture. They developed a nutrition strategy that allows pregnant beef cows and sheep to be fed up to 80% DGS, and growing heifers and feedlot steers up to 70% DGS — more than doubling potential use of this feed in Ohio. Likewise researchers at OARDC have developed technologies for modifying DGS for non-ruminant food animals such as swine, further expanding the market and profitability of ethanol production. DGS has moved from being a "byproduct" to a highly valued "coproduct" with a market value of $180 million in Ohio alone.

More information: http://go.osu.edu/6k *and* http://ohethanol.com

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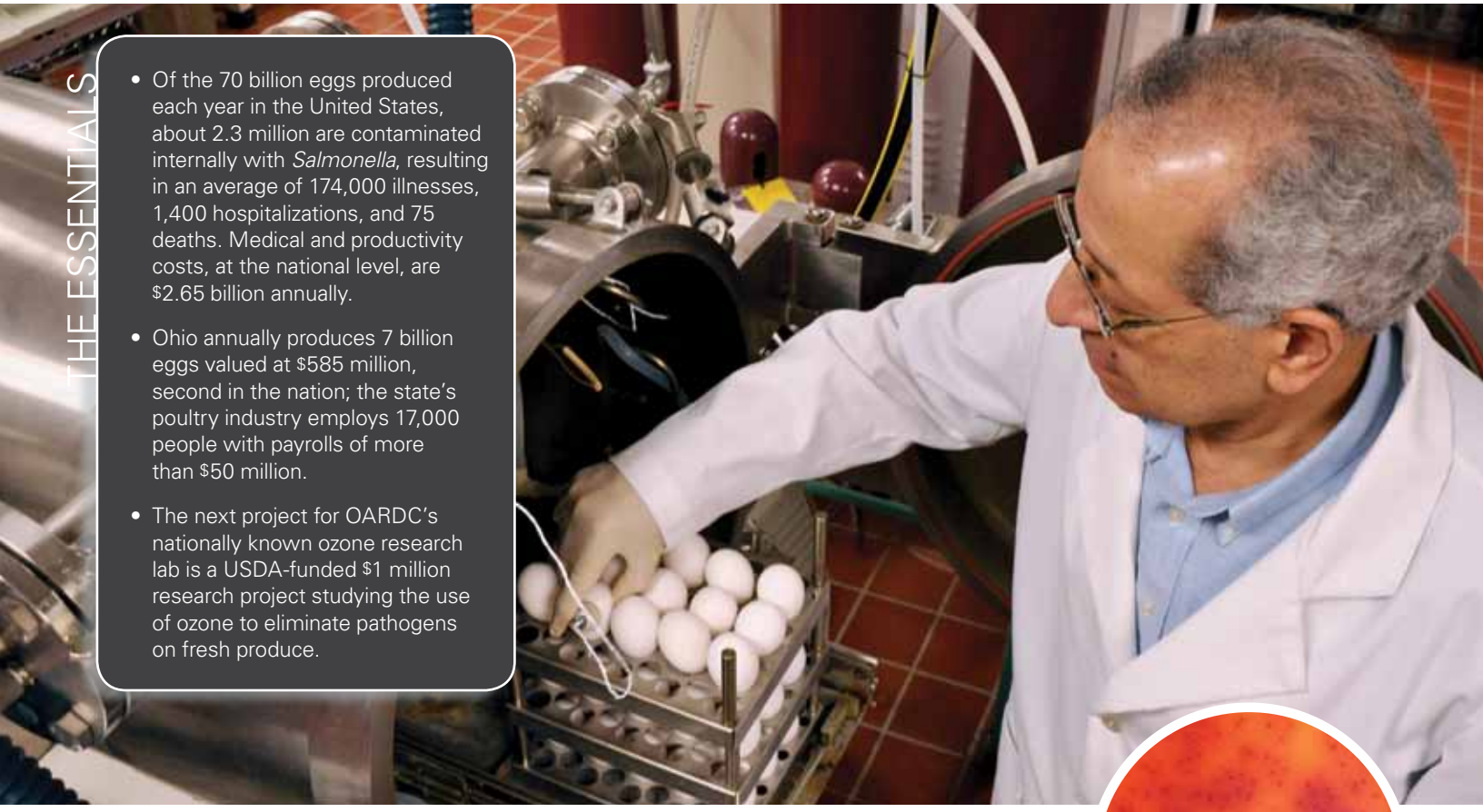
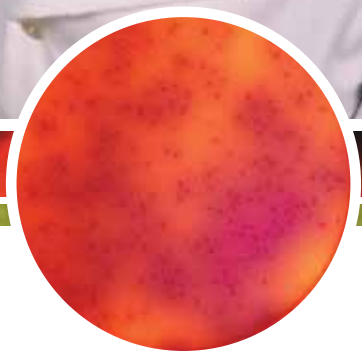
"Having a partner like The Ohio State University brings the credibility and expertise that a project of this significance warrants. This unprecedented research is an enormous step forward for egg safety." — *Tom Hertzfeld, Sr., President, Egg Tech Ltd.*



THE ESSENTIALS

- Of the 70 billion eggs produced each year in the United States, about 2.3 million are contaminated internally with *Salmonella*, resulting in an average of 174,000 illnesses, 1,400 hospitalizations, and 75 deaths. Medical and productivity costs, at the national level, are $2.65 billion annually.
- Ohio annually produces 7 billion eggs valued at $585 million, second in the nation; the state's poultry industry employs 17,000 people with payrolls of more than $50 million.
- The next project for OARDC's nationally known ozone research lab is a USDA-funded $1 million research project studying the use of ozone to eliminate pathogens on fresh produce.



Saving Lives: Egg Safety Innovation a Buoy for Ohio's $585 Million Egg Industry

In 1997, Ohio Agricultural Research and Development Center researcher Ahmed Yousef began testing to determine if ozone could eliminate *Salmonella* serovar *enteritidis* from inside whole shell eggs. "I thought, six months and we'll be done with this," he said. But the first experiment showed no success. Nor did the second, third, or fourth. "We did 10 experiments, and nothing seemed to work," he said.

Today, thanks to industry investment, two dissertations, and sheer persistence, Yousef and graduate students have been granted two patents, one that combines ozone with mild heat to eliminate *Salmonella* that may lurk inside whole shell eggs. The process results in a much more acceptable product to consumers than heat-processed pasteurized eggs currently on the market.

Egg Tech Ltd., a partnership of three major Ohio egg farmers, holds the exclusive commercial license for the technology. It is anticipated that by 2011, commercial equipment based on Yousef's research will be operating in Ohio and used to pasteurize nearly 11,000 eggs at a time.

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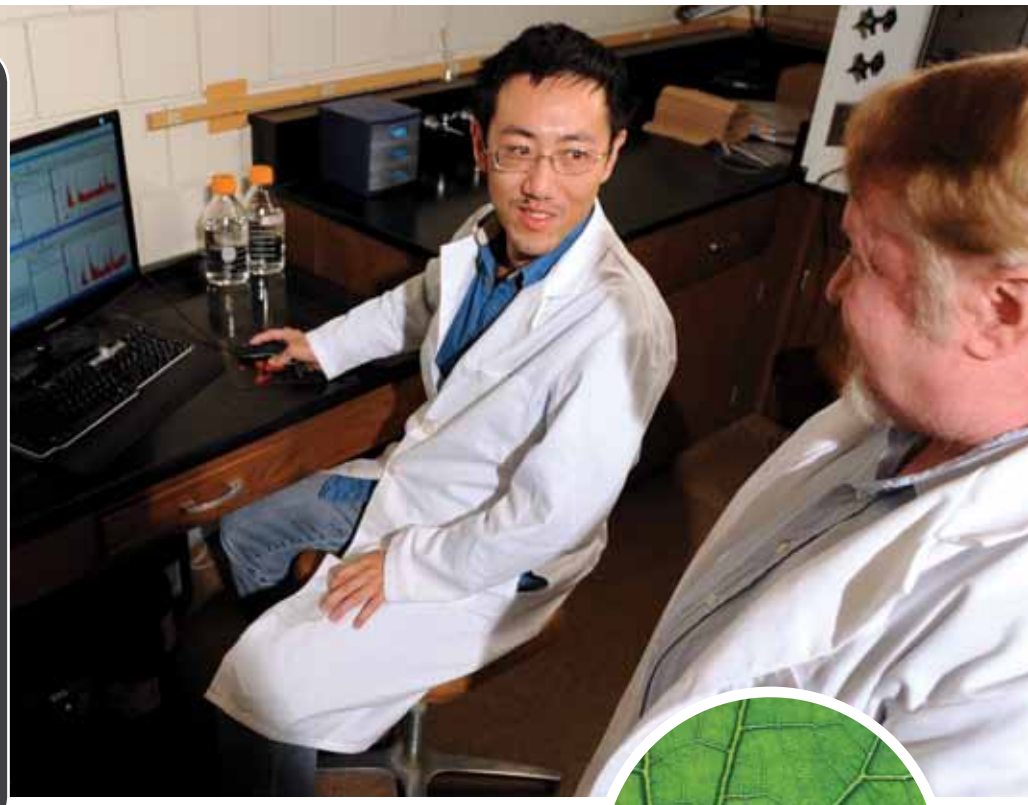
"Dr. Graham's research on soybean and other plants, particularly in the area of plant defense, has led to a better understanding of their roles in pest resistance. Due to our mutual academic interests, Dr. Graham and myself, along with other colleagues on campus, are collaborating to try and determine if plant secondary metabolites with known defense functions also have potential as anticancer agents in humans." *—Douglas Kinghorn, Jack L. Beal Professor and Chair, College of Pharmacy, The Ohio State University*

THE ESSENTIALS

- Ohio's top field crop, soybean, is a versatile source of numerous food and industrial biobased products.
- Research is now paving the road to finding new compounds for fighting plant pests and human diseases alike.
- Using soybean as a model, OARDC scientists discovered that plants make the majority of previously unknown natural products during periods of stress or when defending against attacking pests.
- The scientists used an herbicide, lactofen, to attack soybean plants and stimulate their disease-resistance mechanisms. As a result, the plants produced more than 30 new natural products — five never before reported in soybeans and two never found in any other plant. All of these natural products have potential to grow new Ohio businesses.



Diamonds in the Rough(age): Mining Plants for New Pest Control Agents, Pharmaceuticals

Natural plant compounds help crops protect themselves against diseases and insects. They are also the source of more than 70% of human medicines and health-promoting foods. In the past they have been hard to find and usually scarce.

Not for long.

Ohio Agricultural Research and Development Center Plant pathologist Terry Graham is using a process called metabolite mining to identify new compounds never before seen in plants, specifically soybeans. Even better news is that these compounds may play a critical role in plant defense against pests — a big plus for agriculture — and have potential to provide novel chemicals for pharmaceutical research.

This research, however, does not stop with soybeans. Graham's interdisciplinary team, including researchers from Ohio State's College of Pharmacy, is using the same process to evaluate a wide range of plants for valuable natural products that could be used as herbicides, insecticides, or anti-cancer drugs.

More information: http://go.osu.edu/6z

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"Working with Dr. Grewal has given us the knowledge and confidence to treat our clients' yards with a completely non-toxic alternative to chemical grub controls. He has been instrumental in helping us get set up to provide this service, and we're very grateful to have his assistance. So are our customers!" *— Alec McClennen, Good Nature Organic Lawn Care, Cleveland*

THE ESSENTIALS

- The global biopesticide market is projected to reach $350–400 million by 2015, a 50% increase since 2005.
- A new OARDC nematode strain, licensed by Becker Underwood Inc. (Ames, Iowa), the world's largest producer of beneficial nematodes (350 employees worldwide and annual sales most recently estimated at $100-plus million), targets the lawn care industry's biggest problem, white grubs.
- Called GPS11, the new strain required about five years of research — about typical — from basic lab studies through applied field testing — before it was ready for commercializing.
- Good Nature Organic Lawn Care of Cleveland and Columbus, provider of what its website calls "family friendly and environmentally responsible landscape services," uses nematode-based biopesticides — ones fueled by Grewal's efforts — as a cornerstone in its lawn-care treatments.

The Path to New Biopesticides

OARDC scientists are laying the groundwork for new, safe ways to keep plants healthy

Thanks to OARDC research, tiny worms are showing big benefits as environmentally friendly biopesticides. Insect-parasitic nematodes — ***microscopic roundworms*** — attack and kill specific insect pests of lawns, farms, and gardens but are harmless to other forms of life, including humans.

OARDC scientist Parwinder Grewal is a world expert on nematodes and his findings have led to the development of new, non-toxic pest-control products. He discovers and studies new nematode strains, learns how they work and what they target, and recently has been analyzing certain nematode strains' entire genome — i.e. their hereditary information — and then licensing the strains to companies for commercializing.

Nematodes offer a safe, effective alternative to highly toxic pesticides that soon might be banned, Grewal says. They can step in, too, in communities where the use of cosmetic pesticides, such as for lawns, is prohibited. "Nematodes can replace those chemicals," he says, "and enhance the safety of people and the environment."

"Nematodes are a huge help to our customers," says Good Nature's Alec McClennen. "They enable us to control potentially damaging grubs and insects without using any chemicals, which is great for our over 3,000 customers who prefer not to have chemicals on their lawns."

More information: http://oardc.osu.edu/cueed/

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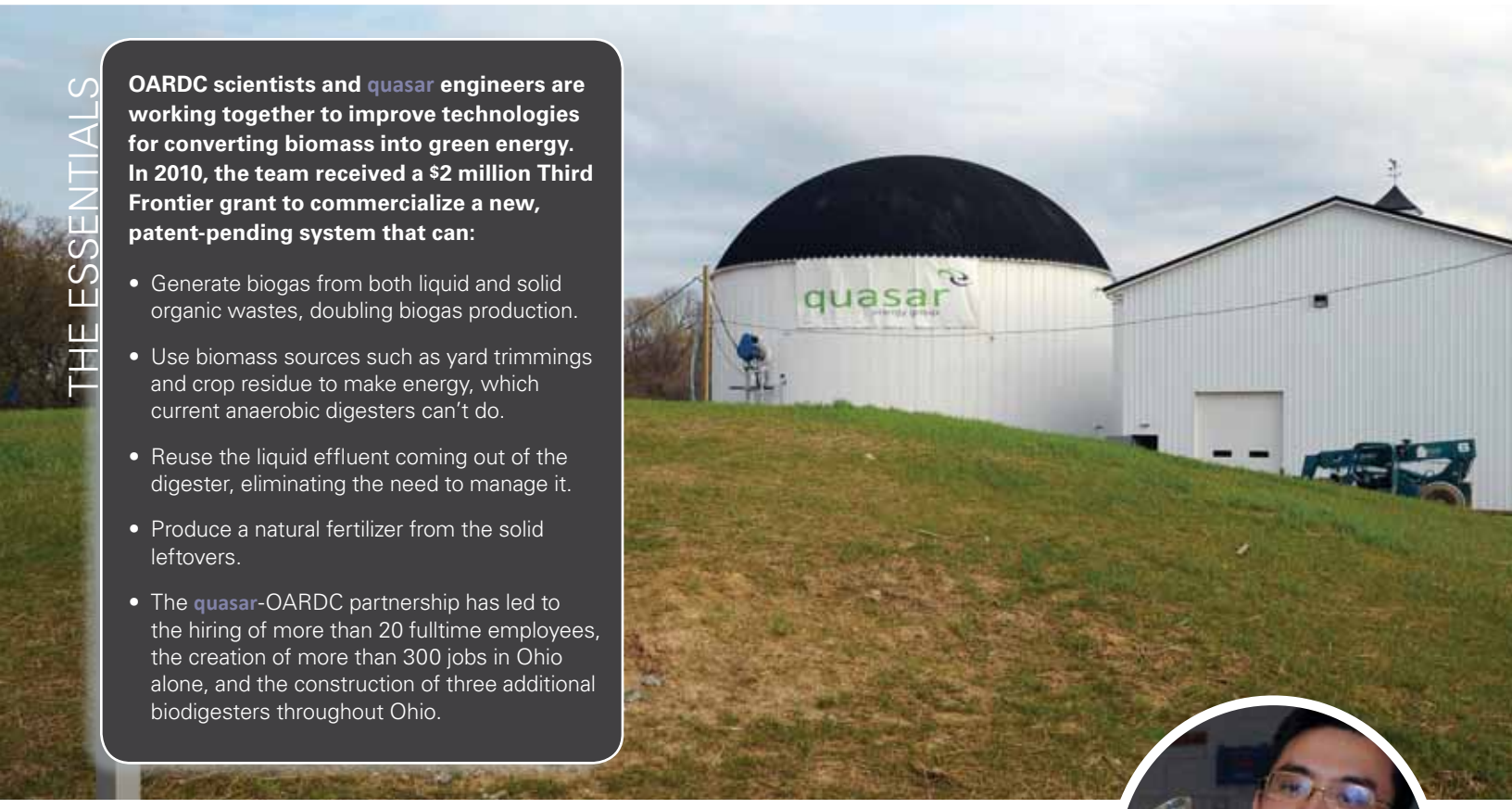
"Working with Ohio State has given us credibility and visibility to get here faster. The people at OARDC are proactive. They want to see change, and they want to be part of driving this agricultural phenomenon to the next level." —*Mel Kurtz, President,* **quasar energy group**



THE ESSENTIALS

OARDC scientists and quasar engineers are working together to improve technologies for converting biomass into green energy. In 2010, the team received a $2 million Third Frontier grant to commercialize a new, patent-pending system that can:

- Generate biogas from both liquid and solid organic wastes, doubling biogas production.
- Use biomass sources such as yard trimmings and crop residue to make energy, which current anaerobic digesters can't do.
- Reuse the liquid effluent coming out of the digester, eliminating the need to manage it.
- Produce a natural fertilizer from the solid leftovers.
- The quasar-OARDC partnership has led to the hiring of more than 20 fulltime employees, the creation of more than 300 jobs in Ohio alone, and the construction of three additional biodigesters throughout Ohio.

A Flagship of Research, Entrepreneurship, Sustainability

When Cleveland-based **quasar energy group** was looking for a place to build its flagship biogas research facility, they looked to the Wooster campus of the Ohio Agricultural Research and Development Center and its bioenergy program.

It was a good match. Today, the modern anaerobic digester — which can process 550,000 gallons of agricultural and food-processing waste, keeping it from landfills and saving businesses disposal fees — is producing 450 kW of electricity. The digester has the potential to supply up to one-third of the campus's energy needs.

The digester is also the first building in OARDC's BioHio Research Park — a unique business and technology center aimed at fostering economic development through innovations in agbiosciences.

The public-private partnership between OARDC and **quasar** is expected to be a key step in building a clean energy industry in the Buckeye State and to generate new jobs: an estimate shows Ohio has enough biomass resources to run 7,721 farm-scale and industrial-scale biogas plants. OARDC researchers are leading the way in researching biogas plants that will be viable for small farms, as well as large farms and industry.

More information: http://www.quasarenergygroup.com/ *and* http://go.osu.edu/6X

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"Without the resources at The Ohio State University, entrepreneurs like me could easily be precluded from ever getting off the ground. Instead of an investment of up to a quarter-million dollars just to test the feasibility of an idea, in three days, you can be up and running."

— Dan Wampler, President of Sensus, LLC, who began testing flavor components in the university's Food Industries Center and 10 years later is expanding to an 80,000 square foot facility, employing 40 workers, and marketing his Hamilton, Ohio, company's unique flavor concentrates and extracts worldwide.

THE ESSENTIALS

OARDC has been a strong partner in the Third Frontier program. Projects awarded since 2008 include $5 million devoted to advanced granule technologies for fertilizers and pesticides that address the economic, health, and environmental concerns; $3 million to develop a renewable, domestic source of natural rubber; $2 million to boost the amount of energy produced from waste; and $2.5 million to assist entrepreneurs in Appalachian Ohio who are bringing new technologies to the marketplace.

In turn these funds have been leveraged to attract extramural research funds and additional business and industry partners.

$100 Million Strong: Research Portfolio Provides Basis for 'an Ohio Center of Excellence'

In 2004, the Ohio Agricultural Research and Development Center launched a targeted effort to expand the economic impact of Ohio's agbioscience economy.

That successful venture contributed to the 2010 designation of The Ohio State University as the Ohio Center of Excellence in Agriculture, Food Production, and Bioproducts by the Ohio Board of Regents and the University System of Ohio. It is the only such designated center to be housed solely within a single university.

"Simply put, this is what we do — and we've been doing it for 100-plus years," says Bobby Moser, vice president and dean of the College of Food, Agricultural, and Environmental Sciences. "From a research perspective, we have a portfolio that comes close to $100 million in state and federal funds and private contracts and grants. The Center of Excellence designation allows us to leverage our position with funders who invest in areas that are already recognized as strong."

Between 2004 and 2008, OARDC generated 123 invention reports and 40 patent applications; its sponsored research grew 23.2%, from $19 million to $23.4 million; and its non-federal research funding increased by 64%, to $12.4 million.

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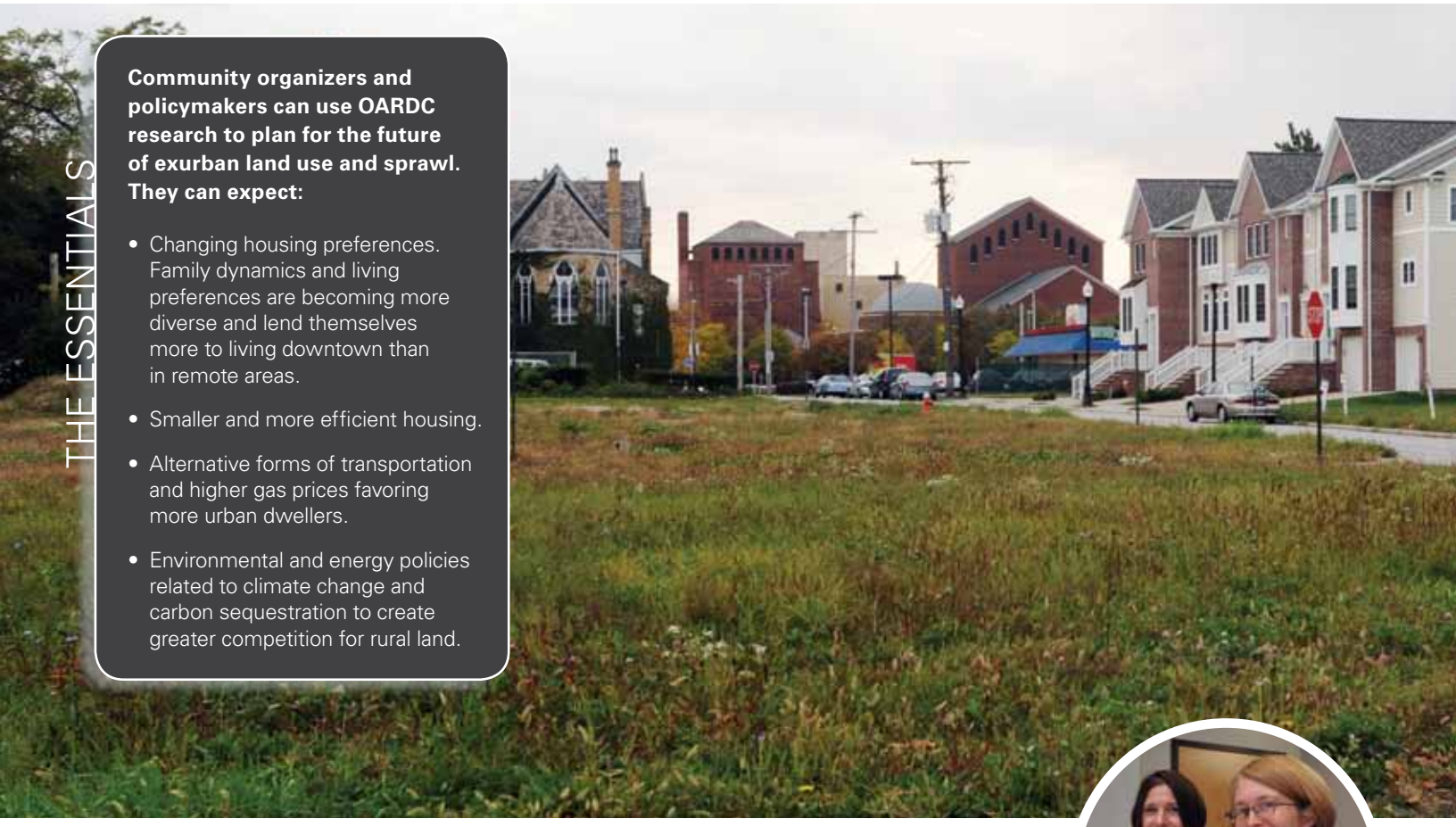
"It was once said that to save farmland we need to make the cities a more attractive place to live. But we must actually also save the farmer. To do that, Ohio needs strong metro regions that are economically viable so farmers have a place to sell products and to provide off-farm employment." *— Gene Krebs, Senior Director of Government Affairs, Greater Ohio*



THE ESSENTIALS

Community organizers and policymakers can use OARDC research to plan for the future of exurban land use and sprawl. They can expect:

- Changing housing preferences. Family dynamics and living preferences are becoming more diverse and lend themselves more to living downtown than in remote areas.
- Smaller and more efficient housing.
- Alternative forms of transportation and higher gas prices favoring more urban dwellers.
- Environmental and energy policies related to climate change and carbon sequestration to create greater competition for rural land.

Shrinking Sprawl Good News for Urban Economic Development

Ohio's exurban sprawl — ***business and residential living between suburban and rural areas*** — is shrinking due to the recession. But that could be good news for urban areas in terms of job growth and economic development. "With the financial crisis, we've seen a dramatic halt in exurban areas. Eventually we can expect exurban areas to rebound, but they probably won't return to the status quo," said Elena Irwin, an Ohio Agricultural Research and Development Center economist.

Based on national level data analysis, Irwin and colleague Jill Clark drew implications on land use changes based on population, technology, and other trends and established theories of population migration, market shifts, and location choice.

Their findings: The economic downturn is shifting people back to the cities providing a potential for urban revitalization.

"The potential benefit in the long run is you have a greater concentration of people and businesses forming interactions and exchanging ideas," said Irwin. "Those are strong factors for economic growth."

More information: http://exurban.osu.edu

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"We think this new research development is going to be an incredibly important contribution in future cereal management programs for Fusarium head blight and the associated mycotoxins that this pathogen produces." *— Sci Protek's Nigel Grech, vice president and director of research and development, on the yeast technology*

THE ESSENTIALS

- Fusarium head blight or head scab is caused by the fungus *Fusarium graminearum*. The disease has a potential multi-million dollar negative impact on Ohio's wheat crop by reducing both grain quality and crop yield.
- For every $1 lost due to head scab, it's estimated that another $2 is lost elsewhere in the wheat industry due to yield impacts and grain contamination.
- The yeast technology developed by OARDC researchers can reduce disease severity by as much as 50%.
- A "green" fungicide product is slated for release by 2014, potentially saving farmers, millers, and bakers $1 billion per year in crop losses.
- Disease prediction accuracy of the Wheat Fusarium Head Blight Risk Assessment Tool is nearly 80%.

Saving Wheat Farmers $1 Billion a Year in Disease-Related Crop Losses

In 2009, when Ohio saw its first major head scab outbreak on wheat in more than 10 years, growers had an Ohio State University web-based tool to manage the risk of the disease developing on their crop.

The Wheat Fusarium Head Blight Risk Assessment Tool (**http://www.wheatscab.psu.edu/**) was developed at OARDC in 2000. Using weather and crop development scenarios the tool can forecast the risk of head scab across 24 states.

"It's an early-warning system for growers that can save yields and protect grain," said Ohio Agricultural Research and Development Center plant pathologist Pierce Paul.

Growers may soon have another weapon in the fight against head scab: a "green" fungicide containing a naturally occurring yeast isolated from Ohio fields and developed by OARDC plant pathologist Mike Boehm.

Sci Protek, Inc., based in Visalia, California, has licensed the technology. In addition, the company has licensed additional Ohio State technology related to head scab: a variant strain of the yeast organism that is tolerant to additional fungicides. The breakthrough may provide dual protection of wheat, both before and after flowering.

More information: http://go.osu.edu/62

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