INVESTING IN SMARTER AGRICULTURE™

The Purdue Plant Sciences Pipeline
Continuing Our Legacy of Engagement and Innovation

In 2014, we marked the 100th anniversary of the Smith-Lever Act, which created the Cooperative Extension Service. Celebrating the centennial, we recognize that the expansion and support of Extension at the national and state levels are key to delivering programs that meet the needs of residents and communities.

This issue highlights some programs that are helping Indiana communities become more economically resilient and discoveries that move Indiana forward in agriculture and life sciences.

• Animal agriculture is a multi-billion-dollar industry in Indiana. Research by Purdue animal scientists has implications for both improving the quality of meat marbling and growth efficiency in animals and developing new approaches to treating human diseases.

• Nineteen research teams are advancing Indiana’s leadership in plant and animal agriculture and rural development. In 2013, the state legislature funded AgSEED, a $1 million grant program. The research and education supported by AgSEED better positions Indiana for economic growth and jobs in food and agriculture.

• Supporting small businesses builds a stable Indiana economy. County-based Extension tailors programs to local needs. In Clinton County, small-business owners benefit from a networking forum that also provides professional development. In Vigo County, Extension partners with the Indiana Small Business Development Center to sponsor Startup Weekend, an intense course for entrepreneurs.

• The Purdue University Plant Sciences Research and Education Pipeline, a $20 million initiative, strengthens the university’s leadership in developing improved crops to feed a rapidly growing world population. Construction on a leading-edge phenotyping facility will begin in spring 2015. Purdue Agriculture and Extension are engaged at every level—from innovations to solve world hunger to local programs that enhance communities.

Jay Akridge
Glenn W. Sample Dean of Agriculture

For more about the topics in this issue, see expanded coverage on the Agricultures website, agriculture.purdue.edu.
Features

Muscular Mysteries
Muscles are more than just the jocks of the body. Purdue animal scientists are advancing knowledge of muscle science, which has important implications for both the meat production industry and human health.

“Seed” Money
Funding from the 2013 Indiana Legislature is supporting Purdue research in agriculture, health and human sciences, and veterinary medicine. Projects from the AgSEED initiative focus on positioning the state for economic growth in the food and agricultural industries.

Investing in Smarter Agriculture™
In the year since Purdue announced its $20-million commitment to enhance plant research, investment in technology to support the research and education is well underway. Data from a cutting-edge phenotyping facility will allow researchers to learn more about plants than ever before.

Spotlights

Profile
Getting a Financial House in Order
SPOTLIGHTS

In recognition of the centennial of the Smith-Lever Act of 1914, which created the national Extension system, Spotlights is highlighting some of the many ways Purdue Extension serves the residents of Indiana.

Young Tamara Hanlin is the latest link in the chain of Hanlin family members who have worked their eastern Indiana farm. The homestead behind Hanlin was built by her great-great-grandfather John in 1836.

Big benefits come from “small” conference

Tamara Hanlin got some big help at Purdue Extension’s Indiana Small Farm Conference, which offers expert advice each year to small farm owners that helps them make their operations more successful.

It’s not that Hanlin needed to learn how to raise and care for her family’s approximately 100 head of Angus beef cattle in eastern Indiana just west of Portland. The family has been doing that for many years. What she wanted to learn more about was how to better market the beef. At the conference, she got what she came for, learning more about how to work with processors and how to use social media in marketing.

“Through the beef marketing class, I really learned a lot about the actual processing and how to better talk and work with the local processor so we can do a much better job of marketing our beef product,” she said. “We also have started to market directly to consumers, at least to a small degree. We wouldn’t have been able to do that without the knowledge I gained from sitting in on those sessions.”

Hanlin also left the conference with an idea to grow sweet corn on three acres of the farm and sell it—something she had never done. She considers that an added benefit of what she gained from attending the event. “I just dove right into it,” she said. “And that’s only because I went to the Small Farms Conference.”

By Keith Robinson

Partners for food safety practices

The Food Protection Program of the Indiana State Department of Health is all about helping produce growers and packers keep food safe for consumers. Purdue Extension expertise has played a large role in the program.

Purdue Extension trained about 20 state program staff members in a course called Good Agricultural Practices from A to Z. Known as GAPs, the good agricultural practices course gave Food Protection Program staff important information they need to advise growers and packers on how to reduce the risk of foodborne illness outbreaks (such as from Salmonella), said George C. Jones, deputy director.

“The training was a very worthwhile endeavor for our staff members, who better understand the many factors that can affect the safety of fresh fruits and vegetables,” Jones said. “It has helped our program to focus on important food protection principles and to offer the produce industry sound advice.”

For example, staff from the Food Protection Program and Purdue Extension presented workshops about melon-packing-shed sanitation procedures during the 2013 and 2014 growing seasons.

“The workshops have been well received by the industry, and growers and packers seem to really appreciate our efforts to bring the knowledge directly to them—and in a nonthreatening way,” Jones said.

By Keith Robinson

George C. Jones (right) of the Indiana State Department of Health turned to Purdue Extension to receive training about good agricultural practices to reduce the risk of foodborne illness outbreaks.

“The training will help to ensure that wholesome produce is delivered to both retail and wholesale markets in Indiana and beyond our borders,” Jones said. “We look forward to ongoing collaboration with Purdue. Offering the produce industry best practices can help growers and packers to have successful businesses and at the same time make sure consumers are offered safe and healthy food choices.”

By Keith Robinson
Winery, Purdue Extension grow deep roots

Ted and Dana Huber of Huber’s Orchard and Winery in Starlight, Indiana, cultivate 22 varieties of wine grapes on their seventh-generation farm. They process more than 500,000 pounds of grapes a year, making them the state’s largest wine grape producers. Since the 1980s, they have counted on members of the Purdue Wine Grape Team, part of Purdue Extension, for expert counsel on matters of the vine and cellar.

“We feel free to call the team at any time with questions about the vineyards or wine quality,” Dana said. “Our interactions are always productive.”

Purdue Extension horticulturalist Bruce Bordelon fields the Hubers’ questions about grape varietals, and enologist Christian Butzke and enology specialist Jill Blume help them stay current on wine production techniques and perfect new styles of wine.

The Hubers have put Purdue Extension information to good use. Huber wines have claimed more than 900 medals in wine competitions, including the Wine of the Year award at the 2013 Indy International Wine Competition.

The Hubers also raise other fruits and vegetables and Christmas trees, and maintain a thriving business with a café and a wine tasting room. For issues in the orchard, they turn to Purdue Extension horticulturalist Peter Hirst. When it comes to their agrotourism business, they rely on Purdue Extension horticulturalist and agricultural economist Jennifer Dennis.

The relationship with the Hubers has proven fruitful for Purdue Extension as well. The Hubers often host Indiana Wine Grape Council meetings and workshops for farmers looking to improve their agrotourism business.

By Natalie van Hoose

Volunteers cultivate community

Patrick Lantz gets a lot out of gardening.

“I get the opportunity to be creative, grow something and produce something that I can see and enjoy,” Lantz said.

And gardening gives Lantz, a Purdue Extension Master Gardener volunteer, an opportunity to give something to his community. He designed and maintained a demonstration garden in the Purdue Master Gardener demonstration gardens in Fort Wayne, Indiana.

The gardens offer more than just a relaxing pastime for volunteers; they teach members of the community about gardening. Allen County’s 320 active Master Gardener volunteers donated more than 18,000 hours in the community last year.

The “Welcome Home” garden is a tribute to veterans. The sign out front reads, “A garden to honor and thank our nation’s service members and their families.” The garden has yielded more than 400 pounds of fresh produce for a homeless shelter that also serves veterans.

By Kelsey Getzin

By Joan Crow

Paying it forward

When Reyna Bracamontes moved to Frankfort, Indiana, nearly a decade ago, she wanted nutrition information for her growing family. She got that information in educational resources from Purdue Extension.

Since then, Bracamontes has participated in many Purdue Extension programs, including high school equivalency classes. “I was very, very happy when I came here,” she said. “I finally got my GED. It was hard in the beginning, but they told me, ‘You can do it.’”

Today, she’s the one educating her friends and neighbors. She is a Promotora de Salud, or community health worker, for Purdue Extension. She connects Frankfort’s Latino community with relevant health information.

“People in the community know who Reyna is and know that she’s a resource,” said Claudia Houchen, Purdue Extension-Clinton County minority health coordinator. “Becoming part of the community is not just about living in it, and going to work, but actually volunteering and being involved. Reyna went and found the resources, and now she’s a resource herself.”

By Joan Crow

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By Kelsey Getzin

By Joan Crow
**SPOTLIGHTS**

**Workshops pay off**

Hands-on training and experience are essential for successful professionals. And that’s why Betsy Bower says she attends workshops at the Purdue Crop Diagnostic Training and Research Center (DTC).

“This is not death by PowerPoint,” said the agronomist for Ceres Solutions, an agribusiness based in western Indiana. “They give you a picture of a problem in your head, so when you see it, you know what it is and can test for it.”

The DTC has sponsored more than 500 workshops for over 22,000 individuals since it began in 1986. Those who attend DTC programs affect nearly 35 million acres of Midwest cropland. The center also produces a series of agricultural field guides (including the Purdue Extension *Corn & Soybean Field Guide*) that have sold more than half a million copies.

That training is especially important for young professionals, said Bower, who has been an agronomist for about 20 years. “When I started out several years ago, I attended every session to start that experience base,” she said. “You really get to touch it, feel it, taste it.”

What she learned in the workshops helped her in her day-to-day work. “It allowed me to see, ‘hey, this is what low soil pH looks like on corn; this is what it looks on beans.’ I could then go out and help a farmer, diagnose what was going on,” she said.

By Emma Hopkins

**Raising livestock more humanely**

Norman Voyles Jr. truly enjoys the work he does on the Voyles Farms, Inc. grain and livestock farm that he and his brother, Jim, own near Martinsville, Indiana. And he credits a Purdue Extension program with helping him stay current on best practices for humane handling of cattle.

Voyles was among 200 producers who attended a beef management seminar at the Lawrence County Fairgrounds in Bedford. The seminar featured Temple Grandin, an international livestock behavior expert at Colorado State University, who spoke about beef cattle handling techniques. Other speakers included livestock specialists and researchers from Indiana.

Voyles said he left the seminar with a better understanding of cattle behavior. He learned, for example, about the animals’ visual range and their perception of humans. This isn’t mere trivia—Voyles said he can use that information to process his herd more efficiently and ensure that he’s treating the animals humanely.

“As fewer and fewer people in our society have personal experience with the raising of livestock, consumers of our products want some assurances that the animal protein they eat was raised in a humane manner,” Voyles said. “Workshops such as this help to reinforce the techniques that we can use to reduce stress for both livestock and livestock producers.”

By Kevin Smith

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**Video**

agriculture.purdue.edu/Winter2015
 Farmers learn from each other

To Mark Kingma, farmers must have two qualities of equal importance. They must be profitable, and they must be good stewards of the land. For the past four years, the Jasper County farmer has turned to Purdue Extension for help in strengthening those qualities.

Kingma operates James Kingma and Son Inc., a corn and soybean farm in Wheatfield, Indiana, that was handed down to him by his father. The Indiana On-Farm Network, a program that relies on Purdue Extension, helped him fine-tune his nitrogen application practices to increase yield in an economically conscious and environmentally friendly way.

“We can learn from our mistakes, but we can also learn from the experience of other farmers in this program, because we look at maps of all the other farms that are involved in it,” Kingma said. “I saw what they did, what works and what didn’t work for them, and used that knowledge to make decisions about my practices.”

Mark Kingma uses the On-Farm Network to help him make the most economical and environmentally friendly nitrogen applications.

Regional educators strengthen community development resources

Five new Purdue Extension regional educators will expand delivery of community development programs throughout the state. They will primarily serve their geographical districts, but each has an area of expertise and will also serve as a statewide resource.

The new educators, who started this fall, include:

- Tanya J. Hall, economic impact analysis and decision making, Southeast District
- Tamara Ogle, local and regional government, East District
- Kris Parker, leadership, civic engagement and collaboration, Northwest District
- Heather Strohm, economic and business development, Southwest District
- Steve Yoder, natural and environmental resources, Central District

Each educator brings specific strengths to help Extension meet strategic goals in five key areas—leadership and civic engagement; community and organizational planning; economic and business development; local government; and quality places, said Lionel “Bo” J. Beaulieu, associate director of Purdue Extension and community development program leader.

“By collaborating, they will help local leaders understand all drivers of community development and build on those key components,” he said.

The next 100 years

Purdue Extension reaffirmed its mission of serving the needs of people and helping to make their communities stronger as the Cooperative Extension Service nationwide celebrated its centennial in 2014.

The Smith-Lever Act of May 8, 1914, created the national Extension system. The centennial observance, however, isn’t only about looking back—it’s also about planning for the future, said Purdue Extension Director Jason Henderson.

“The past 100 years provide a strong foundation for Extension, but we also are preparing for the next 100 years of relevant, university-based information to continue improving lives and communities throughout Indiana,” Henderson said.

By Olivia Maddox

By Emma Hopkins

By Keith Robinson

ag.purdue.edu/agricultures
Muscular Mysteries

Insights Into Muscle Science Improve Human Health and the Meat We Eat

By Natalie van Hoose

Muscles set us in motion. Our every movement—the swing of a tennis serve, a sneeze, the blink of an eye—is powered by muscles, triggered into action by signals cabled down from the neurons in our brain. The human body houses more than 650 muscles, comprising about 40 percent of the body’s total mass and driving motor function and athletic performance.

But muscles are more than just the jocks of the body. They are as crucial to our health—and as vulnerable to disease—as other tissues, such as the brain and heart. Together, muscles also form the largest regulatory organ of the endocrine system and metabolism, roles that are still not thoroughly understood.

One of the researchers advancing our knowledge of muscle biology is Purdue animal scientist Shihuan Kuang. His work focuses on how muscles develop and regenerate as well as the functions they play in communication—how they respond to neurons and how they transmit messages via hormones to other tissues and organs, such as fat and the liver. His research in muscle science has important implications for two areas that may not seem to share much in common: the meat production industry and human health.

Yet the underlying science between these fields is “remarkably similar,” Kuang says. “The goals of meat production are to increase muscle mass and quality. And in the human arena, there are diseases that waste muscle, which we’re working to stop or prevent. The basic science behind both of these areas involves the development of muscle and how stem cells function in muscle repair.”

From Neon Neurons to Satellite Cells

Kuang’s interest in muscles was sparked by his training at Washington University in St. Louis with Joshua Sanes, the biologist who developed the famous “Brainbow” mouse. Neurons in the brain of the Brainbow mouse were individually tagged with a spectrum of fluorescent colors, allowing researchers to track their connections to specific muscles. As Kuang followed the neon paths down to twitching muscles, he became intrigued by motor control.

He honed in on satellite cells, stem cells in the periphery of muscle tissue that contribute to muscle growth and repair. The unspecified nature of satellite cells allows them to become other cell types during development or after an injury to the muscle, repairing wear and tear.
“If you sprain your ankle or run too fast, satellite cells are activated from their dormant state,” Kuang says. “They divide, and a portion of these cells becomes specified and fuses with the muscle to fix the injury.”

Researchers had previously assumed that all stem cells were identical, but Kuang discovered that satellite cells are organized into a hierarchy with a few more “primitive” cells giving rise to the rest. These primitive cells offer significant benefits to medicine because they are the progenitors of all other muscle cells. The finding opened up new avenues for therapies to treat severe muscle injuries and neuromuscular diseases.

Kuang also found that stem cell transplantation, a widely used treatment for muscle-wasting diseases, is far more effective if the stem cells are raised in an oxygen-poor environment similar to that found in human muscle tissue.

Before Kuang’s discovery, stem cells were typically cultured in open-air conditions. Healthy stem cells were then transferred to the weak or wasting muscles to replace damaged cells and restore the strength of the tissue. But the survival rate of these stem cells was staggeringly low—only about 1 in 100 cells lived after transplantation.

“That was an indication to me that there was something in their environment they weren’t happy with,” he says.

Kuang deduced that a petri dish exposes stem cells to far higher levels of oxygen than they would encounter in the body: Oxygen levels in muscle tissue can fluctuate wildly, particularly when the tissue is damaged or regenerating. Growing stem cells in surroundings that mimicked these less stable oxygen levels boosted their post-transplantation survival rate sixfold, a “huge improvement,” he says.

What Muscle and Fat Talk About

Meat production also depends on stem cells to mediate muscle growth. Satellite cells can be stimulated to improve the growth efficiency of animals, and adipose stem cells give rise to fat, which contributes to marbling—the interweaving of muscle and fat tissue, an important quality trait of meat products. Kuang’s research team has mapped the origin of fat cells in the muscle with the goal of improving marbling in meat. The team also studies the ways in which muscle and fat regulate one another.

“Interestingly, fat and muscle stem cells frequently ‘talk’ to each other,” he says. “Muscle cells can send messages that cause fat to shrink or expand, while fat stem cells are required for the regeneration of injured muscles.”

Understanding the “crosstalk” between fat and muscle could lead to ways of stimulating the formation of fat in animal muscle tissue in order to improve meat quality.
Building Better Beef

Animal scientist Brad Kim is taking a fresh approach to aging meat. A renowned expert in meat color, Kim explores how the aging process can enhance beef’s palatability while providing benefits to human health.

He is in search of the perfect parameters for dry aging meat, a process that boosts tenderness and flavor. Dry aging involves placing unpackaged meat in a designated cooler for a period of 14 days to several weeks, causing the meat’s surface to dehydrate and condense. As the meat ages, naturally occurring enzymes break down the muscle structure, and proteins in the muscle tissue are degraded, releasing amino acids and peptides. When the meat is ready for retail, the surface is cut away, revealing a deep cherry-red interior that yields unique, nutty flavors once cooked.

The process is expensive and requires strict hygienic conditions: Processors must tightly control temperature, humidity and airflow.

“Dry aging meat is really an art,” Kim says. “There’s no one proven way of dry aging, although it’s been practiced for a long time. I am trying to identify the dry-aging conditions that will yield the best meat quality.”

Kim is also parsing out the fatty acids and amino acids generated by dry-aged meat in an attempt to pinpoint the source of its distinct flavors. He has found that dry aging liberates a higher number of essential amino acids than wet aging, the standard processing method in which meat is packaged and kept in a cooler for a shorter time. Some of the amino acids and peptides produced by the dry-aging process could be beneficial to human health, he says, “an intriguing outcome.”

Kim is investigating ways of naturally bolstering the number of these amino acids—which include disease-preventing compounds, antioxidants and antimicrobial agents—in meat. He also hopes to develop new food ingredients derived from meat compounds, which could be added in powder form to other food products such as energy bars, cereal and desserts to boost their nutritional properties.

“Many proteins in meat are understudied and underutilized,” Kim says. “There is strong potential to use these proteins as a novel source of food ingredients to improve human health.”

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Follow Shihuan Kuang’s journey from hardscrabble village life to research studies that graced the covers of Nature and Cell. agriculture.purdue.edu/Winter2015

WEB EXTRA

Muscular Mysteries — continued

“A good steak has tiny pieces of fat dispersed evenly throughout the muscle,” Kuang says. “That’s what makes it tender and juicy. Identifying the factors that muscles use to control fat could help us manipulate that marbling process.”

Kuang’s work has also yielded new insights into brown fat, the heat-producing material that keeps human infants and hibernating animals warm. He collaborated with scientists at Harvard to show that brown fat shares a common ancestor with muscle tissue—not white fat, the main culprit in weight gain. Brown fat can break down the lipids stored in white fat, converting them to heat. Kuang found that a key cell-signaling pathway contributes to the development of white fat and suppresses the formation of brown fat in the human body. Together, these findings offer promising new targets for treating obesity and Type 2 diabetes.

“We now have a whole new means of understanding how fat is controlled at the molecular level,” he says. “We’re continuing to investigate how we can make more brown fat and how we can turn muscle or white fat into brown fat. This is potentially a powerful anti-obesity tool.”

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WEB EXTRA
Now that the poultry industry is beginning to use cages that allow hens to move about and act more naturally, Purdue University researcher Maja Makagon says it should know how to make those enriched living quarters work in the interests of the birds, the producers and the watchful public.

“We are moving toward these enriched colony systems,” Makagon says. “This is a time to stimulate further research into how they should be built.”

Makagon, an assistant professor of animal sciences, is leading one of 19 projects funded through a Purdue College of Agriculture initiative called AgSEED, short for Agricultural Science and Extension for Economic Development. The Indiana Legislature in 2013 funded AgSEED through the state’s Crossroads program as part of Indiana’s commitment to agriculture and rural development. Additional projects will be funded in early 2015.

The 19 projects that received 2013 funding were among 95 proposals submitted by faculty and staff in the colleges of Agriculture, Health and Human Sciences, and Veterinary Medicine. Funding was capped at $50,000 for one-year projects and $75,000 for two-year projects.

More Space, Furnishings Not the Only Answer

Makagon’s one-year project was prompted by recent moves on the state and federal levels for cages that provide more space for laying hens as well as furnishings, such as perches, nest boxes and scratch pads, and consumers’ growing interest in how their food is produced.

Makagon notes that while the larger cages allow hens to perform more of their natural behaviors such as roosting, other problems may persist and new issues arise from them. For example, a perch allows hens to roost, which can strengthen bones. But roosting can lead to deformity of the keel (an extension of the sternum), skeletal fractures and damage to footpads.

The research has four objectives:
• Evaluate the effect of novel perch material such as Astroturf, cork, soft wood and metal on behavior, skeletal integrity, foot health and productivity.
• Assess the hens’ preferences for such types of perches.
• Determine how perching materials affect the spread of northern fowl mites, the most common laying hen parasite. The mites can reduce egg production, lessen the quality of eggs and lower body weight.
Enriched colony cages provide hens with more space than traditional battery cages. These cages give hens room to roost on perches, but this behavior may also cause deformities. Purdue researchers are working to develop a perch that promotes hen health. They are testing perches (above) made of Astroturf, cork and soft wood and then comparing the results to the metal perches often used in enriched colony cages.

- Evaluate how the materials affect oils such as lavender, garlic and thyme that might be used to eradicate mites.

Makagon says the project could lead to larger grants, such as from the federal government, for further research into each of those areas.

“This truly is a ‘seed’ project,” she says.

The long-term goal is to develop a perch that is cost-effective and easy to use and promotes hen well-being and biosecurity.

**Industry, Government Respond to Need**

Industry sees the importance of the research and has responded. In addition to the state funding, Creighton Brothers farm in Atwood, Indiana, donated the pullets used in the project, and Syngenta Crop Protection, a member of Purdue’s Industrial Affiliates Program, contributed funds to support parts of the research dealing with control of mites.

Research team members include Patricia (Scotti) Hester, professor of animal sciences; Giuseppe Vezzoli, animal sciences research assistant; and Grzegorz Buczkowski, entomology research associate professor.

Other AgSEED projects underway are working to:

- Develop a sanitizing treatment to improve the safety and quality of Indiana cantaloupe.
- Quantify the effects, both positive and negative, of neonicotinoids (insecticides)—toxic to honeybees and other insects—in and around no-till, cover-cropped agricultural fields.
- Create a mobile app to help livestock producers comply with new state regulations by enabling them to quickly locate setbacks in relation to a field being evaluated for fertilizer application or temporary storage of manure.

Jay Akridge, Glenn W. Sample Dean of Purdue Agriculture, says the AgSEED initiative “will help Indiana better position itself not only for economic growth and jobs in our food and agricultural industries, but for a world that will demand adequate nutrition and energy for 9 billion people by 2050.”

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Purdue Agriculture means Smarter Agriculture™, and the Purdue Plant Sciences Research and Education Pipeline proves it.

In September 2013, Purdue President Mitch Daniels announced the university would commit more than $20 million to establish the pipeline, which enhances plant research throughout the College of Agriculture.

“Feeding a world population expected to grow to more than 9 billion people by 2050 is a grand challenge,” Daniels says. “The plant sciences pipeline positions Purdue to face that challenge head-on by identifying better-yielding crops and high-tech crop-management solutions, while also preparing students to become industry leaders in plant sciences.”

Jian-Kang Zhu, distinguished professor of plant biology and member of the National Academy of Sciences, is excited about the possibilities.

Zhu, who studies how crops perform in adverse conditions on genetic and epigenetic levels, says initiatives like this one are vital. “Investing in the plant sciences is critical for the future of our planet,” he says. “The university has traditionally been strong in this area, and this investment shows we want to strive to be better.”

The pipeline is a four-fold effort to expand research capacity in plant biology, transform plants to improve crops, automate large-scale plant analysis, and commercialize products and graduate leaders—all with the goals to feed the hungry and keep farms sustainable for the future.

Purdue Agriculture researchers have opportunities to collaborate on projects with researchers from other Purdue colleges, such as engineering, technology and science.

Expand Research Capacity in Plant Biology

A new Center for Molecular Agriculture is part of the pipeline’s research mission. Directed by Bob Pruitt, professor of botany and plant pathology, the center will be home to 10 new faculty members, as well as current Purdue faculty, who will study basic plant biology.

“Our goal is to strengthen research and education in basic plant sciences in an innovative, unique and highly collaborative environment,” Pruitt says. “We want to give faculty and students every opportunity to achieve their professional objectives and significantly advance fundamental understanding of the plant sciences.”

Center researchers will study the molecular mechanisms of plant growth, development and function. They will look at how the interaction between genomes and environments determines physical plant characteristics, or phenotypes.
The center is located in Lilly Hall. Recruitment and hiring are underway for the first five new faculty positions. The remaining five positions will be advertised in 2015.

**Improving Crops**

The second aspect of the effort is to redesign plants for crop improvement. Improving crops will require top-notch facilities that equip researchers with the latest technologies they need to identify valuable plant genes.

A new plant genome editing facility will provide this technology.

Genes of potential value identified in crop and non-crop model systems will be modified in the facility using genome-editing technologies, such as CRISPR/Cas and TALENs.

Mitch Tuinstra, professor of plant breeding and genetics and scientific director for the pipeline, says researchers will use these variants to assess the gene function and potential impacts on plant performance.

“When we think of biotechnology, we usually think about genetically modified organisms that contain genes from other species that benefit the crop plant. Some examples include herbicide tolerance and insect resistance characteristics,” he says. “New genome editing technologies allow scientists to precisely rewrite or edit existing genes in crop plants.

“The development of a new genome editing facility at Purdue will enable students and faculty to conduct this type of cutting-edge research. This will contribute to the discovery of new genes and new gene functions.”

**Automated Plant Analysis**

Another key investment is the Automated Field Phenotyping facility, slated to open spring 2016 at Purdue’s Agronomy Center for Research and Education, or ACRE.

Phenotyping is the study of plant characteristics. The new facility will be a hub for researchers to collect massive plant-characteristic data sets. They will be able to monitor crops in the fields on an individual plant level using state-of-the-art sensors and unmanned aerial vehicles. Plants can also be moved from the fields into the facility for further analysis.

The facility will be connected to Purdue’s high-performance computing cluster by fiber optics. Faculty and students will be able to transfer data from ACRE to the cluster for data analysis and then to their labs for study. The results will help them understand the technologies and genotypes that are performing the best and under what conditions.

Karen Plaut, senior associate dean for research and faculty affairs and plant sciences pipeline coordinator, says the new facility will be a high-tech, data-collection point that will allow researchers to learn more about plants than ever before.

“We will not only be able to identify crop problems, but also pick out crops with genetic and phenotypic profiles that indicate they will increase yield under a variety of conditions,” Plaut says.

“Part of the pipeline mission involves developing new sensors, identifying crop management strategies and testing existing technologies to help producers decide what might work best on their farms.”

**New Products and Leaders**

Additionally, researchers at the phenotyping facility will test existing sensors and UAVs, and develop and commercialize new ones. The aim is to provide producers with the very best tools they need to produce high-yielding crops efficiently.

But high-tech research and product commercialization aren’t Purdue’s only missions for the plant sciences initiative. Preparing students for careers in plant sciences also is a major goal.

“Our students are the future of agriculture,” says Marcos Fernandez, assistant dean and director of academic programs. “We want to prepare them to be the researchers and industry leaders of the future and to play a major role in finding the solutions to feed a hungry world.”

Students will benefit from research opportunities and laboratory and classroom spaces for hands-on, collaborative work with each other and with faculty. Two student-teaching labs are being renovated to double seating capacity and provide collaborative workspaces.

Plaut says Purdue Agriculture’s record of research and education in the plant sciences has created a firm foundation upon which to build. “The Plant Sciences Research and Education Pipeline will move us forward and take us to a new level that will benefit consumers, farmers and researchers—at home and around the globe.”

Purdue Agriculture is Smarter Agriculture™, and it’s only getting smarter.

Contact Jennifer Stewart at jsstewar@purdue.edu
Researcher’s Path Started on a Small Farm in China

Cold weather and drought. Salty soils. Backbreaking labor. Hungry people. Jian-Kang Zhu experienced all of these things while growing up in a farming village in central China where people struggled to grow a wide range of crops, including rice, wheat, soybeans, corn, sweet potatoes, sesame and a variety of vegetables.

Helping Plants Cope

Those struggles are what drive his life’s work to this day.

Zhu, a Purdue University professor in the departments of Horticulture and Landscape Architecture and Biochemistry, studies how plants cope with poor environments to improve crops and alleviate hunger. It’s a huge challenge, but one he refuses to back down from.

“I want to make breakthroughs in plant biology,” Zhu says. “I have this root in agriculture, so I want to see some of my work applied to agriculture. I want to do research that could eventually improve crops to better resist drought and other stresses, and help my parents and other farmers.”

That’s exactly what he’s doing. Part of Zhu’s research is in an area called epigenetics. Studying epigenetics means looking at the chemical reactions that switch parts of a plant genome off and on at strategic times and locations.

He also studies a plant hormone called abscisic acid, or ABA, that is produced when plants experience drought. One of the things ABA does is to tell plants to grow deeper roots during drought. Putting more energy into deeper roots can prolong plant life in dry conditions. By understanding this mechanism, Zhu’s work could lead to more drought-resistant crops.

Some of his other studies have led to discoveries that include new pathways for plants to tolerate high-salinity soils and drought, and he was the first to identify the most important plant genes for salt stress.

Sticking To It Pays Off

These discoveries have been anything but quick—some have taken more than 20 years—and real-world application also doesn’t happen overnight. But Zhu says it’s worth the wait.

“That’s the nature of research because you are working with unknowns,” he says. “You might start with a hypothesis, but often you’re proven wrong. With enough patience and persistence, truth will be found, and that’s so for any scientific and innovative research.”

His persistence is paying off. Zhu’s game-changing discoveries in plant genetics and epigenetics earned him a spot in the National Academy of Sciences, and he is one of the most-cited researchers in the world.

Focusing on the Future

“It’s gratifying to see our work recognized by others, especially because when I was growing up, my dream was to have a job where I could feed and clothe myself,” Zhu says. “But that’s not the end of it. That’s past work. We have to focus on our current and future work. I want to stay at the forefront. I want to do better.

“The challenge is that we only have so much land. We need to increase yield with less inputs, and we need to reduce the impact of stress so that yields can be stable,” he says. “That means we need to learn more about plants. We need to find the genes that make plants more resistant to stress and that use fertilizer more efficiently.”

As for Zhu’s family, they’re still farming in his home village in China. His parents aren’t able to do as much anymore, so his sister has taken over. Zhu visits his family each year. He helps on the farm and reminds himself why his research is so important.
The aroma of fresh-brewing morning joe wafts over a group of 15 men and women at Flavors coffee shop in downtown Frankfort, Indiana. It’s early—before their own businesses open for the day.

These members of the Frankfort Small Business Network represent a wide range of fields. They are entrepreneurs in IT consulting, Web design, painting, insurance and real estate. They own or operate a hardware store, a mobile home community and a fireworks company with connections in China. One heads a nonprofit organization.

While their businesses are diverse, everyone in the group shares an interest in local community development. They want not only their own businesses to thrive, but to strengthen Clinton County as well.

Purdue Extension is giving them hands-on support. Melinda Grismer, county Extension director and community development educator, facilitates these monthly networking gatherings. And in her opening remarks, Grismer announces the addition of PowerUp!, a series of lunch-hour, mini-workshops with guest speakers on a variety of professional development topics such as accounting, marketing and social media. Grismer partners with the local chamber of commerce and Main Street Frankfort to serve the business community.

Purdue Extension’s involvement in community development initiatives like this one helps individuals, businesses and communities acquire the knowledge and skills to make sound decisions on how best to move forward. Stage 0 (sole proprietors), stage 1 (2–9 employees) and stage 2 companies (10–99 employees) predominate in Indiana but are often overlooked as economic drivers, says Lionel “Bo” Beaulieu, director of the Purdue Center for Regional Development and leader of Purdue Extension’s Community Development program. “We’re less involved in
attracting new businesses to Indiana and more involved in helping those businesses that are already embedded in Indiana's communities," he says. "Also, we want to inform policymakers of the important contribution that entrepreneurs, start-up companies and small businesses make to our local and state economies.

“We try to create a community environment that helps these companies thrive,” Beaulieu says. Purdue Extension is ramping up its capability, putting five regional community development Extension educators in place and strengthening the synergy between Extension and the PCRD.

“With these additional investments, we’re probably one to two years away from being one of the premier programs in the country,” he says. Community Catalyst

“I think about the implications of networking groups like this popping up all over the state under the community development wing of Extension,” Grismer says. "We have the unique position of ‘community convener and catalyst’ in our counties or municipalities. That’s a great position from which to forge lasting
relationships and move community projects forward."

The Frankfort Small Business Network is free to small business owners and operators, franchisees and potential entrepreneurs. Member Robert Lane opened Northwest Travel in 1979 and since then, has seen the other three travel agencies with Frankfort storefronts close. "I'm a believer in networking and have been for 30 years," Lane says, and he appreciates that his county Extension office backs him up. "To have the power of Purdue University behind you and what Melinda brings to the table is so important to our group," he says. "We really need her resources."

Those resources are directed at the members’ shared need for professional development, community information and connecting.

"It gets us all on a level playing field," says Grant Gangwer, service manager at Del Real Automotive Group in Frankfort. "It gives us a safe environment in which to approach each other and talk business. We're here for the common goal of improving our community and the business landscape." The 30-year-old, born and raised in Clinton County, believes a stronger economy will allow his family to stay there.

Grismer provides printed referral sheets to help the network generate business among its members. The meetings thus far have resulted in more than 100 referrals. "You build camaraderie and trust with people and give a referral to someone you trust," Lane says. "We could go to our networking meeting once a month, drink coffee and sing Kumbaya, but I want to be able to learn something or meet someone new."

At each meeting, networkers introduce their market niche and make their “ask” for the month. An ask can be as simple as trying frozen yogurt, considering the value of life insurance, supporting the county fair or volunteering for a fundraiser. Grismer’s ask: Bring another small business owner to the next meeting.

Entrepreneurial Frenzy

In Vigo County, innovation and entrepreneurship are put to the ultimate test at Startup Weekend Wabash Valley. Purdue Extension partners with the West Central Indiana Small Business Development Center to offer the competition for people with an idea for a new small business.

In a Friday evening “pitchfire,” 15 to 20 contestants have a minute to pitch their idea for an innovative product or service. “Ideas are all over the board," says Heather Strohm, Community Development Regional Educator with Purdue Extension’s Southwest District and former Wabash Valley regional director with the West Central ISBDC. Audience members vote for the pitch they think has exceptional promise.

Six to eight teams form around the top ideas. "We encourage people who aren’t going forward with their own idea to join a team," explains Richard Pittelkow, business advisor with the West Central ISBDC and a coach at the two Startup Weekends held so far. "They will learn an awful lot about what it takes to start a business."

A business-creation frenzy follows. Teams work all day Saturday, with only occasional breaks to eat or listen to short talks. Pittelkow and his fellow coaches, who include business owners, university faculty and Extension educators, circulate among the teams, offering both encouragement and specific assistance in such areas as budgeting, marketing and website development.

"There are so many lessons, tips and experiences someone can garner in 72 hours," says Shelley Klingerman, executive director of Downtown Terre Haute, Inc., which promotes the event, and co-founder of Tech Haute, which is involved in its planning and execution. Klingerman has helped as a planner, coach and speaker. "It’s an incredible experience for a student, entrepreneur or anyone looking to learn and add to their skill set," she says.

And they apply those skills quickly. "Some teams start on Friday and by Sunday noon have impressive websites," Pittelkow says. Other teams validate their business ideas by conducting surveys at a nearby mall. On Sunday, they work uninterrupted from morning to mid-afternoon, before wrapping up their product or prototype and preparing a five-minute presentation. A panel of judges listens to each team’s presentation and selects a top team. Winners receive products and services to support the development of their business.

Small companies are predominant in Indiana but are often overlooked as economic drivers, says Lionel “Bo” Beaulieu. Purdue Extension is committed to helping businesses already embedded in communities thrive.
The 2013 winner was a product—Beach Ez 360, a circular blanket weighted to stay in place at a windy pool or beach. The 2014 winner, eFactory Solutions, was technology-oriented.

eFactory Solutions’ founder, software development consultant Brian Lakstins, participated in both Startup Weekends Wabash Valley, as a team member just willing to help in February 2013 and to pitch his own idea in January 2014. The second year was far more nerve-wracking, he says. He struggled to make his idea—helping small businesses with technology and, through a central portal, providing access to other useful services—understandable to the audience.

“I wrote down every single word in my one-minute pitch. I revised it to be less technical, practiced it in front of my wife and then just read it,” he says wryly. “It was a pretty dead presentation. I had a good number of votes, but nobody came over to join my team.” Lakstins almost gave up until one of the organizers offered to help him. Then, a few other team members came on board, and together they went to work on eFactory Solutions.

The Sunday night presentations are everyone’s favorite part of the weekend. “It’s surprising to see how much can be accomplished when you’re working intensively over a three-day period,” Pittelkow says. “They start with bare bones ideas on Friday, and it’s really fun to see the flesh they’ve put on the bones.”

Lakstins says his Sunday night presentation was far better than his over-rehearsed pitch. “He has spent much of the time since developing his company. He has some customers and is working on the platform that will expand his services to them. And he plans to pay it forward at the next Startup Weekend as a coach and mentor.

“Purdue is critical to the success of Startup Weekend because it offers resources such as data reports and expertise in specific fields,” Strohm notes. “If someone is interested in community leadership or economic development, Purdue has a lot of resources available through its county Extension offices, including people able to assist them.”

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agriculture.purdue.edu/Winter2015
Bio Building Blocks

Students Create “Genetic Machines” in Global Effort to Solve Problems

By Olivia Maddox

When Jenna Rickus interviewed for a position on Purdue’s agricultural and biological engineering faculty in 2002, she was mulling over ideas for some type of student competition—a sort of Rube Goldberg Machine Contest for biological engineers.

About the same time, the foundation for a competition such as Rickus envisioned was being laid at Massachusetts Institute of Technology, where students in an independent activities course designed biological systems to link cells. The class morphed into a summer matchup among five teams in 2004 and became known as the International Genetic Engineering Machine competition, or iGEM for short.

“I learned about iGEM at a science meeting, and my reaction was, ‘Let’s do it!’” Rickus wasted no time setting it in motion at Purdue. She posted a callout for students interested in a new biological and genetic engineering club. Only two showed up—but they were intrigued enough to recruit some friends. Rickus approached Kari Clase, coordinator of the College of Technology’s biotechnology program, to serve as co-advisor, and Purdue fielded its first team in 2006 with seven students. Since then more than 80 students have participated, many landing prestigious fellowships for graduate school.

Think Legos

In the competition, or jamboree, teams receive a kit of standardized biological parts—called BioBricks—that they supplement with other parts of their own design. They assemble the parts into genetic machines that operate in living cells, using engineering design principles to solve a problem.

Clase likens this process to kids playing with Lego bricks. “They have a basic starter kit, then they add to it based on their interests or share pieces with their friends,” she says. “DNA parts are like Legos; you use them to build a device.”

Parts from different Lego sets are interchangeable. After something is built, the bricks can be disassembled and used to make other objects. The same is true for synthetic biology or genetic engineering. “You have to be able to share the parts, so they must work for everyone,” Rickus says. “Without these standards, the science wouldn’t work. DNA BioBricks have to be able to talk to each other.”
And, just like Legos, the ability to reuse the parts to build something else moves the science forward. All knowledge and physical creations become part of the iGEM bank to broaden the science, Rickus explains. “Teams have to create a Wiki page that is open to the public so they don’t hoard information,” she says. The technology is globally owned, with students as key contributors.

An emphasis on human practices requires students to also look at how ethics and the science affect society. They must also follow strict guidelines, and projects are under tight regulatory control.

Playing to Purdue Strengths

When the Boilermakers hopped on board, around 50 schools were competing in the jamboree. In 2014, more than 250 teams from around the world participated at either the regional or international level.

Purdue junior Chris Thompson was an iGEM veteran by the time he arrived on campus. His Greenfield Central (Indiana) High School team won the inaugural high school division in 2010. As president of the executive board, he’s driven the team’s activities since January. Members log hundreds of hours of work over an 11-month schedule. Funded by the club, several team members work through the summer, when lab work begins in earnest. Others stay and work gratis, just for the experience.

This year, the team tackled the problem of global malnutrition. Like this one, most projects are ag-related. “We try to play to Purdue strengths,” says Thompson, a biological engineering major.

The students engineered a microbe, *Bacillus subtilis*, with natural genes from corn to increase plants’ ability to uptake nutrients from the soil. The project—dubbed Minecrobe—combines the power of microbes in soil with a “virtual Legos” Minecraft video game twist. The microbe released phytosiderophores, amino acids excreted by the roots of some crops, to shuttle iron from the soil into plant roots.

“Essentially we’re optimizing bacteria that naturally live around plants to help them take in more nutrients from the soil,” Thompson says. “When this happens, plants’ nutritional value increases, ultimately leading to more nourished plants in the global food chain.”

To date, the students have only conducted their work in well-contained, lab conditions, Rickus says. To learn and consider how this type of future technology could impact people and the environment if implemented in fields, students spoke with key constituents, experts and regulatory agencies, including ag industry leaders, farmers, consumers and the Environmental Protection Agency. Students then had to justify
their technical approach when presenting at the jamboree. Through this process, iGEM strives to instill a new type of innovation model for the next generation of biological engineers in which safety, ethics, environmental protection and public discourse are integrated into the design process up front.

Team members are Mark Aronson, Betsy Benner, Sriram Boppana, Jacob Carmen, Michael Drakopolis, Hailey Edmondson, Ethan Eppele, Charlotte Hoo, Deborah Lee, Arren Liu, Casey Martin, Nidhi Menon, Peter Mercado-Reyes, Joe Muskat, Zach Oberhaus, Joshua Saliutama, Tony Tan, Chris Thompson, Swetha Vinjimoor, Ryan Wagner and James Welch.

**Honing in on Careers**

“Participating in iGEM gives you the opportunity to do research in an up-and-coming field,” says Charlotte Hoo, a junior in biomedical engineering. “I want to make a difference and leave a legacy. It’s a chance to do something great and lasting. We’re at the forefront of all these young minds coming together to do something big,” she says.

And students are also doing something big for themselves. The experience can reinforce a current career choice or lead a student in a different direction. “It helps you realize what you want to do or don’t want to do,” says Thompson, who discovered a passion for entrepreneurship and hopes to start a company after graduation. For Hoo, the experience opened new avenues in computer science, such as standardized databases for medical software.

Former teammates and Purdue alumni Sean Kearney ’13 and Max Showalter ’14 say the projects reinforced their commitment to research. Kearney is enrolled in a Ph.D. program in biological engineering at MIT. Showalter is pursuing dual Ph.D.s. in biological oceanography and astrobiology at the University of Washington.

Kearney, a Carmel, Indiana, native, selected Purdue for engineering. “I was trying to determine which engineering field was the right fit for me when I discovered that Dr. Rickus was offering a course called Synthetic Life. “I contacted her, and we talked about engineered biology and the consequences of that,” he says. “I fell in love with the idea of learning how biology works by engineering machines.”

What separates iGEM from other undergraduate research experiences, Kearney says, is that experiments are designed completely by students. “It’s a huge intellectual contribution as opposed to working on someone else’s prescribed project,” he says. “It all comes from you. You have to be willing to mess up and to try things you likely have never thought about. You have to be willing to fall into the deep end and try to climb back out.”

A recipient of a National Science Foundation fellowship for graduate school, Kearney was drawn to MIT, which he describes as the “hub” for synthetic biology. He says iGEM made the transition to graduate school easier. “It helped me learn the skills I didn’t have,” he says. “I wanted to focus on mathematical modeling. By the time I graduated I had learned what it took to do. As a result, my first-year graduate courses were easy. I had the experience to design experiments.”

Showalter was in a situation similar to Kearney’s. The St. Louis, Missouri, native also picked Purdue for its strong engineering program, thinking he would major in aeronautical engineering, but finding it wasn’t the right fit. He was casting around when Kearney—a year ahead of him—gave an iGEM presentation in one of his classes. Showalter was hooked. He changed his major to biological engineering and joined the team.

Showalter says embarking on a student-driven project can be a daunting task, but the same circumstance makes it exciting. “iGEM projects take a lot of planning—not everything is as glamourous as the lab work. But it’s worth it; you learn so much. It’s a big commitment, but a big payoff, too.”

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Getting a financial house in order

Melissa and Tim Ivey of Huntington, Indiana, felt the excitement of any couple building a new house. But the Ivey family had some additional responsibilities beyond picking out paint colors.

Their home was built through Huntington County Habitat for Humanity, a Christian ministry that constructs affordable housing using volunteer labor. In addition to putting in sweat equity, the Iveys had to complete home education courses. Two required classes—including Where Does Your Money Go?—are taught by Karen Hinshaw, a Purdue Extension educator in Huntington County.

“I went into the class with a mindset of ‘I know about finances,’” says Melissa, a financial operations manager for a credit union. “The class really opened my eyes, not just to finances, but other everyday things.”

Going through class exercises in creating a spending plan and budget helped Melissa and Tim, a para-professional at a local elementary school, identify areas where the family could improve. For example, with their busy schedules, the family of six often relied on takeout meals on the go. “You may not think it’s that much week by week, but when you figure it out for a year, the amount is a huge shock,” Melissa says.

One of the things Melissa found most helpful about the class was goal-setting. Hinshaw had each person make a goal for the following week’s class. She helped Melissa make home life less stressful, such as by having the children do household chores and using the slow-cooker for nights when Adin has ballgames. “It changed how we do things at home,” Melissa says.

Hinshaw says that, like the Iveys, most participants find ideas that they can try immediately. Tracking expenses and developing a spending plan help people see where their money goes and find ways to better manage their finances. “People don’t realize that the coffee or lunch they spend a few dollars on a couple of times a week can add up to a substantial amount of money,” she says. “The savings could help them meet a financial goal if they made just a few adjustments in their spending.”

The Iveys now work together more as a family and eat out about 50 percent less. Melissa also gave up one of her favorite routines—stopping at McDonald’s for morning coffee. They continue to use the financial tools they learned as new homeowners.

“This program has something to benefit everyone,” Melissa says. “In my line of work I see people struggling with money every day. I’ve referred some clients and a coworker to the class.”
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In recognition of the centennial of the Smith-Lever Act of 1914, which created the national Extension system, Spotlights is highlighting some of the many ways Purdue Extension serves the residents of Indiana. See pages 2 through 5.