

IOWA STATE UNIVERSITY
OF SCIENCE AND TECHNOLOGY

FY16 Board of Regents, State of Iowa,
Annual Economic Development and
Technology Transfer Report

PRESENTED BY
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DEVELOPMENT AND BUSINESS ENGAGEMENT,
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Economic development is a top priority for Iowa State University. Indeed, it is a **prominent goal in the university's strategic plan**, and the university is very proud of the tremendous impact it has on the state economy. **In 2016 Iowa State received the prestigious designation as an *Innovation and Economic Prosperity University* by the Association of Public and Land Grant Universities (APLU)**, the first university in Iowa to receive this recognition. As the APLU states, "The designation acknowledges universities working with public and private sector partners in their states and regions to support economic development through a variety of activities, including innovation and entrepreneurship, technology transfer, talent and workforce development, and community development."

The Office of Economic Development and Industry Relations (EDIR), which moved into the new **Economic Development Core Facility** in the ISU Research Park in June 2016, consists of the following key university economic development units that provide integrated and comprehensive business, technical, entrepreneurial support, and educational services to Iowa State's clients and partners:

- **Center for Industrial Research and Service** works with business and industry to enhance their performance through service offerings in four general areas: technology, growth, productivity, and enterprise leadership.
- The **Small Business Development Center**, administered by Iowa State, consists of 15 regional centers serving all 99 counties in Iowa. SBDC assists individuals interested in starting new companies and provides business services and counsel to existing companies across Iowa to solve management problems, to improve operations, to seek financing, and to pursue new opportunities. Iowa State also operates a regional center.
- **Pappajohn Center for Entrepreneurship** serves entrepreneurs, provides entrepreneurial opportunities for students, hosts statewide business plan competitions, and leads university-wide academic programs in entrepreneurship, including an interdisciplinary minor in entrepreneurial studies, graduate courses, a recently-approved major in entrepreneurship for business students, and a newly-launched PhD program in entrepreneurship.
- **ISU Research Foundation** and **Office of Intellectual Property and Technology Transfer** manage, market, and license the intellectual property of ISU researchers and work with them to patent inventions and market the innovations to commercial partners.
- **ISU Research Park** provides a resource-rich environment including close proximity and easy access to Iowa State University for its tenant companies, which include start-ups and established companies that range from growing entrepreneurial ventures to global corporations. The Research Park offers high quality labs and office space, as well as numerous services and amenities that support the efforts of science- and technology-based organizations.

EDIR also serves as the gateway or portal to the university's expertise, capabilities, resources, and facilities that support and enhance economic development throughout the state. Thus, EDIR works very closely with other university units that contribute to the university's economic development efforts and impact, including the Office of the

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Vice President for Extension and Outreach, the Office of the Vice President for Research, and the academic colleges.

ISU promotes economic growth in Iowa in a number of ways. We provide business and technical assistance to existing companies, we support the creation of new companies, we help attract new companies and entrepreneurs to Iowa, we create intellectual property and help move research ideas to the market, and we contribute to workforce and entrepreneurial development.

Business and Technical Assistance

During federal FY15, which is the most recent full year for the program, the **America's SBDC Iowa**, provided business assistance to individuals and companies **in all 99 counties totaling 3,141 clients** and 13,191 counseling hours. As a result of this counseling, **322 new businesses** were started and **1,586 jobs were created**. Additionally, SBDC assistance was credited by clients with increasing their capital infusion by more than \$62.5 million and increasing their sales by more than \$62.7 million. **This translates into 4 new jobs every day, a new business every 27 hours and an increase of \$5.2 million in sales each month.**

The **ISU SBDC regional center**, in partnership with the ISU Pappajohn Center for Entrepreneurship, provided 533 hours of counseling assistance to startup and existing companies; **served 236 clients with one-on-one counseling; educated 184 attendees through workshops**; provided advice to several hundred clients via telephone and e-mail; and advised a number of technology companies in the areas of licensing, equity-based financing, market entry, and numerous operational areas. The centers **documented 45 new business starts with 144 new jobs created** that have generated **\$2,791,160 in capital infusion**.

CIRAS has been working with companies in communities across Iowa for more than 50 years and has a vision for Iowa of healthy communities through business prosperity. **Cumulatively, over the past five years, CIRAS and partners have reported impact from companies totaling over \$2 billion dollars (\$1.8 billion in sales gained or retained, \$229 million in new investments, \$73 million in costs saved or avoided) with 28,653 jobs added or retained as a result of the assistance received.**

During FY16 **1,561 businesses from 95 counties** in the state received assistance on projects or attended educational workshops from CIRAS staff or partners. Companies responding to surveys reported **\$424 million in total impact** — \$359 million in sales gained or retained, \$52 million in new investments, and \$13 million in costs saved or avoided. Company executives stated that **5,400 jobs were added or retained** as a result of the assistance they received from CIRAS and its partners. The following summarizes the results of the four primary CIRAS programs for this past year:

- The CIRAS **Procurement Technical Assistance Program (PTAP)** works with Iowa businesses, from one-person operations to some of the state's largest employers, to help them understand the government procurement process and

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to secure contracts. CIRAS is the only organization in the state of Iowa that provides contracting assistance at all three levels of the government market segmentation—local, state, and federal. Last year, CIRAS staff **counseled nearly 800 companies**, resulting in **more than \$173 million in government contract impact** as a result, in part, to this assistance. The Defense Logistics Agency, which funds CIRAS to provide assistance to Iowa companies, indicated this impact **helped create or retain 3,465 jobs**.

- In 2015, **467 small- to mid-sized manufacturers** received assistance under the **Manufacturing Extension Partnership (MEP)** program. Companies *responding to third party surveys reported nearly \$248 million in financial impact* from technical assistance and workshops on technology, growth, enterprise leadership, and productivity.
- CIRAS' **Economic Development Administration University Center Program (EDAUCP)** focuses on growing small businesses by coaching them on how to develop and commercialize innovative new products, processes, services or business models. Last year, CIRAS staff worked with **40 distinct clients on 10 different projects and events**. The program's Iowa Machinery Manufacturer's Innovation Summit held in the spring attracted 67 attendees.
- The CIRAS Technology Assistance Program (TAP) has a mission to promote assistance to Iowa companies with technical problems and advancing R&D activities. The program is composed of two segments that support Iowa businesses in unique ways: the technology assistance group (includes materials, non-destructive evaluation, and engineering) provides shorter-term technical assistance, while the research cost-sharing program helps Iowa companies access ISU's faculty and facilities for research by providing a 1:1 cash-match on research projects. In 2015, CIRAS provided **technology assistance services to 58 distinct businesses**. Companies responding to surveys reported **\$37.9 million of total economic impact** from the technology services they received.

Appendix 1 provides some illustrative examples of CIRAS, SBDC, and ISU Extension and Outreach projects with Iowa companies and entrepreneurs during the past year.

During the five year time frame FY2011-2015, more than 13,000 different companies in Iowa representing all 99 counties benefitted from CIRAS and SBDC business and technical assistance and/or education/training services.

This past year the **Community and Economic Development (CED) program within ISU Extension and Outreach helped 117 minority-owned business owners start or improve their own businesses, and assisted with the creation and the retention of 78 jobs for minority employees**. The estimated value of the jobs created/retained is \$1,830,000.

For fiscal year 2016, the **ISU Extension and Outreach Value Added Agriculture Program** conducted several business **feasibility and market analysis studies enabling Iowa business' to qualify for loans and USDA loan guarantees** through 4

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their local and/or regional banks and USDA-Rural Development. The in-depth studies examined the economic, market/marketing, technical, management, and financial aspects of the proposed business start-up or expansion. **Rural economic development feasibility and market analysis studies for ten local businesses in FY 2016 resulted in investments of \$57 million into the Iowa economy and the potential for 248 newly created jobs when completed.** The projects cover a wide variety of business sectors, from dairy processing to aquaculture production facilities and a large scale regional sports complex to rural Iowa lodging facilities. The common thread is that VAPG feasibility and market analysis projects help clients gain access to capital that strengthens rural Iowa economies.

The ISU Research Park

The ISU Research Park has been hugely successful because companies find great value in having a closer physical presence to the university as it facilitates working with faculty and graduate students on research, tapping into and recruiting the graduate and undergraduate student talent pool, and accessing university facilities. Research Park tenants include companies of all sizes and industry focus, though engineering and technology firms and bioscience firms comprise the largest proportion, reflecting the STEM strengths of the university. Tenants include companies that were incubated at the Research Park as well as established global companies. **Four of the last five Iowa companies to go public started and reside in Ames, with three getting their start at the Research Park and two are still located at the Research Park.**

Today, the Research Park is a 300-acre development just south of campus with more than 600,000 square feet of building space. **Thirteen new companies and affiliates, five university departments (one of which rejoined the park after a 17-year absence), and seventeen pre-incubator companies joined the Park in FY16, bringing the historical total to 280 companies and 4,985 employees for current and former tenants that are still in existence world-wide.** Currently, there are **74 companies and research centers and 17 pre-incubator companies, and 12 affiliates located in the Park, employing 1,709 and 179 people, respectively.**

In June 2016 the Research Park launched the **ISU StartUp Factory** to provide a stronger support system for students, faculty and staff wanting to create businesses. Entrepreneurs in the StartUp Factory receive formal training, resources, and access to a network of business mentors, advisors, counselors and investors in two 26-week blocks: the first a formal curriculum centered on business validation, and the second, customized to their individual business needs. **The inaugural cohort is comprised of eleven companies** representing a wide range of technologies, products, and services. Two cohorts are admitted each year.

Workforce Development

Of course, a key component of the university's value proposition related to economic development, and its primary mission, is providing a world class education that provides students with the technical, analytical, problem-solving, communications, and social responsibility skills required in today's workplace. Iowa State is the largest

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university in Iowa with **36,600 students**, and despite our Midwest location, our student body is quite diverse. **Nearly one in four Iowa State students is either a minority (12.6%) or international student (11.3%).** Our students represent every Iowa county, all 50 states and 125 countries. This diversity leads to a wide array of perspectives, capabilities, and ideas that enrich the learning environment. Not surprisingly, our graduates are in high demand and we have a **campus wide placement rate of almost 95%** (i.e., 95% of undergraduate students are employed in their field or are pursuing graduate education within six months of finishing their undergraduate studies).

Iowa State is well known for providing students with professional development activities on campus that provide great opportunities for companies to utilize our students' talents. We have excellent entrepreneurship programs in every college as well as "experiential learning" centers that provide opportunities for cross functional teams of students to work on business projects. **Each year more than 200 Iowa State students intern at ISU Research Park companies.** Additionally, engineering students complete a senior capstone project, and several faculty across campus integrate company projects into their courses.

During the summer of 2016, the **Pappajohn Center for Entrepreneurship** kicked off its 10-week summer accelerator program for students. **Thirteen students on eight (8) business teams** who participated in the Center's various pitch and business plan competitions throughout the year **were selected to spend the summer in a hands-on mentoring environment at the ISU Research Park to launch and grow their companies.** Students participated in educational sessions, received mentoring, and essentially interned in their own companies instead of working elsewhere during the summer. **All eight businesses have successfully launched.**

Additionally, the Pappajohn Center for Entrepreneurship **placed 19 student interns in startup companies located at the ISU Research Park,** and reported **more than 2,000 students enrolled in entrepreneurship-themed coursework** across campus. **Over 4,500 individuals participated in programs and classes focused on entrepreneurship, startups and small business.**

The CyBIZ Lab interdisciplinary student consulting program offers business solutions to companies of all sizes as well as supports faculty commercialization efforts. The improved performance resulting from these interactions allow businesses to retain and often expand their workforce. **Eighty (80) CyBIZ Lab students working part-time completed 45 consulting projects** and additionally facilitated several live case classroom projects that gave students the opportunity to work with actual businesses to solve business problems.

CyBIZ Lab has established a number of partnerships across campus that have expanded the learning opportunities for students and significantly increased the impact students have had with real businesses. **CyBIZ Lab worked with CIRAS to support five (5) companies participating in the ExportTech program; completed two (2) projects concurrently with engineering senior design cases; paired up to perform market validation research with 10 tech transfer projects that had received RIF funding** through EDIR; partnered with the Colleges of Business, Design and

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Engineering on internal curriculum and program research projects; and as part of their normal operations worked with clients that included startups, non-profit organizations, communities, college administrators, small and medium sized businesses, and large global companies. CyBIZ Lab is unique in that teams are interdisciplinary and include both undergraduate and graduate students working together; projects also have a flexible timeline outside the classroom schedule, which allows teams to be highly responsive to company needs.

Senior capstone design projects are the culmination of engineering education for undergraduate students. Iowa companies, through a partnership between CIRAS and the College of Engineering, provide students with challenging opportunities to apply their engineering knowledge to real-world applications as a final step in preparation for joining the workforce. In addition to the senior capstone design projects, engineering students have worked with companies on projects related to lean manufacturing and facility planning.

By working with the students, companies gain a new perspective on difficult engineering problems as well as the value engineers bring to an organization. As a result of the projects, many companies achieve innovative solutions that lower costs and enhance quality and productivity. This collaborative program reinforces the benefits and challenges of working in team environments. The program also allows companies to gain insights regarding students as potential future employees.

In 2015, **engineering students worked on 106 projects, 80 of them with Iowa companies. This included 41 different Iowa companies across 23 Iowa counties.** Companies responding to surveys reported **impacts of nearly \$22 million** for these projects.

ISU's **College of Engineering Community Outreach** is celebrating fifteen years of high quality STEM programming to create and deliver experiences that engage, educate and interest students of all backgrounds with a focus on creating an engineering pipeline to support workforce and economic development in Iowa and the nation. In the 2015-16 academic year, college programs engaged with business and industry partners impacting tens of thousands of individuals with over **5,000 young people participating in FIRST LEGO League and Jr. FIRST LEGO League, 386 active Project Lead The Way programs and nearly 1,000 youth engaging in engineering kids summer camps.** In addition, **approximately 20,000 students and families were impacted through hands-on events** such as the state fair, school field trips and activities, and **over 500 teachers and administrators attended ongoing training and professional development** throughout the year. The college is keeping Iowa youth inspired through STEM initiatives today to build a better Iowa for tomorrow.

CED Extension and Outreach is part of the Iowa Retail Initiative (IRI), a collaboration to create thriving rural communities. Iowa State University is leading this initiative to support Iowa's independent retailers and revitalize rural downtowns. Financed by a Strategic Initiatives Grant from ISU Extension and Outreach, IRI unites existing campus services and provides a single point of contact for rural communities and retailers seeking help. In fall 2015, **33 ISU students in the interior retail design studio class developed design concepts to enhance local retail experiences for** 7

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14 Marshalltown retailers on Main Street and within the local mall. These businesses included two ethnic grocery stores, an upholstery store and a local bike shop. In spring 2016 the Retailscapes studio worked with businesses in Jefferson. IRI hosted a summit in June 2016, at which 70 local community retailers and economic leaders showcased their communities, shared their retail and economic needs and lessons learned, and were given the opportunity to connect to IRI and other resources available from ISU and other state programs to help develop thriving communities.

In addition to professional development opportunities on campus, ISU's career services offices work closely with companies to assist them in establishing internships for our students. Internships provide students the opportunity to apply what they are learning on campus as well as the opportunity to experience firsthand the type of work environment they will be entering after completing their studies. Companies benefit from the interns' work output (many companies calculate a return on investment for their internship programs, and the returns are impressive), and they use the internship as a testing ground for prospective new employees. This past year our career services offices were able to document **2,487 ISU interns who were employed by more than 1,067 different Iowa employers located in 164 communities in 76 counties.** These numbers do not include students who found internship opportunities on their own nor do they include students who had non-internship jobs related to their field of study.

Iowa State also contributes to workforce development in the state by supporting students' learning and skill development even before they get to the university.

For example, Iowa State University's North Central STEM Hub, one of six regional hubs of the Iowa Governor's STEM Initiative, has been connecting education and business to increase student interest and ability in STEM. The North Central STEM Hub has hosted STEM festivals at the Iowa State Fair and in Marshalltown and Mason City, where families engaged in hands-on STEM activities hosted by formal and informal K-12 educators, community colleges, businesses, and economic development organizations. **The North Central STEM Hub supported more than 350 educators and 17,900 K-12 students** in the region with STEM Scale-Up programs in an effort to increase the students' interest and ability in STEM. ISU Extension and Outreach professionals play a significant role in each region through representation on each of the six Regional Advisory Boards.

4-H is the youth program of America's Cooperative Extension Service and is the nation's largest youth development organization. In Iowa, 4-H Youth Development programs are headquartered at Iowa State University and available through ISU Extension and Outreach offices in all Iowa counties. 4-H connects almost 1 in 5 Iowa K-12 students to service opportunities in Iowa communities, and to Iowa's higher learning institutions and career opportunities in the state, thus **providing incentives for young people to stay, study, and work in Iowa.** 4-H emphasizes learning by doing, or experiential learning. Iowa 4-H had **direct, educational contact with 99,538 youth in the 2014-2015 program year** (September 1 to August 31) a growth of 5 percent from the previous year. Another 21,000 youth participated in programs of a shorter duration (less than six hours of programming). This means that **Iowa 4-H touches the lives of about 20 percent of all K-12 youth in Iowa** by providing education in citizenship and leadership, communication and the arts, healthy living, and STEM. **This reach includes more than 16,000 youth of color.** 4-H teaches

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youth what they can do and what they can be, right here in Iowa – encouraging entrepreneurship and invention, and developing the state's future workforce.

Finally, several ISU units provide training and related educational activities to a wide variety of individuals, occupations, and industries across the state. **Appendix 2** provides several such examples.

Research and Technology Transfer

ISU promotes economic growth in Iowa through its research and technology transfer – conducting basic research which is at the foundation of many innovations in the marketplace, and collaborating with companies on their specific research and development initiatives to help them introduce new products and services and improved methods for creating and delivering these new offerings. We excel at developing collaborative relationships with companies so that our groundbreaking research can be put to practical use to not only improve business practices but also improve lives.

ISU had a record setting year in FY16 with **total sponsored funding of about \$426 million, including \$252 million for research**. Businesses, corporations, and commodity organizations accounted for approximately \$44 million of sponsored funding.

In FY16 ISU researchers submitted **143 disclosures of intellectual property**, and our technology transfer office **filed 49 patent applications**. Additionally, last year ISU technologies resulted in **84 license and option agreements worldwide with 45 in Iowa**. ISU currently has **153 license and option agreements yielding income. Iowa companies earned \$5.2 million revenue from ISU licensed technologies in calendar year 2015, and five startup companies based on ISU technologies were formed in Iowa**. Globally, total sales revenues from ISU licensed technologies were **\$67 million**, not including germplasm.

The **Regents Innovation Fund** program at Iowa State has a competitive research component that pairs ISU faculty members with Iowa industries (primarily new to young startups) to create economic benefit for the companies. Please see **Appendix 3** for a complete report on Regents Innovation Fund uses and results.

Assistance to Communities

Assistance to Iowa communities is the focus of many of the programs managed by ISU Extension and Outreach. Some examples of direct economic development assistance to Iowa communities are provided below.

Stronger Economies Together (SET)

Over the past year Community and Economic Development Extension and Outreach (CED) has partnered with USDA Rural Development on a national initiative to help rural communities explore regional economic advantages, and formulate economic blueprints for multicounty collaboration. The Stronger

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Economies Together (SET) program involves step-by-step coaching to guide the design and implementation of a viable regional economic development plan; in-depth demographic and socioeconomic data analyses tailored to the region; and identification of the region's comparative economic advantages. CED and USDA-RD worked in two regions: Henry, Jefferson, and Washington counties; and Lee (IA), Clark (MO), and Hancock (IL) counties. Overall, SET is in place in 70 regions in 31 states, and has helped participating rural communities leverage more than \$112 million in economic activity.

CD-DIAL Builds Decision-making Capacity

CD-DIAL (Community Development—Data, Information, and Analysis Laboratory) works with communities and organizations to build decision-making capacity as they collect and use information about their local populations. In 2015–16, CD-DIAL conducted surveys for the city of Ames (4 surveys), and county surveys on Access to Essential Services for Wapello, Cass, Cerro Gordo and O'Brien counties.

Student Involvement in Community Development

This year the Partnering Landscape and Community Enhancements (PLACE) program involved more than 165 students in outreach projects in dozens of Iowa communities, including Sheldon, Marshalltown, Jefferson, Perry and Des Moines. The ILR Community Visioning Program employed eight student interns to assist in assessments and analysis in 10 communities.

University Extension Community Development Collaborative

In 2012, Community and Economic Development Extension and Outreach (CED) established a partnership with the City of Dubuque and the University of Wisconsin and created a joint faculty position specializing in community planning and leadership. The agreement and joint appointment is one of the first of its kind in the country between two land-grant institutions. During spring 2016, the University Extension Community Development Collaborative assembled a team of ISU Extension and Outreach colleagues to begin a three-phase community engagement and development process along the Central Avenue Corridor in Dubuque. The City of Dubuque is interested in revitalizing the Central Avenue Corridor and recognizes that the businesses and residents have a number of concerns about the area. The three phases involve fact-finding civic engagement field work, design and development at the individual business level, and at the business district/corridor level. The project will help the City of Dubuque support and foster the success of businesses along the Central Avenue Corridor.

Extension Community Arts Specialist

During summer 2015 an individual was hired as an assistant professor in the department of Art and Visual Culture and as an extension community arts specialist. Her position was created under the ISU President's high-impact hires initiative, and places her in the role of using the arts to "improve the fabric" of community life in Iowa's cities and towns. Increasingly, research shows that art and the act of "making" can be powerful tools in building a community's identity, economic vitality, and quality of life. Thus far, projects have been undertaken in Sioux City, Perry, Ames, Waverly, Webster City, Hampton, Louisa County, Marion, and Jefferson.

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Regional and Local Partnerships with ISU Extension and Outreach

CED maintains partnerships and shares joint community development specialist positions with the Chamber of Commerce of Keokuk, the economic development organization of West Liberty (WE-LEAD), the development organization of Cedar County (CCEDCO), and the West Liberty Chamber of Commerce. Each local economic development position is jointly funded by ISU Extension and Outreach and a local partner; the person serves as a local development official who provides economic development education on a part-time basis.

Extension and Outreach cosponsors joint position with Iowa League of Cities

A joint educational position with the Iowa League of Cities focuses upon local government finance. In 2015–16, the Office of State and Local Government Programs trained 1,468 government officials. At the 2015 Municipal Professionals Institute and Academy, 284 city clerks, administrators, and finance officers received instruction on a variety of topics related to local government.

Refugee Community Alliance

A new joint position was created in 2016 with the Des Moines Area Refugee Community Alliance, serving as a CED specialist and as the refugee community plan coordinator for the Alliance. The goals of the collaboration are to (1) increase communication, collaboration, and coordination among service providers, and between service providers and refugee communities, and (2) increase community and private sector understanding of refugee resettlement needs and economic opportunities.

Community Sustainability Collaborative

In March 2016 the Center on Sustainable Communities (COSC) and CED partnered to form the Community Sustainability Collaborative. Since 2005 COSC has hosted more than 350 workshops, lectures, seminars, open houses, forums, and hands-on sessions pertaining to sustainability and energy conservation in construction and community planning. The partnership will bring ISU and CED expertise to the efforts to deliver green building and healthy living programming to communities across Iowa. Since forming the Collaborative, solar energy workshops have been conducted in Fairfield, Creston, and Tipton, and two bilingual building science and weatherization workshops have been held in collaboration with Habitat for Humanity.

Iowa's Living Roadways Community Visioning Program

The Community Visioning Program celebrates its twentieth anniversary in 2016. The program has helped rural communities plan transportation enhancements using state funds from the Iowa DOT. To date, 209 Iowa towns have completed the process and collaborated with design teams to create conceptual transportation enhancement plans. The program continues to make a significant impact throughout the state.

Community Design Lab

The Community Design Lab (CDL) is a partnership between the ISU College of Design and ISU Extension and Outreach that focuses on long-term, issue-driven design research with the goal of developing models that focus on sustainable

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development at various scales (building, neighborhood, city, region, etc.). In December 2015 CDL celebrated the second year of the Agricultural Urbanism Toolkit by hosting more than 100 designers, farmers, local school coordinators, chefs, and representatives from health organizations to share success stories in designing and implementing Toolkit strategies. The Toolkit uses strategies such as school gardens, farmers markets, and food hubs to promote economic development and local food-system revitalization in communities. In addition to the toolkit, CDL worked with Seed Savers of Iowa, the Healthiest Ames Initiative, the city of Des Moines (the East 30th Street Corridor Plan), and the city of Carroll Recreation Department to develop sustainable design strategies for their projects/initiatives.

Iowans Walking Assessment Logistics Kit (I-WALK)

First offered in 2010, I-WALK is a partnership with the Iowa Department of Public Health and ISU Extension and Outreach. The goal of I-WALK is to develop community coalitions and provide them with relevant local information to help them continuously update, implement, and evaluate the infrastructure and programs to support a more walkable, healthy, and safe community. In 2015-16 the program revisited four sites to evaluate the progress and provide additional assistance for the community to reach their goals. These sites included Knoxville, West Union, Bellevue, and Perry.

University Facilities and Services

Last year, we featured two university facilities in this report: the Office of Biotechnology that manages 31 facilities and service units on campus and the Veterinary Diagnostic Laboratory, the state's only public veterinary diagnostic laboratory (VDL) and only VDL accredited by the American Association of Veterinary Laboratory Diagnosticians. VDL annually processes 75,000 cases and conducts approximately 1.5 million tests.

This year we highlight the **Iowa State University BioCentury Research Farm (BCRF)**, the first-in-the-nation integrated research and demonstration facility dedicated to biomass production and processing. This one-of-a-kind facility allows the integration of the production, transportation, storage and processing of agronomic crops to end products. Researchers have access to 2,000+ acres of test ground, which includes full crop production management for high risk development and support for high intensity innovative methods. The BCRF is a collaborative university resource managed by the College of Agriculture and Life Science's Center for Crops Utilization Research. Additional funding is provided by Center for Industrial Research and Service and Office of the Executive Vice President and Provost. The BCRF closely partners with the College of Engineering and the BioEconomy Institute on research, demonstration, and commercialization.

From FY2012-2016 sixty research projects totaling nearly \$82.5 million were conducted at BCRF. One-half of these projects were industry funded and one-half were federally funded. Additionally, BCRF received 21 awards and donations totaling over \$12 million, and it completed 32 fee for service projects generating more than \$230,000. Importantly, BCRF serves as an outstanding educational facility preparing future professionals for agriculture and bioengineering careers as 17 professors from eight (8) departments trained 181 undergraduate students, 28 graduate students and three (3) post-docs.

An excellent example of the university-industry collaborations that take place at the BCRF is the **research partnership between Iowa State and Argo Genesis**

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Chemical, a subsidiary of Seneca Petroleum. Together ISU and Argo Genesis developed a process that converts soybean oil into thermoplastics, the soft, rubbery polymers that can be melted and re-formed over and over again. **Argo Genesis funded, and in 2015 donated to the university, the Bio-Polymer Processing Facility, a \$5.3 million industrial-scale pilot plant** that can make about 1,000 pounds of bio-polymers per day. The plant contains two main processes, one to turn soybean oil into a monomer, and the second part to turn that monomer into a polymer. The polymer can then be used in asphalt, adhesives, coatings, and packaging. **Argo Genesis and their affiliated companies have optioned or licensed three technologies and filed 47 patent applications (3 US, 47 foreign) as part of this partnership.**

Major Economic Development Collaborations

Iowa State University takes great pride and pleasure in its collaborations with both private and public sector partners. These collaborations are essential to achieving the university's and the state's economic development goals. The first four sections below identify new collaborations begun or formalized this past year. The remaining sections describe on-going significant state and regional collaborations.

SBDC Partnering to Promote and Support Women Entrepreneurs

Initiatives and resources for women entrepreneurs was a focus of America's SBDC Iowa during the past year, as it partnered with approximately 30 other service providers to create the Women's Entrepreneur Council. This group has met quarterly to gather and disseminate information regarding the resources and services available to women entrepreneurs in the state of Iowa. All participating service providers are committed to this collaborative effort that will better utilize existing programs and avoid duplicating efforts to improve support and service to women entrepreneurs. Due to the work of this group, America's SBDC Iowa has also been working with the Secretary of State's office to establish a definition of women-owned businesses and to better track the number of women-owned businesses in the state. America's SBDC Iowa has also worked with the Lieutenant Governor's office to hold roundtables for women business owners in Iowa. The roundtables provided women business owners the opportunity to showcase their businesses as well as to discuss with the Lieutenant Governor the obstacles to running a small business in Iowa.

SBDC and Google Team Up

America's SBDC Iowa is partnering with Google to present "Let's Put Our Cities on the Map" workshops. The workshops help businesses improve their information where customers search for them the most – Google Search and Maps. Google has found that "businesses that have complete business information online are twice as likely to be considered by reputable customers." The partnership with Google allows the SBDC to provide additional services to small businesses in Iowa, and Google helps promote the SBDC to small businesses in Iowa. A total of 17 workshops have been held thus far, with another 19 scheduled. Interest in these workshops continues to expand.

CIRAS Metal Additive Manufacturing (AM) Partnership

Through a partnership, CIRAS was able to bring a metal additive manufacturing system to Iowa State University. It represents a \$900,000 investment made with funds from CIRAS, Iowa State University's College of Engineering, the Iowa Economic Development Authority, and the federal NIST Manufacturing Extension Partnership. The system will be used to help Iowa's industry to understand how to

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utilize this emerging technology to gain competitive advantages and provide student access to the technology.

CED, SBDC and the Iowa Black Business Coalition Inaugural Event

Community and Economic Development, America's SBDC Iowa and the Iowa Black Business Coalition collaborated in November 2015 to bring together lawyers, professors, and award winning entrepreneurial leaders to share their knowledge about business and entrepreneurialism with African American business owners. The Untraditional Start a Thon was a one day workshop to increase entrepreneurship among African Americans using a culturally relevant framework. Despite inclement weather and a last minute venue change, 16 business owners were able to participate in this inaugural event.

Iowa State University and University of Northern Iowa Collaboration on Technology Transfer Services

Iowa State University and the University of Northern Iowa (UNI) continue to partner in technology transfer. The partnership allows UNI to access Iowa State resources for technology transfer. UNI has the option to manage the protection and commercialization of their innovations, or they can opt to have the ISU Research Foundation provide these services. Iowa State is not charging a fee for this service, but sharing in any income that is generated from the UNI innovations.

ISU Partnership with the City of Cedar Rapids

In 2015 the university formed a partnership with the City of Cedar Rapids and established a jointly funded Iowa State agricultural bio-based industries research and extension liaison position. The liaison has an office in Cedar Rapids, and works closely with the city's processing industries to identify opportunities for collaborating with Iowa State scientists, engineers, economic development, and extension specialists. The nature and scope of future collaborations are still emerging, but will likely include: research and development on more environmentally friendly processing technologies; adding value to processing waste streams through coproducts and byproducts; development of innovative products — such as biorenewable fuels and biobased products — from agricultural raw materials; exploring new directions for food ingredients that boost health and wellness; and facilitating training opportunities to enhance the skills and capabilities of Cedar Rapids industry employees.

ISU Partnership with Cultivation Corridor

Iowa State University serves on the Board of Directors of the Cultivation Corridor, a regional economic development initiative to attract ag-bioscience firms to Iowa that was launched in April 2014. Other board members include Iowa Economic Development Authority, leading Iowa companies in the ag-bioscience industry, and Iowa commodity groups. ISU also serves on the Advisory Cabinet of the Executive Director of the Cultivation Corridor. ISU's Office of Economic Development and Industry Relations works closely with the Cultivation Corridor, providing university expertise and services to support the Corridor's efforts.

State-wide Committees, Councils, and Task Forces

Many representatives from ISU serve on committees that promote economic development programs, such as the Iowa Innovation Council, the Iowa Innovation Corporation, the Biosciences Alliance of Iowa, Iowa Meat Processors Association, Association of Business and Industry Advisory Council, Institute of Food Technologists-Iowa Section, the Iowa Lean Consortium, Professional Developers of

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Iowa, the Iowa Business Council, Innovate Iowa!, Technology Association of Iowa, Capital Crossroads, IA Sourcelink and the Cultivation Corridor.

Midwest Grape and Wine Industry Institute

The Midwest Grape and Wine Industry Institute, supported by ISU Extension and Outreach, was formed in 2006 by the Iowa Board of Regents as a result of the state's evolving grape and wine industry. The goals of the MWGWII are to:

- o conduct research to evaluate cold-hardy grape varieties that can thrive in the Midwest;
- o conduct enology research and develop vinification techniques;
- o develop a wine quality award program that will provide wine buyers with a quality-assurance stamp of approval;
- o establish an outreach program to the industry by offering training opportunities to cellar workers and winemakers;
- o partner with community colleges to develop job training programs specific to growing grapes and making wine.

As of July 2016, Iowa has 104 native wineries producing approximately 333,737 gallons of wine per year, and 300 commercial vineyards covering 1,000 acres of grapes. The grape and wine industry in Iowa continues to grow. According to a 2012 study by Frank, Rimmerman + CO. LLP, the economic impact of the Iowa wine and grape industry on the state's economy is \$420 million.

Future Plans

Iowa State University greatly appreciates the resources and support that it receives from the Board of Regents and the legislature to carry out its economic development initiatives and activities. The primary purpose of this report is to show the huge economic and quality of life impacts we have been able to achieve for the state with the resources entrusted to us. The following sections identify how we plan to use additional resources to enhance the impact of university technology transfer and service on the creation of jobs and wealth in Iowa.

Small Business Development Centers. By helping its clients improve and grow their businesses the SBDC generates new tax dollars for the Iowa treasury in the form of sales tax revenue from increased client sales and income tax revenue from new jobs created by clients. The SBDC is returning approximately \$2.50 in new tax revenue for every one dollar it receives in funding (based on the \$67 million increased sales revenue and 1,568 new jobs attributed to SBDC assistance by clients, and the approximate \$2.3 million state, federal and local funding for the program. SBDC is a good investment for the State of Iowa!

With additional funds, the SBDC would increase its number of satellite locations and staff to better reach the rural areas that currently need more service. Today, America's SBDC Iowa has 50 satellite locations it utilizes to serve clients. Small businesses are an integral part of the economy in Iowa and this is especially true in rural Iowa. Small businesses generate most new jobs, provide a sense of community in rural areas, and create long-lasting positive impacts. **Historic**

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data reveal that the number of businesses started and jobs created is directly tied to the number of counseling hours we provide. Thus, this would be our top priority if state funding for SBDC was increased.

The SBDC also wants to provide more training and do more to educate existing businesses in an effort to strengthen our small business foundation within Iowa. Under the current funding conditions, we are unable to offer the needed level of training.

It should be noted that SBDC is working diligently to collaborate and partner with other organizations, both public and private, throughout the state to ensure that we are not duplicating efforts and to leverage each other's resources and efforts.

Iowa State University Research Park. The Research Park is in the midst of a significant expansion, which will double the developable acreage and include commercial amenities such as a restaurant, fitness center, child care facility, parks, walking and biking paths that are expected by young professionals today. Within the next 12 months, a fitness center and a full-service restaurant will open. Additional commercial projects are in development.

Any new funds to the ISU Research Park would be utilized to support costs associated with the expansion of the Park as well as to increase marketing efforts to attract new tenant companies.

The Center for Industrial Research and Service. CIRAS has been supporting the growth of Iowa industry since 1963. CIRAS has successfully leveraged the state funding to bring in additional federal grants and fees to expand technical assistance, education programs, and economic development studies to assist Iowa businesses. **In FY16 CIRAS helped generate an additional \$1.50** of Federal awards and fee income for each \$1 of base budget provided, yielding over \$3 million of additional funding to support state economic development efforts.

For every \$100,000 of additional funds that are made available, **CIRAS could leverage the funds** to bring in up to \$150,000 from grants and fees and hire two new business professionals **to expand technical assistance and education services provided to Iowa businesses.** These two staff would work with about 70 companies, help them create and retain nearly 250 jobs, and generate \$18 million in new sales, cost savings, and investment impact.

ISU Extension and Outreach. Extension and Outreach works across ISU colleges and with external partners to provide technical assistance, research-based education, and access to the resources of ISU to improve the quality of life in the state. Iowans want an economy that can form new businesses, grow existing industry, enhance communities, and recruit companies to the state. With Iowa STEM jobs expected to grow by 16 percent this decade, Iowans see the need to stop the "brain drain" and take steps to develop the state's future workforce, connecting youth with opportunities here in Iowa.

With additional funding, ISU Extension and Outreach will expand economic development projects to broaden Iowans' entrepreneurial aspirations with

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education and technical assistance. Extension and Outreach also will address the distinct needs of minority populations, as well as a burgeoning local foods industry and many struggling rural downtowns. These are only a few of the basic needs and urgent trends facing this state.

ISU Extension and Outreach expects to leverage every \$100,000 in new state funds with \$150,000 in new federal matching funds, grants, fees, and gifts to generate a projected \$2.5 million of impact and 25 new jobs throughout Iowa. **For every \$100,000 of new funds, an estimated 2.5 additional staff will be hired to address growing demands and increase the depth and reach of work with families, businesses, and communities in all 99 counties across the state.**

Summary of ISU Economic Development and Innovation Data	
a. Number of disclosures of intellectual property	143
b. Number of patent applications filed	49
c. Number of patents awarded	15
d. Number of license and option agreements executed on institutional technologies:	
in total	84
in Iowa	45
e. Number of license and option agreements yielding income	153
f. Revenue to Iowa companies as a result of licensed technology (CY15)	\$5.2 million
g. Number of startup companies formed (through licensing activities)	
in total	6
in Iowa	5
h. Number of companies in research parks and incubators	
pre-incubator companies	17
private	57
university related	17
i. Number of new companies in research parks and incubators	
pre-incubator companies	17
private	13
university related	4
j. Number of employees in companies in research parks and incubators	1,709
Royalties and license fee income	\$3.3 million
k. Total sponsored funding received	\$425.8 million
How much of this is for research	\$252.5 million
l. Corporate sponsored funding received for research and economic development,	
in total	\$43.8 million
in Iowa	\$11.9 million
m. Iowa special appropriations for economic development, in total	\$2.525 million
SBDC	\$1.037M
CIRAS Technology Assistance Program	\$1.365M
ISU Research Park	\$0.122M
Regents Innovation Fund	\$1.050 million
n. Research expenditures (federal, state and local; business; nonprofit; institution funds; all other sources):	\$261.5 million
o. Licenses and options executed per \$10 million research expenditures (FY13 data from AUTM is most recent available)	3.2

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p. Sales of licensed products by Iowa-based companies (CY15)	\$5.2 million
q. Number of employees for current Research Park tenants and incubators, as well as former tenants that are still in existence in basic form world-wide	4,985
Note: Unless noted, the data provided above are FY16 data.	

Appendix 1: CIRAS, SBDC and ISU Extension & Outreach company and community projects

Davenport-based Sears Manufacturing Co., a leading manufacturer of pneumatically controlled seats for construction and agriculture industry, looked to CIRAS for assistance with evaluating and providing insights on a corrosion issue. CIRAS utilized its nondestructive evaluation and material technical resources to identify the root cause. Sears' Strategic Quality Manager, Kelly Sheffler, stated CIRAS "gave us the clarity and the necessary supporting data to understand what the root cause was." This project helped ensure the quality of a new air compressor design and maintain Sears' reputation for reliability. The company estimated impact from this project to be \$4.5 million in retained sales, 12 jobs retained, and a cost savings of \$40,000.

Orange City-based Quatro Composites, a global provider of composite structures for aerospace, medical, and industrial markets was an early adopter of CIRAS' new metal Additive Manufacturing (AM) system. Quatro saw great potential in the technology and worked with CIRAS to build a five-axis fixture that would help the company gain an advantage through speed and the ability to produce complex parts that cannot be produced economically today. Quatro's Program Manager, Jack Ward, noted "To be able to send something out (to be built) and get it back quickly is awesome. Now that the design rules are broken...I can do stuff that I couldn't actually do before."

Harrisvaccines (MERCK Animal Health) in Ames, focuses on revolutionizing animal health vaccines and enhancing productivity in the swine, cattle, equine and farmed shrimp industries. CIRAS provided assistance in designing a new plant layout for the production, shipping and receiving processes. The project led to significant improvements in productivity and plant efficiency, which led to \$6,000,000 in increased sales.

George-based Dur-A-Lift, manufactures farm equipment, scooters and hydraulic lift equipment is ramping up production in a new 26,000-square-foot building. CIRAS helped designed the new building with a focus on maximizing productivity and cost effectiveness. Demand is high for Dur-A-

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Lift products and the expectation is that the new building will enable them to double their sales based on the added capacity.

Humboldt-based Sisters Home Style Entrees produces frozen meals that provide individuals and families the opportunity to eat home-cooked meals made from quality ingredients at an affordable price. The Iowa Small Business Development Center (SBDC) and CIRAS helped boost production by facilitating a move from a 2,500-square-foot facility to a new 30,000-square-foot manufacturing plant. The added capacity has provided added flexibility in pursuing new markets and should generate an additional \$80,000 per month in new sales.

Affordable Buckets in Victor increased sales by \$325,000 after attending one of CIRAS' Internet Marketing Boot Camps. Owner Geri Wester stated "if you're on the Web and you're not getting on that first or second search page, you're kind of lost." Participation in the boot camp, follow up coaching, and recent internet marketing webinars has helped the business better target potential clients and make their business stand out online. Over 100 Iowa manufacturers have participated in the boot camps since their launch in 2012.

Upper Iowa Tool & Die & Innovations in Cresco reached out to CIRAS in search of ways to expand their company. After strategy discussions led to a realization of the company's "default future", it became apparent that their original plans of vertical integration would not help them reach their goals. After exploring options, the company decided to enter in the 3D printing business to complement their precision tooling business. "Iowa State University and CIRAS were a blessing," said owner Scott Fortune. "I'm very thankful for the help they gave us, because we probably would have muddled down the wrong path and regretted it and struggled. But now, it's all good."

Simply Soothing in Columbus Junction worked with CIRAS to streamline its business practices and explore new markets. The company credits CIRAS with helping to boost sales by more than \$1.6 million. As a small business owner, it can be overwhelming to drive to the next step, CIRAS helped the company to concentrate on the right things. CIRAS also has helped the company understand the government procurement process. "Now we work smarter, not harder and make fewer mistakes," CEO of Simply Soothing, Freda Sojka said. "Working with CIRAS is one of the best things that's ever happened to us."

Grasshorse Technologies in Winfield nearly doubled their sales in the past two years after CIRAS helped them find new life in government contracting. CIRAS helped Grasshorse identify find potential business opportunities in the government sector; with market research on competitors and target agencies at the federal, state, and local levels; and with understanding and providing a plan for marketing. They have

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participated in a number of government contracting webinars and events, but found the most value in the one-on-one assistance spent with CIRAS staff. The list of Grasshorse clients now includes the city of Cedar Rapids, the Louisa County Community Foundation, 20th Century Fox and the Iowa Lottery. "It was a miracle that CIRAS contacted us," owner of Grasshorse Technologies, Kathy Buxton said.

CIRAS NEWS has published the final four segments of "**Special Report: Working on Workforce**," providing Iowa businesses with data-driven information and real-world examples of creative ways Iowa companies are addressing the skills shortage. Articles have focused on sharing employees, automation, the benefits of being lean, and key performance indicators (KPIs) that should be watched as Iowa and its businesses plot which overall strategies to implement.

CIRAS, Meat Science Extension (College of Ag and Life Sciences (CALs), Extension and Outreach), and the Center for Crops Utilization Research (CALs) have partnered to help **Iowa food manufacturers** improve their businesses, deliver safe foods, and deploy the latest technology. Over the past five years, this partnership has served nearly 45 percent of food manufacturers in Iowa, resulting in over 1,700 jobs added or retained and creating an economic impact of more than \$326 million.

Legacy Logistics Freight, Inc. won the Deb Dalziel Women Entrepreneur Achievement Award in 2016. Owner, Sarah Novacek worked closely with America's SBDC Iowa to develop and grow her freight brokering businesses from a small one account company to a multi-million-dollar company doing work nationwide. Her business is 100% female owned and operated and serves national brands such as Jennie-O and Hormel. The SBDC partnered with the NIACC John Pappajohn Business Incubator to provide resources, services, and office space to grow her company.

The 2016 Neal Smith Entrepreneur of the Year Award was Tony Halsted of Hoover's Hatchery. Tony came back to help run his family business after spending time working across the nation. Under his leadership, the business has gone from a traditional hatchery to an international business known for their exclusive Red Ranger and Black Asian chickens. Hoover's Hatchery has changed the way they do business and has been able to expand significantly. The company created 40 new jobs in the town of Rudd, which as a population of 370. The company is an example of how businesses in rural Iowa can make a significant impact on the communities in which they are located.

ISU Extension and Outreach's Community and Economic Development program (CED), Iowa Department of Public Health, and University of Iowa College of Public Health continue their collaboration on the **Shop Healthy Iowa** program. Store owners receive technical training in produce handling, assistance in redesigning store space to promote healthy eating choices to customers, and promotional materials. Sales of fresh produce have high gross profit margins for stores, magnified when the volume of sales

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increases. However, the risk in offering more fresh produce for sale lies in the greater energy and time investments required to realize those profits and the potential for increased inventory to perish before sales increase. Participation in the Shop Healthy Iowa program is designed to provide store owners with the needed assistance to increase sales of fresh produce. The program was piloted in Perry, West Liberty, and Muscatine in 2015 and is currently being implemented in Ottumwa and Marshalltown. In 2017 the program will move to Davenport and Sioux City.

During 2015, the **ISU Extension and Outreach Value Added Agriculture Program** conducted several business feasibility studies enabling Iowa businesses to qualify for loan guarantees through their local banks and USDA-Rural Development. The in-depth studies examined the economic, market, technical, management, and financial aspects of the proposed business start-up or expansion. Rural economic development feasibility studies for nine local businesses in 2015 resulted in investments of \$37.2 million into the Iowa economy and the potential for 126 newly created jobs when completed. The projects vary greatly from dairy processing to aquaculture production facilities and rural lodging issues to renewable energy projects; but the common thread is that VAPG feasibility projects help Iowa clients gain access to capital to strengthen rural economies.

CED has managed the **ISU Road Scholar Program** since 2007, teaching local businesses to **capitalize on tourism in Iowa**. In 2015–16, 239 citizens, 85 community leaders, and 295 business leaders/entrepreneurs received assistance through these programs. As a result 41 businesses were expanded or improved, individuals took 7 new leadership roles, 42 organizations were assisted or strengthened. The estimated dollar value of the jobs that were created or retained was \$725,937.

A series of nine **customer service/hospitality trainings** were conducted between April 1 and June 30, 2015, as part of funding received from the Central Iowa Tourism Region through a grant from Travel Iowa. The two-hour sessions focused on the economic development value of tourism in Iowa, customer service skills needed by front-line workers, tips on creating Ambassador programs and Familiarization tours, what travelers are looking for when touring a community, and assessment tools employers can use to determine their employees' customer service skill set. Sessions and their attendance were: Iowa Falls (41), Ames (117), Centerville (52), Marshalltown (25), Pella (84), Newton (44), Ottumwa (80), Bloomfield/Davis County (22), and Clear Lake (50). Outcomes after the session include the community of Ames submitting a grant to create an Ambassadors program and to start Familiarization tours to help front-line hotel, restaurant, convenience store, and gas station workers familiarize themselves with Ames attractions.

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Appendix 2: Training and Related Educational Activities

Center for Industrial Research and Service (CIRAS)

CIRAS held its second annual **Iowa Vendor Conference** in Ankeny with a goal of helping Iowa business leaders gain a better understanding of how to do business in the government sector. More than 100 companies were able to expand their government contracting potential through attending diverse workshops, participating in a best practices panel discussion and networking with a variety of resource partners and buyers, such as the National Parks Service, Offutt Air Force Base, Iowa National Guard, and the Department of Transportation.

CIRAS hosted an **Innovation Summit** with more than 80 attendees to help spark progress in Iowa's metal fabrication sector. Metal fabrication, one of the largest manufacturing sectors in Iowa, is a key driver in Iowa's economy, but economic data shows we are slow to invest and adopt new or even proven technologies. Experts provided updates on technologies, including additive manufacturing, automation, internet marketing strategy and capital equipment advancements, followed by discussion and long-term coaching on finding opportunities to implement these innovative practices in each company's business.

CIRAS partnered with the U.S. Commercial Service, with support from the Iowa Economic Development Authority, Iowa Small Business Development Centers (SBDC), FedEx, and Iowa Farm Bureau, to grow **ExporTech** in Iowa. This program is a structured strategy development process designed to connect small manufacturers with experts to help them navigate the export sales process and develop plans to grow their businesses internationally. In its second year, a total of 12 Iowa manufacturers have participated, and new models are being tested to host local versions of the program throughout the state.

In the fall of 2015, CIRAS launched the **Manufacturing Leadership Program** to help Iowa manufacturers develop their next generation of leaders. Fifteen participants from companies large and small spent a week in Ames to learn fundamental business skills, develop their leadership skills, and grow their network of fellow leaders. "What's really, really important is being able to lead. An effective leader knows what he or she knows and doesn't know about parts of the business" said Jack Ward, program manager for Quatro Composites in Orange City.

Thousands of Iowans celebrated national **Manufacturing Day** throughout the month of October 2015. Manufacturers, Elevate Iowa, community colleges, ISU Extension and Outreach, and countless local organizations stepped up to meet CIRAS' ambitious goal of holding an event in each of Iowa's 99 counties. A total of 132 events were held across the state, ranking Iowa 5th nationally in number of events despite our relatively small size. CIRAS's efforts to ensure that manufacturing day was truly a

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statewide activity were recognized nationally by the U.S. Department of Commerce.

In January of 2016, CIRAS released a step-by-step training schedule that provides access to government contracting training throughout the state of Iowa. The plan includes both online and on-site in each corner of the state. The training is based on best practices from around the country, inputs from CIRAS clients and long standing CIRAS courses. Bill Hayes of Straight Shot Express said the courses have been beneficial "Through several training sessions, we have a better understanding of how the government process works and how to work within the process." **CIRAS received national recognition from the Association of Procurement Technical Assistance Centers for Outstanding Project of the Year** for their work on the development and implementation of this statewide training plan.

Community and Economic Development (CED) in ISU Extension and Outreach empowers communities to shape their own futures through research, education, community engagement, economic development, and community planning and design. CED has multiple community development specialists in place with expertise and/or experience working with minority-owned businesses and community business leaders. CED serves as an essential conduit between Iowa's communities and the resources of Iowa State University, creating partnerships with private and public sectors for the betterment of Iowans.

The **Data Indicators Portal**, a Vice President for Extension and Outreach initiative, is now available to Extension and Outreach staff, and to the public on a test web platform. Iowa Community Indicators Program provides web-based information products such as local retail trade analysis and demographic and economic indicators. Users are able to access 2015 population estimates by county and city, as well as data on the median age by sex, the ratio of males for every 100 females, and total population by sex. CED staff conducted workshops throughout the state on using the website.

In 2015, as part of CED's **Iowa Government Finance Initiative (IGFI)**, CED for the first time released city level annual fiscal conditions reports for all 945 cities in Iowa. In addition to including the up-to-date fiscal data for all the cities in Iowa for the year 2015, the reports also include the recently released U.S. Census data on select socioeconomic characteristics at the city level. The reports are the only source in the state of Iowa for cities wishing to access the most updated socioeconomic and fiscal information in a format customized with a narrative for every city in the state. In addition to the annual reports, IGFI provided local governments an alternate perspective about their financial health and performance and provided training targeted at elected officials and public employees. Using local government finance data, IGFI analyzes trends and financial performance of selected indicators.

The **Geospatial Technology Training Program** conducted five ArcGIS two-day short courses for a total of 25 planners and local officials from

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throughout the state. GIS specialists also provide walkability assessments for two organizations.

CED again co-sponsored the third annual **Bicycle Trail Tourism Conference** in Perry, Iowa. Fifty-five attendees learned strategies for turning the popularity of bicycling into economic development opportunities for communities on and near the nearly 2,000 miles of bike trails in Iowa.

CED published **Reducing Local Regulatory Barriers to Local Foods: Municipal Zoning for Local Foods in Iowa Guidebook**. Using examples of zoning code language from municipalities across the nation, the guidebook provides guidance and sample code language for reducing barriers to, and promoting urban agriculture production and sales activities.

Agriculture and Natural Resources Extension and Outreach

(ANR) provides research-based information and resources to educate Iowa's farmers, producers, and agribusinesses. Much of Iowa's economy thrives on the state's rich agricultural heritage. ANR programs impact all Iowans, whether they live in rural or urban areas, and have been developed to improve quality of life. ANR specialists are engaged with farmers, researchers, organizations, agencies, agribusiness, and communities at state, regional, and national levels.

Commercial horticulture programs increase fruit and vegetable production in Iowa. According to the 2012 National Agricultural Statistics Service, total horticulture sales in Iowa equal \$123 million. ISU Extension and Outreach horticulture specialists work with fruit, nut, vegetable, nursery, sod, and greenhouse growers to enhance yield, quality, efficiency and safety. For example:

- Iowa has 7,724 acres under vegetable production that generate nearly \$14 million in local food sales. Research in vegetable cropping systems at Iowa State has shown that integrating cover crops can decrease fall nitrogen (N) leaching by 20 lb. per acre. This improves water quality and leads to a total saving of 154,480 lb. of N that otherwise would leach and make its way to our rivers and streams. Cover crops field days, workshops, hands-on-activities, and on-farm trials reached more than 700 Iowa growers.
- Over the past few years Iowa State research has focused on selecting cold hardy grapevines adapted to Iowa's harsh winters, apple rootstocks that increase 'Honeycrisp' production efficiency, and low labor training systems. These efforts have resulted in increased yields and an increase in unit price. Iowa's largest and most profitable fruit crops are apples and grapes. Apples at \$0.863 (record high) per pound brought in an estimated \$3.45 million in 2015 (up 17 percent from 2014). Wine grapes generated an estimated \$2.5 million in revenue in 2012 (the wine and grape industry has an economic impact estimated at \$420 million). As Iowa State research continues to focus on crops and cropping systems suited for Iowa, growers will continue to see an increase in yields and unit price.

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- The apple industry is small, with less than 40 orchards across the state, but even a single orchard can have a significant impact. Orchardists actively used methods learned from Iowa State webinars to protect their crop from frost. One orchard alone was able to save approximately 25 percent of their crop by applying methods learned from the discussion. Sold directly to consumers, that crop has a direct value of \$250,000 and an indirect value of greater than \$500,000 in other sales related to the agritourism portion of the business that revolves around the orchard. Other orchards had varying degrees of success based on the protection method they implemented.

Farmers, financial lenders, farm managers, and agriculture educators need current, unbiased agricultural economics and business information to make sound farm management decisions. The **Ag Decision Maker website**, www.extension.iastate.edu/agdm, offers access to up-to-date information, including new and emerging issues critical to their success. This web-based resource supports many ISU Extension and Outreach farm management programs. From July 1, 2015, to June 30, 2016, the website averaged 9,488 visitors per day, a 9 percent increase from the previous year. The average visitors per day was more than 10,000 in five of the last 12 months. Overall, downloads of information sheets and decision tools reached 1.8 million for the 2016 fiscal year while more than 100 information files, decision tools, voiced media, and teaching activity files were added or updated on the site. More than 15,000 users receive monthly updates highlighting the materials on the Ag Decision Maker site. The [AgDM Twitter](#) feed promotes materials and events throughout the month to 1,293 followers and had 122,000 impressions during the past 12 month period.

During 2015, **Highly Pathogenic Avian Influenza (HPAI)** resulted in the loss of more than 30 million layers and pullets (chickens) and 1.5 million turkeys in Iowa from infection or depopulation due to exposure to the virus. Seventy-seven poultry production sites across 18 Iowa counties were impacted by HPAI, including backyard flocks and pullet and hatchery sites. A study commissioned by the Iowa Farm Bureau Federation estimated Iowa's economic loss at \$1.2 billion. This study projected that egg layer operations affected by the outbreak expected to take 18-24 months before reaching pre-outbreak production levels due to quarantine requirements, access to pullets, and the need to maintain a desired age distribution among layers. Turkey producers were predicted to be out of production for approximately 30 weeks.

- Starting July 7, 2015, poultry producers associated with 58 of the 77 premises affected by HPAI worked with ISU Extension and Outreach farm management specialists to develop, improve, or make final adjustments to the USDA-APHIS Work Plans and Financial Plans, including budgets outlining the necessary steps to prepare and finance their operation's return to productivity.

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- Through in-person meetings with producers, business partners, and family members, farm management specialists assisted producers as they worked through USDA-APHIS procedures to determine fair compensation and calculate losses and predict future expenses.

With specialists in the field and on campus, the Iowa Pork Industry Center works to promote efficient pork production technologies in Iowa, maintain Iowa's pork industry leadership, and strengthen rural development efforts. For example:

- Working with a feed company, **ISU Extension and Outreach administered training, coaching, and guidance to 19 pork finisher sites** owned by 15 farm families. From the ongoing program, producers were able to improve their feed efficiency by a reduction of 12 pounds per pig each year. As a result of implementing these new practices an estimated 5 million pounds of feed was saved. Valued at \$0.085 per pound, the savings is \$400,000 for less feed being fed. Other management areas showing improvement included reducing medical costs to \$1.52 per pig. Implementing practices to reduce sort loss (sorting pigs by size) resulted in savings of thousands of dollars.
- As Iowa produces about one-third of the pork in the nation, health and safety is important to this industry. Over the past two years, **more than 5,000 producers have been trained on how to implement bio-security protocols**. While the exact savings of the bio-security training is not known, even a small adoption of implemented changes in biosecurity result in a potentially large payback.
- Extension workshops **prepare pork producers for the Common Swine Industry Audit**, which provides consumers greater assurance that animal well-being and food safety criteria are being met. While economic budgets are not yet available, a significant number of Iowa pork producers now have the information to pass an audit, which will enable them to continue marketing their pigs through specific packers.

In 2012 and 2014, the Iowa Beef Center and allied industry partners conducted two statewide **Heifer Development meeting series focused on best management practices** for developing yearling females and longevity of first-calf females. More than 900 producers attended. A follow-up survey in summer 2015 monitored medium- and long-term impact. As a result of the 2014 program, 90 percent of survey respondents implemented or planned to implement a new best management practice. Together the 2012 and 2014 Heifer Development programs have had an economic impact of \$1.04 million per year for the 900 attendees of the in-person series. In addition, this program has educated an additional 4,400 people through YouTube, as well as helped drive economically sound decisions for an additional 3,450 producers through Ag Decision Maker document downloads of heifer development decision tools and accompanying fact sheets. This expansion of the cowherd will not only help support a strong cow-calf industry, but also adds value to Iowa's economy and ensures a consistent supply of high quality, affordable beef for the consumer.

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Iowa State University Extension and Outreach annually trains representatives from about 600 businesses and 2,000 employees who come from more than 90 counties in Iowa and from the six surrounding states in the **commercial manure applicator program**. These businesses annually handle and apply about 1.5 million tons of solid manure and 3 billion gallons of liquid/slurry manure that has a fertilizer value of about \$250 million, while doing about \$70 million of business. At Iowa's liquid manure application companies, each employee handles about 5 million gallons of manure per person, meaning each person annually impacts how \$150,000 of organic fertilizer is applied. More than 75 percent of the trained employees reported that the information provided was useful to their company. Many of those surveyed reported that it helped them make better equipment purchase decisions and provide better manure application recommendations to their clients.

Roughly 13 million acres of Iowa's land is cash rented each year for crop production, pasture, and other purposes. ISU Extension and Outreach offers a variety of **tools to assist landlords and tenants in determining fair land rental rates**. In 2015, ISU Extension and Outreach farm management specialists conducted 81 leasing meetings across the state, with more than 1,845 land owners, operators, and ag business professionals attending. A post-meeting survey found that 30 percent of respondents indicated that they would decrease land rental rates for the following year based on the information provided at the leasing meetings. Iowa State's annual cash rent survey for 2016 found that typical cash rental rates declined by \$16 per acre, confirming the leasing meeting survey result. Thus, the \$16 per acre drop in typical land rental rates would result in a \$208 million decline in farm expenses to tenants and lowered rental income for land owners. The [ISU Extension and Outreach Cash Rent Survey](#) was downloaded 164,234 times in 2015. Sample cash lease forms were downloaded 138,820 times.

In 2015, the **Pesticide Education Safety Program** directly contributed to 10,649 Iowa commercial pesticide applicator jobs with a total salary base of over \$357 million, based on 2015 wage information from Iowa Workforce Development. In addition, 14,887 private pesticide applicators received recertification training through the program.

ISU Extension and Outreach Meat Science program provides companies from the United States and around the world with cutting edge education on meat processing and food safety technologies. In addition to offering workshops for small processors, training programs for some of the nation's largest processors also are developed and delivered. In FY16, 890 people from the United States and 150 from other countries participated in extension short courses, regulation updates, Hazard Analysis Critical Control Point (HACCP) food safety workshops, and multi-level training sessions. These educational programs resulted in an economic impact in Iowa of approximately \$78 million in retained or increased sales, \$1.1 million in cost savings, \$3.4 million in increased investment, and 21 jobs created or retained.

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ISU Extension and Outreach hosted 14 **Crop Advantage Conferences** across Iowa; 2,094 farmers and agribusiness professionals attended. Participants could be categorized as 60 percent farmers, 34 percent agribusiness, and 6 percent other. The majority (55 percent) of the attendees farmed between 250 to 1,000 acres and 28 percent farmed 1,000 to more than 5,000 acres. As a result of hearing information on soil fertility and nutrient management, 45 percent of farmers surveyed felt savings would be \$5-10 per acre on their farms, while 26 percent estimated the savings would be \$10-20. After attending the presentation, 95 percent of producers agreed they would be using soil testing to re-evaluate crop fertility inputs before applying chemicals. After attending a session on managing crop margins, farmers agreed or strongly agreed they were able to manage seed costs, seed treatments, fertilizer inputs, and herbicide inputs, and improve grain marketing. As a result of implementing these changes, 44 percent indicated there would be an impact of \$5-10 per acre, while 24 percent indicated there would be an impact of \$10-20 per acre.

According to the USDA Economic Research Service Economic Research Report 184, page 21, published in April 2015, herbicide resistance costs farmers over \$60 per acre per year. Unfortunately, several fields in Iowa have developed herbicide resistant weed populations and in tight economic times, farmers cannot afford this loss. To address this issue, ISU Extension and Outreach conducted a series of **Weeds Week workshops** in August 2015; 234 farmers, dealers, crop consultants, and Department of Transportation employees, representing approximately 2.5 million row crop acres, attended the meetings held across the state. If information provided at these meetings prevents herbicide resistance development on each of the approximately 2.5 million acres represented at the workshops, at \$60 per acre, the impact will be over \$135,000,000 in improved farm profits annually in Iowa. In their after-meeting evaluation, participants recorded that they were better able to properly identify weeds, select herbicides effective on those weeds, use effective herbicide rates, and manage the weeds in a manner minimizing the potential for the development of herbicide resistance.

4-H Youth Development prepares Iowa's young people for future careers. Youth develop communication, citizenship, leadership, STEM, and healthy living skills by participating in 4-H educational learning experiences. Youth are challenged to actively pursue education beyond high school and build skills that improve their communities and world. 4-H programs reach more than 100,000 Iowa youth every year.

4-H Youth Development addresses the STEM literacy gap; last year 50,059 youth participated in STEM-related programming. The Iowa Governor's STEM Advisory Council has identified STEM-abled workers (skilled in science, technology, engineering, and math) as a critical component of the growth of Iowa's economy. The council has stated that

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STEM workers drive our nation's innovation and competitiveness and are central to our economic vitality. The growth in STEM jobs continues, and it is imperative to address the critical talent gap in the current workforce and student education related to STEM literacy, decision-making, and practices.

Educating Iowa's 4-H youth in the area of **Animal Science STEM** programming is a key priority for ISU Extension and Outreach. More than 14,000 youth are enrolled in a livestock project area. It is critical that they gain the necessary skills in science, technology, engineering, and math. By partnering with internal and external resources, several initiatives both statewide and nationally have been developed to increase knowledge and behavioral change in youth involved in animal science fields. Face-to-face and online resources allow youth to learn in the changing environments of today. A variety of project opportunities include the Iowa State Fair, an annual 4-H Animal Science conference, as well as the more than 10,000 youth required to be certified in food safety and quality assurance training. This training has resulted in more than 85 percent of the youth indicating their increase in both ag production knowledge and applying that knowledge to management and animal care changes in their own operations.

The **Entrepreneur for a Day (E4D®)** program was launched by the North Iowa Area Community College John Pappajohn Entrepreneurial Center in 2005, and purchased for use by Iowa State University College of Business and ISU Extension and Outreach 4-H Youth Development in 2015. The purpose of the E4D® program is to introduce students to the essential concepts of business and entrepreneurship, through both personal enrichment and for future community, county, and statewide economic vitality. Additionally, E4D® serves as a recruitment tool for the College of Business. The initial objective is to introduce the E4D® program by educating and motivating students about business and entrepreneurship. The current program model is delivered in two segments: a 2 to 2 ½ hour in-class presentation and an all-day program at Iowa State University College of Business. Students learn the definition of "entrepreneur" and practice teamwork and leadership skills in a business simulation. They also gain knowledge of how supply and demand affect the price of a product. In addition they learn how to identify resources necessary to operate a business, marketing as a way to advertise products, and the difference between a debit and credit. E4D® also introduces youth to opportunities within the field of business, including accounting, finance, marketing, management, information systems, and supply chain.

Human Sciences Extension and Outreach provides research-based information and education to help families make decisions that improve and transform their lives. Specialists work with Iowa State's College of Human Sciences and in partnership with other organizations and agencies to meet the needs of Iowa families.

The Earned Income Tax Credit (EITC) augments the wages of low- and moderate-income workers and, in turn, this flow of income makes a

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substantial economic impact in local communities. EITC recipients circulate their refunds through the local economy, creating a ripple effect that exceeds the size of the original refund. This money bolsters family financial well-being, strengthens neighborhoods, assists small businesses, and spurs local economic development. During the 2016 tax season, ISU Extension and Outreach worked with community partners to recruit and train 51 volunteers to provide free tax preparation services to low- and moderate-income families through the **Volunteer Income Tax Assistance (VITA) program**. In 2016, VITA volunteers working at 17 VITA sites helped 1,555 low- and moderate-income Iowans complete their 2015 income tax returns. Special efforts are made to increase awareness of the EITC and VITA programs in rural Iowa. As a result, 482 filers qualified for the EITC and received \$841,392 in the 17 counties that participated in the ISU Extension and Outreach/community partnerships to expand VITA programs in rural Iowa.

Human Sciences Extension and Outreach offers educational opportunities to strengthen Iowa's early childhood education workforce

Iowa ranks first in the nation for the percentage of young children with employed parents (American Community Survey, 2014). In Iowa, 42% of children under age 5 and 27% of children ages 4-15 are in some form of paid child care. The Iowa early care and education industry employs 22,716 individuals and supports an additional 5,100 jobs in related industry sectors (CED, 2015). Throughout Iowa, there are 13,260 licensed and registered child care programs, with revenue of \$447.6 million. These regulated programs employ an estimated 7,280 child care professionals. Non-regulated child care is estimated to employ an additional 3,000 or more individuals. The projected average growth rate of child care professionals from 2014-2024 is expected to increase nationally by 5% (Bureau of Labor Statistics, 2016). Although child care is expensive for families, the national median pay for child care workers is \$9.77 per hour (Bureau of Labor Statistics, 2016). Iowa families and employers depend on early care and education for more stability for today's employees and to lay the foundation for tomorrow's workforce. Iowa business leaders recognize that investments in high quality care and education lead to improved outcomes for Iowa's children, resulting in less need for special education, higher graduation rates, and increased college attendance – all leading to higher earnings and greater productivity.

- Human Sciences Extension and Outreach training programs include on-site and online learning experiences for new, emerging, and skilled professionals. The aim is to increase understanding and practice of research-based best practices to improve quality care and education for young children.
- Human Sciences Extension and Outreach programs taught 4,727 early care and education professionals new skills to promote early learning, literacy, science, math, and nutrition education.
- Of the more than 2,469 participants completing course assignments and responding to surveys, 96 percent demonstrated new knowledge, skills, or program improvements. Evaluations show that teachers and caregivers significantly increased understanding in

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parent communication, child development, early learning, managing children's behavior, nutrition, and health and safety practices

Through "**Juntos Para Una Mejor Educación (Together for a Better Education)**," ISU Extension and Outreach worked with local school districts and community organizations to bring together 184 community volunteers, 174 Latino youth, and 187 Latino parents to assist these youth in graduating from high school and pursuing higher education. Youth who do not complete high school cost the state nearly \$90 million in reduced state tax revenues over their lifetime, and close to \$2 million per year in additional welfare costs, and will face higher unemployment and have increased health issues. They also are 10 times more likely to be incarcerated. Research shows that Latino youth are at greatest risk for dropping out of school between the ninth and tenth grades.

- Juntos helps Latino parents learn how they can help their children be successful in school, and also helps parents and youth realize the long-term benefits of graduating from high school and participating in higher education.
- Based on data from individuals who completed evaluation surveys, after participating in Juntos, 99 parents gained information about navigating their children's school system. They also have gained information about how to help their youth access higher education.
- In addition, 140 youth have improved their understanding of what they need to do as a student to prepare for and increase their opportunities to go to college. Youth also increased their communication with their parents, teachers, and school counselors in regard to accessing information and assistance to help them succeed in school and pursue higher education.

Human Sciences Extension and Outreach specialists have taught the **ServSafe® food safety certification** program for more than 20 years as registered instructors for the National Restaurant Association Educational Foundation's internationally recognized food safety certification program. ServSafe® is one of the programs approved to meet the Certified Food Protection Manager credential. Participants are from commercial retail foodservices such as restaurants and institutional operations such as hospital and schools. Close to 2,500 Iowans participated in the classes taught by ISU Extension and Outreach last year, with about 80 percent successfully earning certification. In recent years, classes have been taught in Spanish to reach new Iowans. This outreach effort continues in partnership with the Iowa Restaurant Association. Commercial operations recognize the value of training staff in safe food handling procedures, as an incident of a foodborne illness can be devastating for business. In addition, having staff members certified in food safety can be a marketing advantage, as many operations post these certificates. Proper preparation, holding, and service of food are critical in any place where food is served. Many ServSafe® participants work in operations that serve those considered at greater risk of contracting a foodborne illness due to

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compromised immune systems; food safety training can avoid costly medical expenses. Iowa has adopted a version of the Food and Drug Administration Food Code that requires at least one supervisory employee in licensed foodservices be certified in food safety through an approved program.

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Appendix 3: YEAR END FULL REPORT: JULY 2016, IOWA STATE UNIVERSITY RIF PROGRAM

EXECUTIVE SUMMARY

GIVE/RIF Commercialization Program

The projects pair ISU faculty with Iowa companies to create or improve products or processes. Each project lasts two years. One year after the completion of the project, the Iowa companies are surveyed for impact by the Center for Industrial Research and Service (CIRAS). These funds are a **critical source of gap funding**. They represent a unique resource that can be applied toward the success of Iowa companies. A summary of the projects funded to date is below, followed by the list of active projects. **Since its inception, 130 projects have been funded through the Commercialization Program. One hundred eighteen of these projects are complete** and many show excellent progress in improving the competitiveness and profitability of the Iowa companies involved. **Forty four startup companies have been assisted; including 26 new companies that were started in the first ten years as a direct result of the GIVE/RIF funding; one of these startups was acquired in the past year by a large international firm, based in part of the success of the projects funded through RIF.** In addition, one industry partner invested in a \$5.3 million biopolymers plant at the ISU Biocentury Research Farm that was dedicated on August 26, 2015. **In total, more than 85 Iowa companies have participated in the program.**

Surveys are conducted by CIRAS one year after project completion (true impact takes a minimum of 5-10 years).

Survey Results for FY06-07 through FY14-15 Projects

Project Dates	Survey Year	Companies Surveyed	Jobs Created or Retained	Total Sales Increase	Total Investment & Cost Savings	Average Impact per Company
FY06-FY07	FY08	9*	71	\$9,100,000+	\$23,500,000	\$3,600,000
FY07-08	FY09	9	18	\$3,700,000	\$2,760,000	\$720,000
FY08-09	FY10	8**	6	\$600,000	\$732,000	\$166,500
FY09-FY10+	FY11	7**	13	\$675,000	\$967,000	\$234,571
FY10-FY11	FY12	6**	6	\$1,750,000	\$1,730,000	\$580,000
FY11-FY12	FY13	12**	13	\$2,470,000	\$2,571,000	\$420,083
FY12-FY13	FY14	6**	21	\$750,000	\$1,315,000	\$344,167
FY13-FY14	FY15	2	3	N/A	\$1,167,000	\$583,500
FY14-FY15	FY16	5**	3	N/A	\$454,500	\$90,000

*All surveyed companies were start-up companies. ** Surveys were not completed for all projects (not everyone chooses to participate in the survey). +The sales increase was primarily from 1 successful project, but the jobs impact was spread. Many companies indicated it was too early to tell the sales impact (this is a frequent comment through the years).

Project Outcomes for FY09 through FY16**

Year Project Completed	Number of Projects	Number of Publications & Presentations	Number of Invention Disclosures	Number of External Funding Applications	Number of Applications Awarded	External Funding Received*
FY17+	7	11	4	7	3	\$425,000

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FY16+	15	10	3	15	2	\$770,000
FY15	14	10	2	3	2	\$384,999
FY14	7	19	1	16	4	\$370,000
FY13	4	6	2	12	5	\$795,000
FY12	11	50	4	12	6	\$6,364,000
FY11	11	46	3	20	6	\$940,000
FY10	14	99	6	47	13	\$2,720,000
FY09	15	53	4	48	20	\$3,500,000

**Data was not collected for FY07-08. *A number of external funding applications were still pending at the time of reporting and not all award amounts were reported. *Partial results, projects are not complete.

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Proof of Concept Initiative

The GIVF/RIF funds have been incorporated into a Proof of Concept Initiative (POCI) <http://www.industry.iastate.edu/POCI.html>. The POCI is intended to build on the foundation started by the GIVF program, include additional funding sources such as i6, IPRT company assistance, Plant Sciences, etc., and position Iowa State to more rapidly propel technologies toward market opportunities. We will do this by emphasizing both the business opportunity and the technology in projects that are funded through the POCI. By doing this we will position young companies to be able to attract the next stage of funding from either the state, angel or VC sources and/or position technologies to be more attractive commercialization opportunities for existing companies.

There were an additional 16 projects funded under the POCI, using non-GIVF/RIF funding sources. A grand-total of 146 projects have been funded through the POCI model from FY07 – FY16; note that i6 funding terminated on March 31, 2014, so future POCI projects will not include this funding source. Final reports for projects funded with i6 and Plant Sciences Institute funds were provided in the full year report for FY14. Summary statistics for all POCI projects (GIVF/RIF and all other funding sources) are as follows:

Project Outcomes for FY09 through FY16⁺⁺

Year Project Completed	Number of Projects [†]	Number of Publications & Presentations	Number of Invention Disclosures	Number of External Funding Applications	Number of Applications Awarded [†]	External Funding Received ^{**}
FY17 ⁺	7	11	4	7	3	\$ 425,000
FY16 ⁺	15	10	3	15	2	\$ 770,000
FY15	14	10	2	3	2	\$ 384,999
FY14	11	22	1	25	8	\$ 1,330,000
FY13	5	10	6	16	6	\$ 1,020,000
FY12	11	50	4	12	6	\$ 6,364,000
FY11	11	46	3	20	6	\$ 940,000
FY10	14	99	6	47	13	\$ 2,720,000
FY09	15	53	4	48	20	\$ 3,500,000

⁺⁺Data was not collected for FY07-08.

[†]Includes all projects funded through the POCI.

^{**}A number of external funding applications were still pending at the time reports were submitted and some information on award amounts was not included.

⁺Partial results, projects are not complete.

Principal Investigator	FY15 RIF Projects (To finish May 31, 2016)	Award Amount
Steve Carlson	Development of Plant-Derived Feed Additives that Eliminate Salmonella from Poultry	\$37,630

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Namrata Vaswani	Video Denoising-Phase I	\$50,000
Tim Day	Identification of a Non-antibiotic Drug that Prevents BRD at the Feedlot	\$12,500
Zhiyou Wen	Establishment of a mobile Revolving Algal Biofilm (RAB) cultivation system for treating industrial and municipal wastewater on site	\$50,000
James Reecy	A Novel Assay for Rapidly Identifying Bovine STEC Carriers in Feedlots	\$49,734
Steve Carlson	Development of a Genetic Test for Salmonella Resistance in Cattle	\$23,500
Amy Kaleita-Forbes	Towards Real-Time Nitrate Monitoring in Tile-drained Water in the Midwest: Assessment of Ion Species	\$26,330
Tim Ellis	Static Granular Bed Reactor (SGBR) Pilot Test Treating Primary and Secondary Sludge	\$40,413
Steve Carlson	Plant Extracts that Efficiently Enhance Muscle Growth in Swine	\$33,300
Jim Roth	National Implementation of the Secure Egg Supply (SES) Data Portal—Phase II	\$50,000
Hui Hu	Development of an Advanced Spray Diagnostics Test Rig for the Measurements of Spray Flows Exhausted from Liquid Fuel Injectors—Phase II	\$50,000
Eric Cochran	Development of Biorenewable Thermoplastic Block Copolymers—Phase II	\$50,000
Balaji Narasimhan	Evaluation of α -Synuclein Immunotherapeutics in Animal Model of Parkinson's Disease—Phase II	\$50,000
Alan Russell	A Castable, Ceramic-reinforced Aluminum Composite—Phase II	\$23,329
David White	Plunger Cast Equipment Design, Fabrication, and Product Engineering for Commercial Scale Polymer—Phase II	\$10,000
	FY16 RIF Projects (To finish May 31, 2017)	
Namrata Vaswani	Video Denoising—Phase II	\$50,000
Al Jergens	Electronic Canine Collar Advancement thru Multi-purpose, Proof-of-Concept Trials	\$44,500

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Ratnesh Kumar	In-Situ Wireless Soil Moisture and Salinity Sensor and Extension for Nitrate and Other Nutrients/Ion Sensing	\$50,000
Rudy Valentine	Effect of HMB Supplementation on Adipose Tissue Inflammation and Metabolism	\$50,000
Keith Vorst	Technology for Real-Time Detection of Contamination in Food Processing Systems and Packaging for Value-added, Waste-Stream Diversion	\$50,000
Wenyu Huang	Co-Production of High-Value Chemicals with “Drop-in” Biofuels from Lignocellulosic Biomass Using a Novel Liquid-phase Refinery Process	\$50,000
Martin Thuo	No Heat Soldering	\$50,000

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RIF FUNDING: PROGRESS REPORT

Report Type: Final

Title: Development of a Plant Derived Feed Additives that Eliminate Salmonella from Poultry

PI: Steve Carlson

Company Partners (if applicable, company names only): Diamond V

Project Goal: To identify essential oils that dislodge Salmonella from the intestinal tracts of poultry.

Publications/presentations based on project: A publication has been created and is under review by the co-authors at Diamond V. We recently presented the work to FSIS and we presented the work at an international poultry conference (IPSF) in January 2016.

Invention disclosures: none

External funding applied for (indicate received/denied/pending): We submitted a grant to the National Pork Board to examine the possibility that these results extrapolate to swine- unfunded

Progress report (300 word maximum, please focus on results in non-technical terms and commercialization progress):

We found that the essential oils had only a modest effect on dislodging Salmonella from the poultry gut, and that the dislodge Salmonella were potentially more virulent after exposure to the essential oils. Thus the essential oils alone will not be pursued further in broilers. However, our preliminary studies revealed that one of the essential oils may be effective in turkeys if combined with a prototype product being developed by Diamond V. We would like to pursue this possibility in Phase II.

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Additionally, we found that an existing Diamond V poultry product (XPC) dislodges Salmonella from the chicken gut and it also minimizes the antibiotic resistance and virulence of the Salmonella. These findings have profound implications for the poultry industry and the Iowa-based company Diamond V:

XPC's novel effects on Salmonella burden, virulence, and antibiotic resistance is a unique marketing tool for Diamond V, and the company will likely acquire a greater market share in the broiler industry.

By reducing the load and virulence in Salmonella through the use of XPC, the poultry industry is going to see a reduction in poultry-associated salmonellosis in humans.

This latter point will dramatically aid in the marketability of U.S. poultry, while also boosting consumer confidence.

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RIF FUNDING: PROGRESS REPORT

Report Type: Interim (Phase I and Phase II)

Title: Novel Machine Learning Based Approaches for Low-light Image or Video Denoising

PI: Namrata Vaswani; Soumik Sarkar

Company Partners (if applicable, company names only): Rockwell Collins

Project Goal: Development of denoising algorithms for low-light images and videos

Publications/presentations based on project:

1. *Technical report submitted to Rockwell Collins:* Literature Review: Low-light Images & Videos, Noise types and Denoising Algorithms, Final report under preparation
2. *Review presentation made to Rockwell Collins:* Low-light Images & Videos, Noise types and Denoising Algorithms, Phase II interim review (April 2016), Co-PI Sarkar presented "A Deep Autoencoder Approach to Natural Low-light Image Enhancement" in Rockwell Collins Inc., Cedar Rapids, IA (May 2016)
3. Journal paper: K. G. Lore, A. Akintayo, and S. Sarkar, LLNet: A Deep Autoencoder Approach to Natural Low-light Image Enhancement, Pattern Recognition, 2016.
4. Conference paper: Guo and Vaswani, Video denoising via online sparse and low rank matrix decomposition. SSP workshop 2016.

Invention disclosures: None

External funding applied for (indicate received/denied/pending): None

Progress report (300 word maximum, please focus on results in non-technical terms and commercialization progress):

In Phase II of the project, PI Vaswani and student has focused on developing an automatic and robust video denoising toolbox that combines the state-of-the-art existing denoising approaches with online robust PCA methods such as ReProCS - We tested the effect of replacing ReProCS with other robust PCA methods in their proposed Layering- Denoising (LD) method. Results on the Waterfall dataset shows that ReProCS is

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the best kernel. We also proved a theorem that, for an image corrupted with i.i.d. Gaussian noise, the number of pixels with very large noise magnitude (larger than some threshold) is upper-bounded. We are currently exploring the advantage of ReProCS for correlated Gaussian noise.

Co-PI Sarkar and students focused on deep learning based approaches to image denoising – we have developed a technique called LL-net and have evaluated it on the dark text image provided by Rockwell Collins, as well as on other data. Besides showing the enhancement results for the Poisson vs. Gaussian noise models, we showed the pros and cons of training with either type of noise and explained the underlying factors contributing to our observations. Dataset generation technique is equally crucial to algorithm effectiveness. More recent results involve a union of the two noise models with modifications in the synthetic image generation scheme involving a combination of tone mapping in addition to gamma darkening. A color version of LLNet is now available. The team is currently discussing with Rockwell Collins scientists to move towards hardware implementation of the proposed algorithm.

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RIF FUNDING: PROGRESS REPORT

Report Type: Final

Title: Identification of a Drug that Prevents BRD at the Feedlot

PI: Tim Day

Company Partners (if applicable, company names only): AeroGenics LLC

Project Goal: The goal of this study is to perform a small pharmacokinetic study to establish that the non-antibiotic drug reaches therapeutic levels and does not leave residues in meat at two weeks after the drug has been discontinued.

Publications/presentations based on project: none

Invention disclosures: none

External funding applied for (indicate received/denied/pending): We applied for a USDA SBIR grant in October 2015- unfunded. However, AeroGenics has raised the cash to pay for half of the efficacy study in 2016. We have already submitted a Phase II RIF proposal for the other half of the money.

Progress report (300 word maximum, please focus on results in non-technical terms and commercialization progress):

The pharmacokinetic study was performed in August 2015. We received the data in early 2016 and found that the drug achieves therapeutic concentrations in the blood. Thus we are planning on performing an efficacy study to demonstrate that the drug will prevent the development of BRD in feedlot calves. We would like to perform this study in the Fall of 2016, if Phase II funding is acquired.

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RIF FUNDING: PROGRESS REPORT

Report Type: Final

Title: Establishment of a Mobile Revolving Algal Biofilm (RAB) Cultivation System for Treating Industrial and Municipal Wastewater on Site

PI: Zhiyou Wen

Company Partners (if applicable, company names only): Gross-Wen Technologies

Project Goal: To develop a pilot-scale mobile Revolving Algal Biofilm (RAB) cultivation system that can be used to treat effluents produced by industrial manufacturing facilities and municipal wastewater treatment plants.

Publications/presentations based on project:

Gross M, Zhao XF, Mascarenhas V, Wen Z. (2015) Effects of surface physicochemical properties and the surface textures on the initial colonization and attached growth in algal biofilm. *Biotechnology for Biofuels*. 9: 38.

Gross M, **Wen Z.** (2015) Revolving Algal Biofilm (RAB) Cultivation System: Evaluation of Production, Economics, and Life Cycle. In: *9th Algal Biomass Summit*, Washington DC. September 30-October 2, 2015

Wen Z. (2016) A Revolving Algal Biofilm (RAB) reactor for microalgal cultivation. In: *Institute of Biological Engineers (IBE) 2016 Annual Conference*, Greenville SC. April 7-9, 2016.

Invention disclosures: N/A

External funding applied for (indicate received/denied/pending):

Funded: Evaluation of the performance of a revolving algae biofilm system for recovery of nitrogen and phosphorus from municipal wastewater. \$199,409; PI: Wen Z; Sponsor: Metropolitan Water Reclamation District of Greater Chicago. Period: 07/2014 – 12/2016

Funded: Deriving a new biobased product from wastewater: Production of a slow release algal-based fertilizer. \$100,000; PI: Gross M; Sponsor: USDA SBIR Phase I: 06/2016 – 12/2016

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Pending: Deriving a new biobased product from wastewater: Production of a carbon negative algal-based slow-release fertilizer. \$100,000; PI: Gross M; Sponsor: EPA SBIR. Period: 06/2016 – 12/2016

Pending: Enrichment of selenium in microalgae biomass for enhancing the feed quality. \$866,460; PIs: Probir D.; Wen Z; Sponsor: Qatar National Research Fund. Period: 01/2017 – 12/2019

Progress report (300 word maximum, please focus on results in non-technical terms and commercialization progress):

In this project, we propose to develop a pilot-scale mobile Revolving Algal Biofilm (RAB) system that can be used to treat effluents produced by industrial manufacturing facilities and municipal wastewater treatment plants. In particular, we proposed build a mobile RAB system in a trailer that can be transported into on-site in either industrial facility or municipal wastewater plant.

During the project period, we have designed the mobile RAB system, procured the large equipment (such as pilot-scale RAB system and the customer trailer), and developed the standard operational protocol of the RAB system. The trailer was delivered in February 2016. In term of RAB based algal culture, we started the RAB reactor in the algal production greenhouse to confirm the new RAB design to be functional with smooth operation. We then installed the RBA reactor in the trailer. The mobile RAB algal culture system proved very efficient for growing algae at a pilot scale with great flexibility of location.

Use the mobile RAB system, the algal culture research get a lot of exposure and interests from various industries needing cost-effective wastewater treatment technologies. ISU researchers are currently working with Chicago Wastewater Treatment Plant and two local companies to install the mobile RBA system for treating the wastewater produced from those facilities. The final goal is to implement a commercial scale RAB system as an efficient way for nutrient recovery from those wastewater streams.

During the project period, the research team worked on several proposals for extending the algal research. The team successfully secured a USDA SBIR (Phase I) project to develop a fertilizer product from the algal biomass after the wastewater treatment. It is expected that the RAB system will eventually be a solution to wastewater treatment plant for treating wastewater in an efficient way.

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RIF FUNDING: PROGRESS REPORT

Report Type: Final

Title: A Novel Assay for Rapidly Identifying Bovine STEC Carriers in Feedlots

PI: Jim Reecy

Company Partners (if applicable, company names only): PathoVacs; USDA

Project Goal: To develop a test to rapidly classify cattle with respect to their potential colonization with *Escherichia coli* (STEC; *E. coli* O157:H7 [O157]).

Publications/presentations based on project:

Invention disclosures: June 15th Provisional Patent Application submitted.

External funding applied for (indicate received/denied/pending):

Dr. Indira Kudva has submitted a CRIS project to USDA-ARS for funding to further this research (pending).

Progress report (300 word maximum, please focus on results in non-technical terms and commercialization progress):

Serum samples were collected from 12 calves before (day 0) and after (approximately day 21 and 49) colonization with human Shiga toxin producing *Escherichia coli* (STEC; *E. coli* O157:H7 [O157]) as well as 3 calves which were not colonized and had samples collected at the same time points. These serum samples were analyzed with a gas chromatograph/Mass spectrophotometer where we were able to quantitate more than 1000 metabolites. Statistical analysis shows that there are a subset of metabolites (33) that are nominally significantly associated with time points, suggesting that they change with *Escherichia coli* (STEC; *E. coli* O157:H7 [O157]) infection. Using this subset of metabolites we are able to group animals by *E. coli* strain or lack of colonization and time point. To date our analyzes indicate that it may be possible to develop a rapid test to classify cattle with respect to their potential colonization with *Escherichia coli* (STEC; *E. coli* O157:H7 [O157]). This has food safety implication for the beef industry as they would have an easy to use test to monitor for STEC *E. coli* colonization.

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RIF FUNDING: PROGRESS REPORT

Report Type: Final- update on SBIR funding

Title: "Development of a Genetic Test for *Salmonella* Resistance in Cattle"

PI: Steve Carlson

Company Partners (if applicable, company names only): PSR Genetics

Project Goal: The goal of the project is to identify a genotype that confers *Salmonella* resistance to black cattle. Our previous studies identified a resistance-conferring genotype in non-black cattle, which comprise only 20% of the cattle in the U.S. And thus the aim of this project is to expand the scope of this genotype, and thus the marketplace for a genetic test, to the majority of U.S. cattle.

Publications/presentations based on project: We presented our data to the Akaushi Breed Association Annual Meeting on Oct. 31, 2015 in Santa Rosa, NM. We also presented our data to the Aubrac Association on Nov. 7, 2015 in Wellsburg, KS.

Invention disclosures: None as of yet

External funding applied for (indicate received/denied/pending): We submitted a USDA SBIR grant proposal in Oct. 2015. We will be submitting a revision in October 2016.

Progress report (300 word maximum, please focus on results in non-technical terms and commercialization progress):

PSR Genetics previously found a gene that consistently leads to *Salmonella* resistance in certain cattle, specifically those that are non-black (e.g., Red Angus, Charolais, Piedmontese, Braunvieh, Shorthorn, Tarentaise, etc.). For black cattle, the resistance is rare and only occurs sporadically with an unknown genetic basis. In this study, we screened 3,717 blood samples for potential *Salmonella* resistance using an assay that was developed by PSR Genetics. In this assay, we incubated *Salmonella* with blood cells and quantified the number of *Salmonella* that can survive within the white blood cells- this is the assay that preliminarily identified the non-black cattle that resist *Salmonella*. Of these 3,717 blood samples, *Salmonella* resistance was observed in 60 samples from black cattle. Our next step was to identify genes whose expression was diminished in these 60 samples. We focused on 34

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genes that encode for proteins exploited by *Salmonella* during the infection process. In 55 of the 60 samples, 10-12 genes were significantly less expressed although it was not the same 10-12 genes in each sample. That is, any of the 34 genes could be “hypo-expressed” and lead to resistance. The next step is to identify the genetic differences in these 34 genes in the 55 samples. We will also need to confirm that the white blood cell-associated resistance extrapolates to the live animal, by performing experimental infection studies. As such, we will be submitting a USDA SBIR grant for the funds needed for the next study. Once completed, we will identify a set of genetic differences that confer the *Salmonella* resistance to black cattle. We will then partner with GenSeek to create a multi-gene “chip” that will detect the specific subset of genes differences that lead to *Salmonella* resistance in black cattle. Given the likelihood that *Salmonella* will be declared as an adulterant in beef in the next year or two, we envision that the packing plants will pay a premium for cattle that are verified to harbor the subset of resistance genes. This premium will augment the appeal of the genetic test for the industry.

Update on SBIR funding:

In October 2015 we submitted an SBIR grant proposal to the USDA. In April of 2016 we received the reviews of this proposal and the program officer indicated that we just missed the funding cut-off. He indicated that we would have been the next funded grant if the program had the additional funds. He strongly encouraged that we address the few criticisms and re-submit next year.

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RIF FUNDING: PROGRESS REPORT

Report Type: Final

Title: Towards Real-Time Nitrate Monitoring

PIs: Amy Kaleita-Forbes

Company Partners (if applicable, company names only): Agri-Drain

Project Goal: To characterize ion species present in tile drained water, in support of development of a nitrate sensor.

Publications/presentations based on project:

Zimmerman, B. and A. Kaleita, "Analysis of the constituents that influence electrical conductivity of agricultural drainage water," Poster presented at the 2016 Iowa Water Conference, March 2016, Ames, IA.

One poster to be presented at the annual meeting of the ASABE in July 2016; two journal articles to be submitted for review July/Aug 2016.

Invention disclosures: None

External funding applied for (indicate received/denied/pending): None at this time.

Progress report (300 word maximum, please focus on results in non-technical terms and commercialization progress):

During the summer and fall 2015, thanks to an unusually wet summer and autumn, we collected drainage water samples from ISU tile drainage research plots outside of Ames, as well as from a drainage district collector tile culvert near Colo. These were sent for analysis of ion species composition at the Iowa Hygienic Laboratory in Ankeny. We then characterized the typical levels and variability of ions that affect the electrical conductivity of such waters, as well as determined the major drivers of changes in electrical conductivity and ion composition.

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This information will be necessary in order to further our development of a nitrate-specific dielectric sensor, because all ions, including nitrate, will contribute to the dielectric signal generated by the tile drain water. Moving forward, we are using the concentration information developed through this RIF project to refine our laboratory procedures in development of the sensor, which is currently funded by the USDA National Institute for Food and Agriculture (NIFA). Working with Agri-Drain and the CyBiz student team on this project, we determined a target price point of \$300 for an accuracy of +/- 2 mg/L.

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RIF FUNDING: PROGRESS REPORT

Report Type: Final

Title: SGBR Pilot Test on Primary and Secondary Sludge

PIs: Timothy G. Ellis

Company Partners (if applicable, company names only): Fox Engineering Associates

Project Goal: To evaluate the performance of the SGBR to treat primary and secondary sludge at short retention times (e.g., 24 hours) and ambient temperature.

Publications/presentations based on project: manuscript in preparation entitled: Laboratory and pilot-scale demonstration of the Static Granular Bed Reactor (SGBR) for treating primary and secondary sludge from a municipal wastewater treatment plant

Invention disclosures:

External funding applied for (indicate received/denied/pending): proposal in preparation for the NSF Grant Opportunities for Academic Liaison with Industry (GOALI) program

Progress report (300 word maximum, please focus on results in non-technical terms and commercialization progress): The laboratory portion of the study has shown that the SGBR system achieved removal efficiencies of TSS and COD of over 90% treating primary and secondary sludge from the Ames Water Pollution Control Facility. This is well in excess of the approximately 50% removal efficiency currently being achieved by the conventional (heated) digesters at the plant. The influence of the organic loading rate on the removal efficiency was evaluated under differing conditions ranging from 0.93 to 1.66 kg/m³·d at a range of hydraulic retention times of 48 to 24 hours. Effluent pH, alkalinity, and VFA values did not fluctuate much indicating the superior stability of the system.

A pilot-scale 1000-gallon SGBR was installed at the Ames Water Pollution Control Facility and has been operating for approximately 4 months with excellent results. The target influent concentration was 2000 mg/l and within 3 weeks of start-up the SGBR achieved greater than 95% solids removal. Chemical oxygen demand (COD) removal also exceeded 95% removal within 2 weeks of start-up. These results have been even better than

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the laboratory portion of the study suggesting that scale-up of the SGBR from lab scale to full scale will be feasible. Other indicators of system performance and stability (e.g., volatile fatty acids, alkalinity, gas production, etc.) have been excellent. The SGBR has been operated at an ambient temperature of 23°C. Methane content of the biogas produced has averaged 71.5% with the balance being primarily carbon dioxide. This study demonstrates the good applicability of the SGBR system to treat primary and secondary sludge and reinforces the premise that the system is a viable option for municipal wastewater treatment plants wanting to optimize the performance of their anaerobic digestion systems with respect to solids and COD removal, renewable energy production, prevention of odors, and minimization of sludge requiring ultimate disposal.

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RIF FUNDING: PROGRESS REPORT

Report Type: Interim

Title: Plant extracts that efficiently enhance muscle growth in swine

PIs: Steve Carlson

Company Partners (if applicable, company names only): Diamond V

Project Goal: To identify plant extracts that reduce myostatin expression and thus enhance muscle growth in swine that are fed these extracts.

Publications/presentations based on project: none as of yet

Invention disclosures: ISURF Case Number 04531, Cruciferous plant extracts that inhibit myostatin in swine

External funding applied for (indicate received/denied/pending): none as of yet

Progress report (300 word maximum, please focus on results in non-technical terms and commercialization progress):

In our preliminary studies (Phase I) we identified two diets that increased feed efficiency, muscle accretion, and muscle fiber density in growing pigs. These two diets are: (1) kale extracts plus ground mustard seed; and (2) four cruciferous vegetable extracts plus ground mustard seed.

We are awaiting data regarding myostatin gene expression and serum sulforaphane, the latter of which is the beneficial inhibitor of myostatin expression. These data will be available at the final report.

Based on the data derived to date, Diamond V would like to pursue Phase II funding in order to demonstrate the beneficial effects of these diets in finisher pigs. Ultimately, these diets could be added to their existing swine products- either XPC or SynGenx.

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RIF FUNDING: PROGRESS REPORT

Report Type: Final

Title: National Implementation of the Secure Egg Supply (SES) Data Portal—Phase II

PI: James Roth, Center for Food Security and Public Health

Company Partners (if applicable, company names only): GlobalVetLINK (GVL)

Project Goal:

The project goal is to gather system requirements for a National Secure Egg Supply (SES) Data Portal. We plan to use the project funds to hire two contract programmers to work with the Center for Food Security and Public Health (CFSPH) and GVL to gather system requirements for the data portal. This work is an essential step for transitioning the current Iowa – only data portal to a sustainable national portal commercialized by GVL. The portal will be beta tested by an Iowa egg producer that has used the Iowa –only demonstration portal. The long term goal is that the SES plan and data portal will become operational nationwide and that it can be expanded to control additional poultry diseases nationwide.

Publications/presentations based on project:

September 12, 2014: Webinar (Jim Roth and Kevin Maher) with Pat Stonger (DayBreak Eggs) and University of Minnesota Partners

September 15, 2014: SES Group Conference Call (approximately 60 participants) – Presentation by Jim Roth on the future plans for the data portal and voluntary preparedness component of the SES.

Meeting with Pat Stonger, UMN partners at the US Animal Health Association meeting in Kansas City, on October 19.

GVL Workshop with Iowa Egg Producers, Thursday, December 18, 2014

Invention disclosures: None

External funding applied for (indicate received/denied/pending):

Currently exploring potential funding sources related to the egg industry

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Progress report (300 word maximum, please focus on results in non-technical terms and commercialization progress):

In close collaboration with the CFSPH team at Iowa State, between January 2015 and May 2015, GlobalVetLINK delivered the following functionality in the national Secure Egg Supply portal in Phase I of the RIF grant:

- Implemented the SES portal prototype complete with SES branding and sample data
- Created three user role types (Production Manager, Incident Command, Auditor)
- Established data architecture
- Created beta API for data inputs and outputs with minimal usage documentation
- Implemented basic functionality for an SES Producer
 - Premises maintenance
 - House maintenance
 - Daily reporting
 - Enhanced cleaning and disinfecting checklists
- Implemented basic functionality for an SES Auditor
 - Associate a third party audit "sign-off" with a premises
- Implemented basic functionality for an SES Incident Commander
 - View premises, daily production data and bio-security data by premises

Implemented a user sign-up process

Phase II of the project began on June 1, 2015

- GVL hosted two webinar sessions.
 - The audiences were egg producers and state veterinarians. A third session was hosted specifically for the state of Michigan.
- The GVL development team worked to ensure a sound product was available for demonstrations and prepared the sign-up protocol for egg producers.
- A GVL team member attended the SES meetings in conjunction with the NEUSAHA meetings in Harrisburg, PA.
- Deployment process has been finalized and the system is available on GVL production servers.
- Marketing designed and executed a training worksheet in addition to training GVL staff on onboarding and customer support of the product.
- The GVL team is working to determine a method to share data with EMRS2.
 - GVL team member met with Dr. Fred Bourgeois at USAHA annual meetings to discuss this possibility.
- The incident command feature has been implemented as an option in the GVL SAHO login for streamlined access and ease of use.
- GVL and ISU held several meetings to discuss lessons learned from the HPAI outbreak and the direction the industry is taking the SES program
- A GVL team member attended NCUSAHA conference to attend HPAI lessons-learned sessions including one presented by Dr. Patty Fox, USDA
- GVL and ISU held several meetings to discuss leveraging work done with the SES portal to accommodate other SFS programs. We are optimistic that this investment will be successfully leveraged with other SFS programs in the future.

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RIF FUNDING: PROGRESS REPORT

Report Type: Final

Title: Development of an Advanced Spray Diagnostic Test Rig for the Measurements of Spray Flows Exhausted from Liquid Fuel Injectors—Phase II

PIs: Dr. Hui Hu (Iowa State University; Tel: 515-294-0094/Email: huhui@iastate.edu)
Mr. Spencer Pack (UTC Aerospace Systems; Tel: 515-633-3460/Email: Spencer.Pack@utas.utc.com)

Company Partners (if applicable, company names only): UTC Aerospace Systems

Project Goal: Build and certify a 250 psi spray rig at ISU to the characterize spray flows exhausted from liquid fuel injector/atomization nozzles.

Publications/presentations based on project: None to date.

Invention disclosures: None to date.

External funding applied for (indicate received/denied/pending):

UTAS \$50K cost match with ISU agreement. No others pending.

A joint research proposal to be submitted to NSF is under preparation.

Progress report (300 word maximum, please focus on results in non-technical terms and commercialization progress):

The joint program, entitled “Development of an Advanced Spray Diagnostics Test Rig for the Measurements of Spray Flows Exhausted from Liquid Injectors- Phase IP”, has begun at United Technologies Aerospace Systems and Iowa State University. The objective of the project is to develop an advanced spray diagnostics test rig (up to an elevated pressure of 250psi) to quantify spray characteristics and to elucidate important processes in fuel spray flows, such as the breakup of liquid fuel jets and sheets, atomization and evaporation of fuel droplets, and air/fuel mixing by using advanced laser-based spray diagnostic techniques. The proposed high-pressure spray test rig will be used to assist UTAS in developing next generation fuel nozzles/injectors for maximized energy efficiency while minimizing pollutant emissions, and maintaining the operability requirements.

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The high-pressure spray diagnostics test rig has already been successfully manufactured and installed at Aerospace Engineering Department of Iowa State University. Some preliminary experiments have already been conducted to test the spray flow rig at several elevated pressure levels. More comprehensive experiment campaign to characterize spray flows exhausted from UTAS fuel injectors are undergoing. The researchers from ISU and UTAS are in the conversation to write joint research papers and submit joint research proposals for external funding in order to build a self-sustainable high-pressure spray test facility based on the preliminary measurement results derived from this RIF project.

In summary, the project has made very good progress. The research team has been holding bi-weekly meetings throughout the entire program to ensure that all the program goals are met in a timely manner.

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RIF FUNDING: PROGRESS REPORT

Report Type: Final

Title: Development of Biorenewable Thermoplastic Block Copolymers—Phase II

PIs: Eric Cochran, Chris Williams

Company Partners (if applicable, company names only): ArgoGenesis Chemical, LLC, Archer-Daniels Midland Co, Seneca Petroleum, Kraton Polymers, LLC

Project Goal:

The goal for this project is to create a cost effective way to chemically synthesize specialized hybrid materials (biorenewable thermoplastic block copolymers) that current technology does not allow for.

Publications/presentations based on project: None

Invention disclosures: ISURF 04435

External funding applied for (indicate received/denied/pending): None

Progress report (300 word maximum, please focus on results in non-technical terms and commercialization progress):

The goal of this project, as mentioned before, is to create a method that will help merge industry's cost effective, but limited in the number of monomers that can be polymerized, way of synthesizing rubber with a novel technology that allows the polymerization of a wider spectrum of monomers, including biorenewables.

Our main focus is still in the synthesis of chain transfer agents (CTAs) that can serve as termination agents for industry's rubber production. Currently we have synthesized a wide variety of CTAs which have seen some preliminary success. One of our CTAs has a halogen handle and has seen as high as a 50% effectiveness as a termination agent. Other CTAs have also shown some potential, however their effectiveness rate is lower than 30%. We are currently working on taking the successes that we have had and optimizing the reaction conditions so that we increase our conversions and get into the 90+% range.

Additionally we are looking at a new way of "growing" the CTA off of a living polymer. Instead of terminating the reaction with a CTA, the new procedure will consist of a series of steps to convert the living

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polymer into a CTA. First few attempts have shown some partial success (<10%) and we are currently working on the reaction conditions to improve these results.

We are still very confident that we are now closer to creating a different molecules that will serve as terminator with a high termination efficiency which will require no other undesirable side reactions. Once we synthesize these CTAs we will continue to test their efficacy to polymerize a wide range of different monomers.

Kraton Polymers, LLC continues to be very interested in joining efforts in perfecting and further developing this method. We are currently negotiating a Master Sponsored Projects agreement with Kraton.

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RIF FUNDING: PROGRESS REPORT

Report Type: Final

Title: Evaluation of α -Synuclein Immunotherapeutics in Animal Model of Parkinson's Disease

PI: Balaji Narasimhan

Company Partners (if applicable, company names only): PathoVacs, PK Biosciences

Project Goal: To delay onset and/or retard progression of PD in a proxy murine model of human PD via delivery of “Trojan horse” polyanhydride nanoparticles formulated with F(ab)₂ fragments of high affinity polyclonal antibodies (sHA-PAbs, developed in phase I) and monoclonal antibodies (sHA-MAbs) experimentally generated against epitopes unique to aggregated/pathological human α -Synuclein, across the blood brain barrier to slow down neuronal degeneration and cell death.

Publications/presentations based on project: None

Invention disclosures: None

External funding applied for (indicate received/denied/pending): An STTR grant proposal submitted to the National Institutes of Health was denied funding. The proposal “ α -Synuclein based nanomedicines for Parkinson's disease” has been bolstered with new data for re-submission.

Progress report (300 word maximum, please focus on results in non-technical terms and commercialization progress):

This Phase II study comprised **three objectives:** Toward objective #1 (PathoVacs, Inc.), we successfully generated F(ab)₂ fragments of sHA-PAbs [sHA-PAbs-F (ab)₂], which were encapsulated within polyanhydride nanoparticles for animal studies. Additionally, in collaboration with the ISU Hybridoma Core Facility, we successfully generated a panel of 27 sHA-MAbs with exquisite singular specificity for the pathological (aggregated) form of human recombinant α -Syn. Toward specific aim#2 (PathoVacs and PK Bio), we examined one clone and determined that the sHA-MAb (IgG2a isotype, secreted by clone 6G7) has diagnostic potential as evidenced by its differential reactivity, i.e., react more strongly with sera of PD patients compared with sera from healthy age-matched individuals. We are systematically evaluating diagnostic potential of the remaining 26 sHA-MAbs, following which an ELISA for early accurate diagnosis of PD will be developed using the best sHA-MAbs.

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Animal studies: The next step in the project was to test the therapeutic efficacy of our F(ab)₂ fragments of sHA-PAbs. Prior to injecting F(ab)₂ fragments into animals, we determined whether they crossed the blood-brain barrier to reach their intended target. The dose and route of were similar to that described previously for an α -synuclein antibody (Games et al., J Neurosci, 2014 • 34(28):9441–54).

Animal study 1: Animal protocols were approved by the Iowa State University IACUC. Albino mice (Jax strain B6(Cg)-Tyr^c-2J/J) were purchased from Jax Mice, and after acclimation were administered fluorescently labeled F(ab)₂ fragments via intraperitoneal injection. Each mouse received either 25 μ g F(ab)₂ solubly or encapsulated in 500 μ g of 20:80 CPH:SA nanoparticles. All mice were imaged on days 3, 7, and 14 days post-administration. During imaging, mice were kept under anesthesia with 2.5% isoflurane in 100% O₂, at 2.5 L/min. At each time point, a cohort of mice was euthanized and the brain, liver, kidney, and spleen were dissected for ex vivo imaging.

Results: We observed an increased fluorescence in liver, kidney and spleen but not in brain.

Animal study 2: Since F(ab)₂ fragments did not reach the brain after intraperitoneal administration, we next explored if intranasal administration would be facilitate entry into the brain. In this study, we intranasally administered 25 μ g F(ab)₂ solubly or 25 μ g encapsulated within 500 μ g of 20:80 CPH:SA nanoparticles. Anesthetized animals were imaged on days 1 and 3 post-immunization. In addition, ex vivo images of the brain and lungs were captured.

Results: We observed an increased fluorescence in lung tissue but not in brain.

Animal study 3: Finally, a repeated, high dose regimen was used to examine the ability of encapsulated F(ab)₂ fragments to reach the brain. Each mouse received an intraperitoneal administration of either 250 μ g F(ab)₂ solubly or encapsulated within 5 mg 20:80 CPH:SA nanoparticles for three consecutive days. Anesthetized animals were imaged 1 and 4 days after the last administration. In addition, mice were euthanized at each time point and the brain, liver, kidney, and spleen were imaged ex vivo.

Results: We observed an increased fluorescence in liver, kidney and spleen but not in brain.

Next steps: Based on the current studies, polyanhydride nanoparticles are being functionalized with TPP to enable BBB penetration. These functionalized particles will be used to encapsulate the F(ab)₂ fragments and animal experiments will need to be performed to confirm BBB penetration. In addition, we mentioned previously, we are evaluating the diagnostic potential of the remaining 26 sHA-MAbs, following which an ELISA for early accurate diagnosis of PD will be developed using the best sHA-MAbs. Based on these studies, we anticipate submitting multiple grant proposals to NIH.

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RIF FUNDING: PROGRESS REPORT

Report Type: Final

Title: A Castable, Ceramic-Reinforced Aluminum Composite—Phase II

PI: Alan Russell

Company Partners (if applicable, company names only): NewTech Ceramics

Project Goal: Develop a test casting of Al + BAM composite that contains regions with slow cooling rate, intermediate cooling rate, and fast cooling rate. Test the mechanical properties of metal taken from each of these regions to determine the relationship between cooling rate and mechanical properties.

Publications/presentations based on project: None yet.

Invention disclosures: This IP is protected by U.S. patent no. 7,172,641, “Ultra-hard boride-based matrix reinforcement”; issued 6 Feb, 2007, Cook B.A., Russell A.M., Harringa J.L., Biner S.B., and Anderson I. ISURF has licensed this patent to NewTech Ceramics.

External funding applied for (indicate received/denied/pending): An SBIR Phase I proposal entitled “Processing Optimization to Produce a Low-cost, Eco-friendly, High-modulus, Weldable Aluminum-matrix Composite” was submitted on June 13, 2016 to the National Science Foundation requesting funding in the amount of \$211,000 to continue development of this material. This funding decision is pending.

Progress report (300 word maximum, please focus on results in non-technical terms and commercialization progress):

Several test castings were performed from specimens prepared by mixing aluminum, magnesium, and boron in alumina crucibles and heating for various combinations of time and temperature. From these experiments, it was determined that a slowly cooled specimen held at 1400°C for one hour produced the best result. It is nearly free of the porosity that had marred earlier test castings in this project. The composite was 92.7% Al and 7.3% BAM.

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A test weld demonstrated that the material can be welded by tungsten inert gas (TIG) welding. A cross-section of the welded piece is revealed that the size and distribution of BAM in the fusion zone is essentially the same as in the material that was not welded, a desirable outcome.

Al + BAM specimens were tested at Oak Ridge National Laboratory by pin-on-disk wear testing. These measurements predict how well this composite material will perform in severe wear environments. Aluminum metal generally performs poorly in high-wear environments. The presence of BAM in the aluminum was expected to improve wear resistance. The wear test showed that the Al+BAM wear rate was three times lower than in aluminum without BAM, and the Al+BAM also had a 25% lower coefficient of sliding friction.

The commercialization goal is to produce a simple, low-cost, environmentally friendly method for producing a high-modulus, wear-resistant, weldable aluminum. The findings of this project confirm that every one of the characteristics underlined is achievable in Al+BAM.

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RIF FUNDING: PROGRESS REPORT

Report Type: Final

Title: Plunger Cast Equipment Design, Fabrication, and Product Engineering for Commercial Scale Polymer Mortar Composite (PMC) Pipe Manufacturing—Phase II

PI: David White

Company Partners (if applicable, company names only): r-Pipe

Project Goal:

- 1) Fabrication of Plunger Cast Equipment and Molds for 24" product; 2) Manufacture 24" diameter specimens for commercial testing; 3) Commercial testing and validation
-

Publications/presentations based on project:

Invention disclosures:

External funding applied for (indicate received/denied/pending):

Progress report (300 word maximum, please focus on results in non-technical terms and commercialization progress):

June, 2016

During May and June, there have been a series of on-site meeting with representatives from the Ames Laboratory to deliver the mold, install connection pieces to the mold press, and evaluate the performance of the mold and heaters. During this process it was discovered that the outer mold and the top flange to not match up properly and the Ames Laboratory picked up the mold on June 23 to make modifications.

Several trial mixtures were evaluated during this period and the results look promising.

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There have also been several meetings during this period with ISU officials regarding the rental of the pipe mold. Currently a draft agreement has been developed and R-Pipe is waiting on our insurance carrier to verify the insurance requirements.

Once the mold is returned from ISU, it will be evaluated and casting of the pipe sections for commercial evaluation can begin.

December, 2015

The plunger cast equipment and molds are in the final stages of assembly by the Ames Laboratory Machine Shop. The prototype equipment has gone through a preliminary run out and some minor modifications are being addressed. A project review was conducted on December 18 to identify the final assembly details. 100% completion is anticipated for on the equipment and mold will be completed by January 8, 2016. R-Pipe has hired an Iowa company to fabricate the needed hydraulic press, and this will be completed by January 15, 2016. With equipment now nearly completed, it is anticipated that the manufacture of test specimens can begin in January 18, 2016. According to our most recent project review with the Ames Laboratory, the Phase 2 funding as approved will be sufficient to complete the work.

July 2015

Project goals have been slowed because of the extra time taken to fabricate the Plunger cast equipment and molds. The Ames Laboratory Machine Shop is expected to complete the equipment by 6.26.2015. Requirements for a hydraulic press has been completed and this will be purchased using Phase 2 funding. It is anticipated that manufacture of the test specimens will begin in late August.

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RIF FUNDING: PROGRESS REPORT

Report Type: Final

Title: Electronic Canine Collar Advancement thru Multi-purpose, Proof-of-Concept Trials

PIs: Al Jergens

Company Partners (if applicable, company names only): PetMeasure

Project Goal:

This trial aims to use an automated dog collar to measure real-time animal core body temperature and transmit these data to veterinary clinicians via a mobile (phone) application. The measurement of these data will optimize remote patient management following general anesthesia events and/or surgical procedures.

Publications/presentations based on project:

None at this time

Invention disclosures:

External funding applied for (indicate received/denied/pending):

Progress report (300 word maximum, please focus on results in non-technical terms and commercialization progress):

This project has made real advances in collar design and in vivo data collection over the past 6 months. The focus has been on collar device refinement with regards to consistency/longevity of paired sensor (temperature) readings and their correlation to other measures of core (e.g., esophageal and rectal) body temperature. Using 3 student workers trained in collar placement and recording, 10 dogs undergoing orthopedic surgical procedures were targeted for assessment due to the length and nature of their anesthetic event and the impact this intervention plays in maintenance of body temperature.

Results indicate that consistent temperature recordings are possible with the collar device although there is some variability in the sensor-to-sensor readings on a patient. Temperature recordings were possible in all phases of an

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anesthetic event in each dog, including IV catheter placement, anesthesia induction, anesthesia maintenance with/without external heat, and patient recovery. Trial data also show good and predictable correlation of collar temperature detection to core body temperature via esophageal probe but not with core body temperature using a rectal probe. Another subset of animals where remote monitoring of body temperature is advantageous will be performed in dogs in ICU with recurrent or persistent fevers. In these instances, temperature fluxes may occur in response to natural disease course (clinical relapse or remission) or medical (antimicrobial) intervention.

Goals for the next 12 months are ambitious and include: (1) expansion of canine cohorts to include other specialty cases (such as internal medicine), (2) beta testing of ICU patients as described above, and (3) out-patient monitoring with a harness device in healthy dogs. In this latter trial, we will be investigating out-patient, continuous monitoring of body temperature but also measurement of other indices including mobility patterns, heart rate, respiratory rate, and pulse character.

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RIF FUNDING: PROGRESS REPORT

Report Type: Final

Title: In-Situ Wireless Soil Moisture and Salinity Sensor and Extension for Nitrate and other Nutrients/Ion Sensing

PIs: Ratnesh Kumar

Company Partners (if applicable, company names only): Microwaves by the Weber, Inc.

Project Goal: Research and Technology Transfer Efforts towards In-Situ Wireless Soil Moisture and Salinity Sensor, and extension for Nitrate Sensing

Publications/presentations based on project: Several industry presentations have been made to Monsanto/ClimateCorp/Solum, DuPont-Pioneer, and Raven Industries. I am trying to also organize a presentation in India to folks at [International Crop Research Inst. For Semi-Arid Tropics](#) and [Ministry of Agriculture and Farm Welfare](#). The work was also presented at these conferences:

1. Energy Harvesting and Storage, 2015, Santa Clara, "In-Situ, Sensor-Aided Sustainable Agriculture and Broadband Vibrational Energy Harvesting"
2. S. Tabassum, Q. Wang, W. Wan, S. Oren, M. A. Ali, R. Kumar, and L. Dong, "Plasmonic Crystal Gas Sensor Incorporating Graphene Oxide for Detection of Volatile Organic Compounds", IEEE International Conference on Micro Electro Mechanical Systems (MEMS), Shanghai, China, Jan. 2016.

Invention disclosures: One invention disclosure on soil moisture and salinity sensor with its wireless interface was filed prior to the RIF funding (ISURF 04183), and development and tech transfer work on that is continuing. In addition, two new invention disclosures were filed in Fall 2015, one on Nitrate sensing (ISURF 04454) and another on Plant Gas Sensing (ISURF 04453). Also, the Vibration Energy Harvesting invention (ISURF 4354) was submitted for a Full Patent Application, on 4/11/16. (The harvested energy can be used for powering our remote sensors.)

External funding applied for (indicate received/denied/pending): One NSF proposal that was submitted to NSF titled, "PFI: AIR - TT: In-Situ Wireless Soil Sensor for Moisture, Salinity and Ions", with period of performance May 2016-Oct. 2017 (18 months) has been funded in the full amount of \$200K. A second NSF proposal was submitted to NSF titled, "INFEWS/T3: Reducing Energy Demand and Water Discharge Pollutants in Agricultural Food Production: Sensors, Models and Socio-Economics", with period of performance August 2016-August 2020 (5 years) in the amount of \$3M, engaging 8 researchers from 4 institutes (ISU-ECE/Ag/Econ, USDA-ARS, UCI, McGill) and 3 Industries (Raven, mCUBE and MWBW Inc).

Progress report (300 word maximum, please focus on results in non-technical terms and commercialization progress): The research work on In-Situ Soil Moisture and Salinity Sensing and its Wireless Interface was completed prior to RIF funding. Subsequent to RIF funding we have been engaged in its prototyping and technology transfer efforts. A new version of the sensor is currently prototyped, with some hardware bugs corrected, and that will have the additional capability of operating in Sleep mode, and extra

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amplification of transmission power. Once the hardware development is completed, software development work will be started to interface computer with the sensor, and to calibrate the sensor readings.

The development work on Nitrate sensor is also progressing. A Dept. level seminar presentation was made by the PhD student Zhen Xu in March 2016, along with a poster presentation. The current work is focused on the sensing part, which consists of a microfluidic system for flowing the soil solution along a channel for electrophoretic separation of different ions and a current readout mechanism. The sensing part and its sensing principle has been verified in the lab. Additional research would be needed to make a complete sensor that will have additional microfluidics for drawing in soil solution, its filtering to remove soil particles and gasses, and an integrated stimulation and readout mechanism.

We signed a NDA with the Raven Industries in Sept. 2015. A demo to Raven was presented on ISU campus in the same month. Raven invited us back for another demo at their site in Sioux Falls, SD in Nov. so a larger group could see the working of the sensor. The discussion about options licensing is taking place between Raven and ISURF, and is close to being finalized (Jay Bjerke is our point of contact, and can share more details of the progress). We also signed an NDA with Pioneer in Jan. 2016, and a demo and presentation to them on March 30, 2016. Finally, an NDA with Monsanto/ClimateCorp/Solum was signed in August 2015, and revised in May 2016, while a demo and presentation was given in May 2016. IntelliFarm is another company, a start-up based in Nebraska, that is interested in our technology, and to whom we made a presentation in May 2016. For further discussion, we would need to enter an NDA with them.

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RIF FUNDING: PROGRESS REPORT

Report Type: Interim

Title: The Effect of HMB Supplementation on Adipose Tissue Inflammation and Metabolism

PIs: Rudy Valentine

Company Partners (if applicable, company names only): MTI

Project Goal:

To examine the mechanisms of a novel and safe therapy that results in fat loss, reduced adipocyte size and inflammation, increased adipocyte fatty acid metabolism and improved metabolic health in obese individuals.

Publications/presentations based on project: N/A

Invention disclosures: N/A

External funding applied for (indicate received/denied/pending): N/A

Progress report (300 word maximum, please focus on results in non-technical terms and commercialization progress):

The project is underway, with six participants officially enrolled in the study. Baseline data, including body composition, metabolism, muscular fitness and inflammation, has been collected on five of six participants and the intervention will be complete on this first wave of participants in early September.

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RIF FUNDING: PROGRESS REPORT

Report Type: Final

Title: Technology for Value-Add Recycled Plastics and Real-Time Detection of Contamination in Food Packaging and Waste-Stream Diversion

PIs: Keith Vorst and Wyatt Brown (Cal Poly, San Luis Obispo)

Company Partners (if applicable, company names only):

Amcor Rigids
Dart
Peninsula Packaging
Niagara Bottling
IdeoPak
American Packaging Company

Project Goal: To define methods and systems for optimizing recycled plastics packaging substrates to provide value-add features and increase shelf-life of perishable products through real-time data capture during manufacturing and packaging operations.

Publications/presentations based on project:

Speaker/Presenter

K.Vorst. 2016. Innovations in Recycled Plastics Packaging Technology. REFOCUS Recycling Summit for Society of Plastics Industries (SPI). Orlando, FL. April 26-27.

K.Vorst. 2016. Real-Time Detection of Organic and Inorganic Contamination in Packaging. 6th International Symposium on Food Packaging-Supporting Safety and Innovation, International Life Science Institute (ILSI). Barcelona, Spain Nov 16-18.

Publications:

Curtzwiler, G., Maples, A., Williams, E., Davis N., De Leon, E., and Vorst, K. 2016. Added value of increased ultraviolet protection by incorporating recycled polyethylene terephthalate into packaging. Trends in Food Science and Technology Submission June 2016 (in-submission).

External Funding:

2016 INFIEWS/T3: Enabling Innovative Systems Solutions with High Voltage Atmospheric Cold Plasma at the Intersection of Food, Energy, and Water, National Science Foundation

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(NSF) Proposal number 1639054 \$2,168,720.00 (not reviewed). Note: Includes a large component on monitoring packaging contamination, removal or organic and inorganic compounds to add value to plastics.

2015-2016 Online Contamination Analysis of RPET During Extrusion and Thermoforming Processes and Shelf-life Extension of Fresh-Cut Produce. Funded – Iowa State University Polymer and Food Protection Consortium.

Invention disclosures:


- 1.) **Application Number 62/324,790; ISURF# 04335:** Atty. Docket. No 29609.0740 Method for Optimizing Plastics Compositions Used in Packaging to Increase Shelf-Life of Perishable Products and System Thereof
- 2.) **Publication Number US 20140332994 A1 Detection in Thermoplastics (Danes and Vorst)**
International Application Number PCT/CL2014/000020

Progress report (300 word maximum, please focus on results in non-technical terms and commercialization progress):

This work has shown commercial viability of real-time analysis during plastic conversion is correlated to PCR content, compound identification and thus, shelf-life extension. The results from thermo-mechanical processing of polyethylene terephthalate, which is known to cause main chain degradation of the polymer, produced a multitude of degradation byproducts that reflect or absorb UV light and can be controlled through blending, additives and monitoring during conversion. Work completed at ISU mounted with in-line sensors (UV-vis, IR, X-ray), with room for three more optical sensors (i.e.- Raman, fluorescence, etc.) demonstrated optimized blends and compounds for increased material performance. The current system has successfully collected full scans from 200-800 nanometers at a speed that can match industry standard extrusion rates. This data will be processed using an algorithm that combines data from the aforementioned sensors to predict PCR content and extend shelf-life by utilizing additives and compounds not visible to the human eye but capable of blocking specific electromagnetic wavelengths that cause degradation to food products .

Blends of polyethylene terephthalate containing various amounts of post-consumer recycled material (PCR) were run simultaneously through several different types of sensor arrays such as inline UV-Visible light spectrometer (UV-Vis) and an energy dispersive x-ray diffraction (ED-XRF) and infrared (IR). Each sensor collected various data signals from which determines various classes of chemical compounds and heavy metals present in the polymer matrix. Proof of concept work was done in the Iowa State University Packaging Lab in conjunction data collected on a commercial extrusion monitoring equipment has demonstrated the potential integration into existing manufacturing and packaging systems. Corporate partners have been engaged to allow the current lab beta system to be installed in commercial extrusion and packaging lines to demonstrate scalability to provide value add to recycled plastics (Table 1).

Table 1. Task Progress

Obj.	Task	Milestone or Type	Milestone Verification	Anticipated Date	Status
1	Build sensor array	Milestone	Calibrate sensor array at ISU	July-November 2015	Completed 

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2	Determine sensitivity of sensor array in lab	Go/No Go	Threshold levels established for multiple polymers using lab extruder	November-December 2015	Completed ✓
3	Install array in commercial processing facility	Milestone	Sensor array output to website server	January- February 2016	August 2016
4	Model output and predict quality using sensory array and lab validation	Milestone	Data collected by sensor array compared to values collected in lab considering safety, quality; shelf-life predictive modeling	February-May 2016	Completed ✓
5	Investigate commercialization strategy with corporate partners; economic analysis	Milestone	Licensing and revenue opportunities to university and IP partners	May 2016	Completed ✓

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RIF FUNDING: PROGRESS REPORT

Report Type: Interim

Title: Co-Production of High-Value Chemicals with “Drop-in” Biofuels from Lignocellulosic Biomass Using a Novel Liquid-phase Refinery Process

PI: Wenyu Huang

Company Partners (if applicable, company names only): Esstar Bio Technology, LLC

Project Goal: The goal of this project is to demonstrate the technical feasibility of a two-step biomass conversion process, and the economical feasibility of co-production of high-value chemicals and “drop-in” biofuels from biomass.

Publications/presentations based on project: One presentation was given to a group of surface scientists in Ames Lab with the focus on structure-catalytic property relationship of the catalysts. Two presentations were given in BASF (03/15/16) and ExxonMobil (3/16/16) to attract industrial interests. Private presentations were given during conferences for potential collaborations.

Invention disclosures: Plan to file one application based on the conversion of levulinic acid to β -acetylacrylic acid. β -acetylacrylic acid is a high-value chemical that sales at \$20~100/gram currently.

External funding applied for (indicate received/denied/pending):

Denied: DOE STTR (Project title: Catalytic Transformation of Cellulosic Waste Streams to Dicarboxylic Acids and Diols)

To be submitted: NSF STTR (Project Title: Catalytic Transformation of Lignocellulosic Waste Streams to Value-Added Chemicals)

Progress report (300 word maximum, please focus on results in non-technical terms and commercialization progress):

During Phase I of this project, we successfully achieved all the milestones. We successfully converted raw corn stover to target chemicals with high yield, and separated them with high extraction efficiency. We demonstrated that the crude levulinic acid obtained in the first step could be used directly for biofuel production with excellent yield. These results proved our two-step biorefinery concept.

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We successfully conducted a large scale conversion of levulinic acid to fuels and chemicals using a 1-liter reactor at Iowa Energy Center's BECON facility. We demonstrated that biofuel production could be conducted at large scale with excellent yield. We also evaluated the lifetime of the catalyst in continuous flow mode. The catalyst can maintain its activity during a 2-day run.

We collaborated with the ISU CyBIZ group to carry out techno-economic analysis. The results showed that the co-production of high-value furfural and succinic acid could significantly cut down the minimum selling price of biofuel, which could be competitive with petroleum-based fuels. The results also suggest the utilization of low-cost dry animal manure may make the biofuel production even more competitive. The results greatly encouraged us to carry out more research using manure as the feedstock.

We applied for a DOE STTR grant based on the core technology in the RIF phase I project, which is the conversion of cellulosic waste streams to dicarboxylic acids and diols. Even though the proposal was not selected for funding, it was a good practice and we received many constructive comments. We will act on those comments and revise our proposal for future SBIR/STTR applications.

In Phase II, we will continue collaboration with Esstar and Daniel Anderson (ISU Agricultural & Biosystems Engineering) to utilize abundant animal manure in Iowa for the co-production of high-value furfural, succinic acid, and biofuels.

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RIF FUNDING: PROGRESS REPORT

Report Type: Interim

Title: No Heat Soldering

PI: Martin Thuo

Company Partners (if applicable, company names only): SAFI-Tech

Project Goal: Scale production of undercooled metal materials and develop application demonstrations for cold soldering and printing conductive lines.

Publications/presentations based on project: None

Invention disclosures: Contributions to ISURF #04335, new disclosure in preparation

External funding applied for (indicate received/denied/pending):

SAFI-Tech PI, Ian Tevis, with Prof. Martin Thuo: NSF SBIR Phase I – funded (\$225,000)

SAFI-Tech PI, Ian Tevis, with Prof. Martin Thuo: DoD SBIR Phase I - Denied

Progress report (300 word maximum, please focus on results in non-technical terms and commercialization progress):

Project Milestones

1. SAFI-Tech has scaled the technology production to 50 g by adopting a commercial heated soup maker to the manufacturing process. The undercooled state is confirmed by ion milling leading to flow of the underlying liquid.
2. The higher temperature solder (SnZn) was sheared into solid microparticles at elevated temperatures. At elevated temperatures, Zn was too reactive to allow formation of a self-limiting protective oxide shell at ambient conditions. Pure indium is being considered as an alternative to SnZn while we explore methods of controlling reactivity of zinc (e.g. by working under Argon). Eutectic BiSn is also being explored.
3. An organic flux with moderate flux activity was used to join two copper sheets together to make a conductive joint. Flux allows pressed undercooled particles to wet and adhere to the surface of the copper.

Business Milestones

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1. CyBIZ lab continues to work with SAFI-Tech to identify customers who may purchase our technology, identify potential competitors, and assess possible markets. SAFI-Tech has been admitted to ISU's StartUp Factory program that has a large focus on customer discovery.
2. SAFI-Tech has pivoted from the syringe application system to the direct write and paste application systems with great success.

Deliverables

1. SAFI-Tech has developed a paste/flux and application method for cold soldering copper sheets together using Field's metal. These sheets can be picked up and can support the sheets through the soldered connect.
2. SAFI-Tech has developed paste and direct-write demonstrations.

Despite some challenges in achieving the milestones, significant progress has been made and alternatives sought. We will continue to pursue these deliverables by developing alternative design rules or pathways to generate better interfaces between materials and at reduced cost.