IOWA STATE UNIVERSITY
OF SCIENCE AND TECHNOLOGY

FY17 Board of Regents, State of Iowa, Annual Economic Development and Technology Transfer Report

PRESENTED BY
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OFFICE OF THE PRESIDENT

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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:

- The ***Center for Industrial Research and Service*** works with business and industry to enhance their performance through service offerings in five general areas: technology, growth, productivity, enterprise leadership, and workforce.
- 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 two regional centers.
- ***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*** protect, manage, market, and license the intellectual property of ISU researchers and implement agreements related to research collaborations with industry.
- ***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

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

Iowa State pioneered the first statewide Extension Service in 1906. The extension experiment – universities actively transferring their research and expertise to every corner of every state – was immensely successful across America and remains so today. Each year more than a million Iowans directly benefit from ISU Extension and Outreach programs. ISU Extension and Outreach in collaboration with ISU colleges impacts economic development in the state through all of its programs – Community and Economic Development, as well as Agriculture and Natural Resources, Human Sciences, and 4-H Youth Development.

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 FY16, 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 4,442 clients** and 15,134 counseling hours. As a result of this counseling, **279 new businesses** were started and **1,689 jobs were created**. Additionally, SBDC assistance was credited by clients with increasing their capital infusion by more than $70.4 million and increasing their sales by more than $68.8 million. **This translates into 4+ new jobs every day, a new business every 31 hours and an increase of $188,755 in sales every day.**

The **ISU SBDC regional center and the Mid Iowa SBDC regional center**, in partnership with the ISU Pappajohn Center for Entrepreneurship, provided 2,651 hours of counseling assistance to startup and existing companies; **served 798 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 64 new business starts with 358 new jobs created** that have generated **$13,022,101 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 more than $2.3 billion dollars ($2 billion in sales gained or retained, $228 million in new investments, $92 million in costs saved or avoided) with 28,727 jobs added or retained as a result of the assistance received.**

During FY17, **1,616 businesses from 96 counties** in the state received assistance on projects or attended educational workshops from CIRAS staff or partners. Companies responding to surveys reported **$679 million in total economic impact** — $600 million in sales gained or retained, $44 million of new investment, and $35 million in costs saved or avoided. Company executives stated that **5,741 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 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 **provided assistance to 964 companies**, resulting in an economic impact of **more than $194 million.** The Defense Logistics Agency, which funds CIRAS to provide assistance to Iowa companies, indicated this impact **helped create or retain 3,898 jobs**.

- In 2016, **498 small- to mid-sized manufacturers** received assistance under the **Manufacturing Extension Partnership** (MEP) program. Companies *responding to third party surveys reported nearly **$352 million in financial impact*** from technical assistance and workshops on technology, growth, enterprise leadership, and productivity.

- The CIRAS Technology Assistance Program (TAP) has a mission to assist Iowa companies with technical problems and advance R&D activities. The program is comprised 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 2016, CIRAS provided **technology assistance services to 214 distinct businesses**. Companies responding to surveys reported **$125.8 million of total economic impact and 310 jobs created or retained** 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 FY2012-2016 more than 13,700 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** has multiple community development specialists in place with expertise and/or experience working with minority-owned businesses and community business leaders. During the past year these specialists **helped 41**

minority-owned business owners start or improve their own businesses, and assisted with the creation and the retention of 13 jobs for minority employees.

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 650,000 square feet of building space. **Fifteen new companies and affiliates, and thirty pre-incubator companies joined the Park in FY17**, bringing the **historical total to 325 companies and 5,029 employees for current and former tenants that are still in existence world-wide.** Currently, there are **82 companies and research centers and 13 affiliates located in the Park, employing 1,702 and 153 people, respectively**. There are 25 pre-incubator companies that remain in StartUp Factory space.

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. To date one cohort has completed the program and two are currently in the program for a total of 26 new startup companies. The first cohort has raised more than $5 million of private and public capital, including seven (7) SBIR Phase I grants, three (3) SBIR Phase II grants, and seven (7) angel investment rounds. Additionally, these 10 companies have created 40 jobs.

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 university in Iowa with more than **36,300 students**, and despite our Midwest location, our student body is quite diverse. Total U.S. multicultural and international enrollment at Iowa State is 24.2% of the student body (12.9% multicultural and 11.3% international). Our students represent every Iowa county, all 50 states and 127 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 2017, the **Pappajohn Center for Entrepreneurship** sponsored the second cohort of CYstarters, a 10-week summer accelerator program for students. **Sixteen students on 12 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. Eleven (11) of the 12 businesses successfully launched. Six (6) of the 8 (eight) businesses from the inaugural year's cohort are still active and have gone on to be successful in state and national competitions. Also, some have received state funding awards.

Additionally, the Pappajohn Center for Entrepreneurship **placed 46 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 5,000 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. **Ninety-one (91) CyBIZ Lab students working part-time completed 43 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 completed two (2) projects concurrently with mechanical engineering senior design cases;** paired up to perform **market validation research with four (4) tech transfer projects that had received RIF funding** through EDIR, with another six (6) tech transfer projects underway fall 2017; partnered with the Colleges of Business on internal curriculum and program research projects; and collaborated with Model Farm creative agency on a number of projects. As part of normal operations, CyBIZ Lab works with clients that include startups, non-profit organizations, communities, college administrators,

national professional organizations, 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. 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.

In 2016, **engineering students worked on 134 projects, 112 of them with Iowa companies. This included 56 different Iowa companies across 26 Iowa counties**. Companies responding to surveys reported **impacts of more than $92 million** for these projects.

ISU's College of Engineering Community Outreach offers 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. The Community Outreach program is working to increase the diversity of STEM students through various programs to K-12 audiences, such as Iowa State Engineering Kids camps, Project Lead The Way, FIRST LEGO® League (FLL) and FIRST LEGO® League Jr. (FLL Jr.). Youth participating in this year's summer camp offerings included 30 percent underrepresented minorities and nearly 50 percent female participants. Camps were held with partnering industry and civic organizations to increase reach to underserved communities. Increasing the gender equity in STEM is also evidenced by strong female participation of nearly 40 percent in FLL Jr. with the program exceeding growth metrics for the second year in a row. From its inception in 2002, the community outreach programs have grown to serve over 600 FLL and FLL Jr. teams participating in over 46 statewide events this past year, as well as over 400 Project Lead The Way school programs and more than 1000 volunteers from across the state collaborate with the college's STEM efforts to impact future workforce development.

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 **nearly 2,500 ISU interns who were employed by more than 1,000 different Iowa employers located in 268 communities in 90 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 250 educators and more than 11,000 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 Youth Development prepares Iowa's young people for future careers. Youth develop communication, citizenship, leadership, STEM, healthy living, and general learning skills by participating in 4-H educational experiences. Youth are challenged to actively pursue careers and/or education beyond high school and build skills that improve their communities and world. In fact, annually about 90 percent of 4-H seniors report they intend to pursue trades or post-secondary education within 12 months of graduation. 4-H programs reach more than 100,000 Iowa youth every year**.**

- Last year, there were 30,706 project enrollments in citizenship and leadership curriculum, which not only aid youth in developing leadership skills, but encourage them and develop them as leaders in their home communities, today and in the future.
- There were 42,797 enrollments in the Healthy Living project areas, including food, nutrition, health, and fitness. As Iowa continues to struggle around the issue of obesity and a lack of physical activity by youth and adults, this is critical education for the overall health of Iowa communities.
- More than 7,000 youth completed Food Safety and Quality Assurance training that is required to be certified. Nearly 93 percent of the youth indicated their increase in both ag production knowledge and their ability to apply that knowledge to management and animal care changes in their own operations.
- STEM continues to be a very strong component of 4-H, with more than 143,000 project enrollments. However, there is more work to be done, as 47 percent of the youth reported improved STEM processing practices. Iowa 4-H has invested heavily in the last year on curriculum development and vetting. Strengthening 4-H STEM curriculum is a priority to improve this measure.

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 FY17 with **total sponsored funding of more than $500 million**, **including $244 million for research**. Businesses, corporations, and commodity organizations accounted for $51 million of sponsored funding.

In FY17 ISU researchers submitted **130 disclosures of intellectual property**, and our technology transfer office **filed 50 patent applications**. Additionally, last year ISU technologies resulted in **85 license and option agreements worldwide with 39 in Iowa**. ISU currently has **199 license and option agreements yielding income. Iowa companies earned $99.9million revenue from ISU licensed technologies in calendar year 2016, and nine startup companies based on ISU technologies were formed in Iowa.** Globally, total sales revenues from ISU licensed technologies were **$95 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.

CED specialists provide skills training each year for more than 50,000 community leaders, local government officials, business owners, entrepreneurs and volunteers.

Retail Specialist June 2017, CED hired a retail specialist to provide technical assistance and consultation, develop educational curriculum, and deliver educational programs for retail business owners and for communities seeking to build stronger local retail economies. Within Value Added Ag, this specialist will work on discovering ways to link the entire supply chain from producer to customer and will be responsible for linking rural producers, processors, local businesses and customers in support of local economies. Within CED, the retail specialist will work with entrepreneurs and start-ups, as well as small businesses.

Student Involvement in Community Development

This year the Partnering Landscape and Community Enhancements (PLACE) program involved 196 students in outreach projects in Iowa communities, including Manning, Newton, Humboldt, Sheldon, Ottumwa, Fort Dodge, Johnston, Ackley, Pocahontas, and Ames. The Iowa Living Roadways Community Visioning Program employed 8 student interns to assist in assessments and analysis in 10 communities.

Central Avenue Corridor Project

During spring 2016, CED assembled a team of ISU Extension and Outreach colleagues to begin a three-phase community engagement and development process to revitalize the Central Avenue Corridor in Dubuque:

- **Research and Education**: The ISU Extension and Outreach Central Avenue Corridor (CAC) team was awarded $15,000 to begin a fact-finding community engagement process along the corridor, which included developing a detailed inventory of businesses, service organizations, and residences along the corridor and its surrounding area.
- **Economic Development**: CAC team members connected corridor businesses with SCORE for business assistance.
- **Community Planning and Design**: The City of Dubuque awarded an additional $5,500 to the project to bring a design studio to the corridor for the purpose of engaging the local community in long-term creative public design process for corridor redevelopment. In addition, the project was awarded a $1,550 planning grant as well as $5,000 for direct studio support from the College of Design Fieldstead Company Endowment Outreach Studio Funds. Funds were used to cover costs of bringing students to Dubuque to work with Central Avenue corridor community members.

Refugee Community Alliance

A new joint position was created in 2016 with the Des Moines Area Refugee Community Alliance. The alliance cosponsored the second annual Refugee Summit in Des Moines in October, which was attended by 300 participants. This event generated $3,000 in community grants. In 2017, the alliance cosponsored the activities for World Refugee Day, including a cultural celebration, a screening of the film Warehoused, and a soccer tournament. These activities drew approximately 1,000 participants and generated community grants totaling $4,300.

Center on Sustainable Communities

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. In FY 2017, a joint-institution board was formed to advise the new partnership and solar workshops were conducted in Fairfield, Creston, Perry, and Tipton. In addition, two bilingual building science and weatherization workshops were held in collaboration with Habitat for Humanity. The activities of the partnership resulted in 403 citizens receiving training and $8,100 in grants being awarded.

Iowa's Living Roadways Community Visioning Program

The Community Visioning Program celebrated its twentieth anniversary in 2016. The program has helped rural communities plan transportation enhancements

using state funds from the Iowa DOT. To date, 232 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 Food Systems (CFS)
The Community Food Systems Program is a multi-phased, multi-year program housed within ISU Extension and Outreach's Agriculture and Natural Resources program, Local Foods Team, and Community and Economic Development program. The program strategically partners with the ISU Community Design Lab for design assistance throughout the community process.

- Established in 2013, the primary objective of the program is to partner with communities to develop, design, and implement local and regional food systems, by creating long-term community empowerment and lasting impacts. It has been implemented in seven communities across the state, including implementation of more than 20 different projects and programs.
- In January 2017, the program celebrated its third year of collaboration with communities across the state by hosting more than 150 partners: planners, farmers, local food coordinators, culinary professions, public health, and many more organizations across the state gathered to share success stories of community food systems development and implementation.

Comprehensive Grocery Design Curriculum
In FY 2017, Extension and Outreach developed a grocery interior design toolkit available in both **English and Spanish**. Five grocery interior design toolkit components were created: (1) exterior chapter, (2) layout chapter, (3) merchandising chapter, (4) lighting chapter, and (5) energy chapter. Each chapter contains specific design content for grocer education and implementation, which includes images, diagrams, and resources. The singular toolkit was further developed into a comprehensive grocery design curriculum the materials for which are currently being tested and evaluated for their effectiveness and impacts for the user.

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, Google, and Secretary of State Work together for small businesses
America's SBDC Iowa is partnering with the Iowa Secretary of State and Google to ensure Iowa businesses have claimed their listing on Google and that the information is verified for accuracy. Through this joint venture, the SBDC has a presence in the Secretary of State's booth at the Iowa State Fair. SBDC staff working in the booth help small businesses find their Google listing and assist them to customize their listing. Businesses with complete listings on search engines are two times more likely to be considered reputable. Google is supporting the booth by providing giveaways for attendees and also provided training for SBDC personnel. This will

also allow SBDC to provide additional services to small businesses in Iowa. The support from the Secretary of State's office is helping to expand the reach of SBDC services to businesses in Iowa.

CIRAS Teams up with Iowa Economic Development Authority (IEDA) and Association of Business and Industry (ABI) to create "Year of Manufacturing"
This partnership has been formed with a goal of increasing manufacturing output 10 percent by 2022, to $32 billion. A new website identifying resources was launched at www.IowaMFG.com, coordinated visits to manufacturers are in progress, and new strategies are being developed to cooperatively grow manufacturing.

CIRAS Assisting Effort to Improve Iowa's Targeted Small Business Program
Iowa officials are working to streamline and improve Iowa's Targeted Small Business (TSB) program, which provides purchasing preferences for designated Iowa companies that are owned and managed by members of certain disadvantaged groups. Over the past year, a group that includes a CIRAS staffer has worked to streamline the TSB application process, increase awareness among eligible companies, and improve communication about the program's benefits. The changes have helped the TSB program become more active in assisting Iowa businesses.

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 income generated from the UNI innovations.

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, the Iowa Year of Manufacturing Initiative, Institute of Food Technologists-Iowa Section, the Iowa Lean Consortium, Professional Developers of 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 Institute are to:

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

As of July 2017, Iowa had 101 native wineries and 270 commercial vineyards covering approximately 1,250 acres of grapes. For calendar year 2016, total wine production was 405,317 gallons (a 20.2 percent increase over last year) and wine sales totaled 310,803 gallons (a 9.1 percent increase over last year). Iowa wineries sold 6.5 percent of the retail wine sold in Iowa during 2016. The grape and wine industry in Iowa is maturing, but continues to grow. According to a 2012 study by Frank, Rimerman + 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. In federal fiscal year 2016, SBDC clients generated an increase of $68.8 million in sales and created 1,689 jobs. All information reported by the SBDC is verified and attributed to the assistance of the SBDC by the client through the client milestone collection process. 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. Business succession is an important issue facing rural Iowa. The number of self-employed individuals in Iowa who are over the age of 70 is more than 14,000. Additional

resources would support targeted services to this group of business owners to help ensure successful transitions.

It should be noted that SBDC is working diligently to collaborate and partner with other organizations throughout the state, both public and private, 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. This past year both a fitness center and a full-service restaurant opened, and construction began on a medical clinic that will also house a child care facility. Additional commercial projects are in the planning.

Also, this past year three more Iowa-based companies established operations in the Research Park to get better connected with the research expertise and infrastructure at the university as well as the workforce talent being developed on campus.

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 FY17 CIRAS helped generate an additional $1.60** of Federal awards and fee income for each $1 of base budget provided, yielding more than $3.3 million of additional funding to support state economic development efforts.

For every $100,000 of additional funds made available, **CIRAS could leverage the funds** to bring in up to $160,000 of new money from grants and fees. These funds would be used to hire two new business professionals **to expand technical assistance and education services provided to Iowa businesses**. The goal would be to add staff in the area of **digital manufacturing** to support the state's effort to enhance Iowa's supply chain competitiveness. These two staff would work with several hundred companies, which would include about 50 new companies. They would help the companies create or retain about 170 jobs and generate $20 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 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	130
b. Number of non-provisional patent applications filed	50
c. Number of patents awarded	15
d. Number of license and option agreements executed on institutional technologies: in total in Iowa	 85 39
e. Number of license and option agreements yielding income	199
f. Revenue to Iowa companies as a result of licensed technology (CY16)	$9.9 million
g. Number of startup companies formed (through licensing activities) in total in Iowa	 9 8
h. Number of companies in research parks and incubators pre-incubator companies private university related	 33 64 18
i. Number of new companies in research parks and incubators pre-incubator companies private university related	 30 13 0
j. Number of employees in companies in research parks and incubators Royalties and license fee income	 1,702 $3.3 million
k. Total sponsored funding received How much of this is for research	$503.6 million $243.7 million
l. Corporate sponsored funding received for research and economic development, in total in Iowa	 $51.1 million $14.3 million
m. Iowa special appropriations for economic development, in total SBDC CIRAS Technology Assistance Program ISU Research Park Regents Innovation Fund	$2.525 million $1.037M $1.365M $0.122M $1.050 million

n. Research expenditures (federal, state and local; business; nonprofit; institution funds; all other sources):	$263 million
o. Licenses and options executed per $10 million research expenditures (FY13 data from AUTM is most recent available)	3.77
p. Sales of licensed products by Iowa-based companies (CY16)	$9.9 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	5,029
Note: Unless noted, the data provided above are FY17 data.	

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

Jefferson-based American Athletic Inc., a leading manufacturer of sports equipment, turned to CIRAS for assistance with product and production development for a new product. The new training device for cheerleaders, called the Elite™ Cheer Stand, had a tight timeline to reach markets in time for Christmas. CIRAS staff utilized their plastics experience to support the product design along with their metal additive manufacturing system, commonly called a 3D printer, to create the required tooling in time. Senad Salkic, senior design engineer at American Athletic, praised CIRAS' help in designing the Elite™ Cheer Stand. "Additive manufacturing means CIRAS helped us keep our initial costs low, which results in a more affordable product for our customers."

Preston-based Plastics Unlimited, a 50-employee plastics thermoforming company is poised for significant growth after transforming the company (with CIRAS' assistance on both technical and business issues) from a contract manufacturer to an engineering-driven diversified company. "We're at the point where we could double in size in a month, or we could not grow at all," said sales manager Dakota Kieffer of the uncertainty associated with growth. Dakota and his brother Travis, recent graduates of ISU, have taken a leading role in diversifying the business from agriculture to include parts for rail cars, forklifts, and toothbrush makers.

Rock Valley non-profit Double HH, a subsidiary of Hope Haven Inc., is a vocational rehabilitation firm that uses physically or intellectually disabled workers to manufacture products for a range of industries. "We've worked with CIRAS a number of times over my 30+ years here, and it's been quite successful," said Loy Van't Hul, director of manufacturing operations. "CIRAS has always been good about approaching it the right way—just treating it like a business and adapting things slightly." Over the past five years, CIRAS has provided services in process improvement, worker training, and testing. It's produced an economic impact of more than $1.2 million.

Calhoun Communications in Sioux City increased sales by more than $400,000 through assistance from CIRAS in improving the company's ability to reach the federal government market. "[CIRAS] demystified the whole process," said Lance Martin, operations director. "We, for quite some time, had wanted to break into the federal market. This has opened the door to a much broader reach for us." He praised a CIRAS workshop on capability statements as especially useful in helping Calhoun approach new customers. "It's been amazing how powerful the capability statement has been for marketing our business," he said.

Elgin-based Donlon Brothers turned to CIRAS for help in transitioning from commercial excavation projects to city, county, and state projects. After attending a CIRAS networking event and receiving counseling in the

Iowa Department of Transportation contracting process, the company successfully secured more than $100,000 in bridge project subcontracts.

Puck Custom Enterprises in Manning has manufactured manure application equipment since 2005. Between 2011 and 2016, the company doubled its export sales. Company leadership reached out to CIRAS in 2014 to ensure that their approach to exporting was appropriate. Puck participated in ExporTech, a three-part educational program developed by the U.S. Department of Commerce. It's deployed locally by CIRAS, Iowa's U.S. Commercial Services office, the Iowa Economic Development Authority, and other CIRAS partners. Jeremy Puck said the ExporTech sessions essentially reassured his firm that Puck employees were going in the correct direction. Periodic difficulty with foreign paperwork and having products get trapped in overseas ports were common headaches, Puck employees learned, but they also made connections to solve these problems as they occur. The 12 companies that have attended ExporTech in Iowa have reported more than $35 million in new or retained sales and 99 new or retained jobs as a result of participating.

Des Moines manufacturer Seneca Tank brought a team of engineering students in to assist them in simplifying production tooling approaches. Rather than stationary tool boxes with more than 100 tools, students and company employees collaborated on a mobile cart that housed 20-30 of the most-used tools. S.J. Risewick, director of unit sales and production, said the college students were "much more approachable than a consultant. Our employees were much more engaged in educating them on our products and processes." Risewick said the final design has made employees' workdays much easier. "It's reduced the walking time tremendously."

Donatech Corporation's decade-long relationship with CIRAS has helped the company's Cedar Rapids arm broaden its reach into the world of government contracting. Donatech has attended a wide variety of CIRAS-provided training over the past five years and used a bid-match program provided by CIRAS that allows a businesses to view local, state, and federal opportunities specific to their industries. "The results have been really good in making a lot of favorable introductions to local companies that we might be able to partner with from a business standpoint," said Pat Adam, vice president of strategic accounts. Additionally, Adam said the company received solid guidance from CIRAS about working with prime government contractors.

Spencer Economic Developers are partnering with CIRAS and the Iowa Area Development Group (IADG) to pilot a new approach to attracting manufacturers to rural communities. Over the past 30 years, IADG has partnered with rural communities to build 75 speculative industrial structures – most of which are filled. Now, CIRAS will engage with prospective companies to help identify and break down barriers to selecting these rural sites. "Historically, we've referred business to CIRAS many times over the years, but always they were existing employers in the

region," said Kiley Miller, president and CEO of the Iowa Lakes Corridor Development Corporation. "This is a new opportunity for us to use CIRAS as a business-attraction partner."

Over the past several years, CIRAS has published four reports as part of the EDA program to develop and implement the Iowa Advanced Manufacturing Network (AMIN) program in the state. Studies and reports published to date include the following subsectors: Plastics and Rubber Manufacturing, Machinery Manufacturing, Metals Fabrication Industry, and Food & Beverage, Feed & Graining Manufacturing.

Alisa Roth won the Deb Dalziel Women Entrepreneur Achievement Award in 2017. Alisa Roth had a dream to start and run her own floral business so she contacted the Iowa Western SBDC to see how they could help her. Within six months, Alisa opened Bloom Works Floral in the historic 100 block of downtown Council Bluffs. As a well-respected entrepreneur, she is a major influencer in the region as she has participated in many mentoring activities through the SBDC and other local organizations, to help and support other businesses as well as future entrepreneurs. Alisa is also extremely involved in her community and uses her business as a means to raise awareness and dollars for issues important to her.

The 2016 Neal Smith Entrepreneur of the Year Award was Steve and Leona Fogle of Fogle True Value Hardware. Steve and Leona Fogle have had a growing impact on Centerville. Steve started out taking construction classes from the Indian Hills Community College's Building and Trade program and then started his own construction business, which grew over time and filled a need in the area, as many local contractors had retired.

In 2012, Steve and Leona had an opportunity to purchase the True Value Hardware store in Centerville, which had been part of Centerville for many years. After purchasing the business in 2013, the couple was able to add a line of rental equipment to the business and Fogle True Value & Hardware has continued to prosper ever since. Recently the company moved into new, larger space and expanded its offerings to include farm and ranch items, paint, home décor, and clothing.

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 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 was conducted in Davenport and Sioux City.

Through **ISU's Road Scholar Program**, local business owners received training on how to capitalize on tourism in Iowa. In 2016–17, 277 citizens, 123 community leaders, and 530 business leaders/entrepreneurs received assistance through these programs. As a result, 45 businesses were expanded or improved, 12 individuals took new leadership roles, and 42 organizations were assisted or strengthened. The estimated dollar value of the jobs that were created or retained was $289,275.

Hospitality Customer Service Training was delivered through three contracts with the Western Iowa Tourism Region, the Central Iowa Tourism Region, and the Eastern Iowa Tourism Association through funds provided by the Iowa Economic Development Authority. These are two-hour, interactive classes. The first half of the class focuses on community-level tourism as a form of economic development. The second half of the class focuses on skills in customer service such as complaint resolution, dealing with negative online reviews, and providing exceptional customer service. Each of the 38 participating cities were surveyed prior to their training session in order to customize the training to each community's local tourism issues and assets. The total number of business leaders and entrepreneurs who participated is 1,276.

Appendix 2: Training and Related Educational Activities

Center for Industrial Research and Service (CIRAS)

CIRAS held its third annual **Iowa Vendor Conference** in Des Moines 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 by attending diverse workshops, experiencing national-level keynote speakers, and networking with a variety of resource partners and buyers, such as the National Parks Service, Ames Lab, Offutt Air Force Base, Iowa National Guard, Iowa Air National Guard, and the Department of Transportation.

CIRAS, in cooperation with Illinois and Missouri, developed and hosted the first annual Tri-State Procurement and Economic Development Summit in Keokuk. This event was organized to educate companies about the incentives and programs that are available to help them grow their businesses. The summit shared information about services offered through local economic development organizations in southeast Iowa, northeast Missouri and northwest Illinois. Experts shared tips with the more than 75 attendees on how to find financial assistance, expand a client list, and navigate the government's procurement process.

CIRAS launched the **Future of Manufacturing Series** in January 2017 to build Iowa' awareness and ability to deal with the next manufacturing revolution. Events covered during FY17 included augmented/virtual reality, next generation metals, recruiting and retaining a tech-based workforce, 3D printing, and new ways to grow your business. More than 175 attendees participated. The series will continue throughout FY18.

The Iowa Innovation Corporation, the Iowa Economic Development Authority, and CIRAS partnered on a **Manufacturing Matchmaking** event as part of the 2017 Year of Manufacturing and in response to strategic recommendations to increase networking among manufacturers. The event featured 400 one-on-one meetings for 70 participants looking to increase their sales and purchases within Iowa.

CIRAS expanded its successful ISU Lab Tour Program to include the Polymers and Metal Additive Manufacturing Labs in 2016. The Lab Tour Program now includes two tracks offering a total of 8 tours a year to Iowa companies. These companies gain first-hand knowledge of technology that can support industry's innovation and quality objectives. Over the last year, more than 100 attendees have participated in these tours.

In response to the new Food Safety Modernization Act, CIRAS partnered with the Center for Crops Utilization and Research, the department of Food Science and Human Nutrition, and Meat Science Extension to host Preventative Controls Qualified Individuals (PCQI) Training for 54 participants. In addition, CIRAS has partnered with Agriculture and Natural Resources Extension to co-hire a food safety expert to expand educational and implementation services associated with PQCI training.

CIRAS hosted an **Innovation Summit** with 85 attendees to help spark progress in Iowa's food manufacturing sector. The food manufacturing subsector is the second largest contributor to Iowa's manufacturing GDP, at 21 percent, and encompasses 24 percent of the state's total manufacturing jobs. Four technologies were showcased at the summit: process automation, food safety and quality, internet market strategies, and ultrasonics to reduce costs and improve packaging.

Thousands of Iowans celebrated national ***Manufacturing Day*** throughout the month of October 2016. 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 149 events were held across the state, ranking Iowa 4th nationally in number of events despite our relatively small size. CIRAS's efforts to ensure that manufacturing day was truly a statewide activity were recognized nationally by the U.S. Department of Commerce.

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, provides web-based information products such as local retail trade analysis and demographic and economic indicators. Associate professor and extension landscape architect Christopher Seeger and GIS support specialist Bailey Hanson continue to update the Data for Decision Makers downloadable report. Users are able to access 2016 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 FY2017, the Indicators Portal had 17,117 page views and 3,505 sessions by 1,741 users.

As part of the **Iowa Government Finance Initiative** (IGFI), CED 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 2016, 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 FY 2017, 135 county IGFI reports and 677 city IGFI reports were downloaded. 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. CED specialist Cindy Kendall trained local government leaders on the initiative.

The **Geospatial Technology Training Program** conducted four **ArcGIS** two-day short courses for a total of 48 planners and local officials from throughout the state.

The **CED Geospatial Technology Program** hired a **data scientist to conduct data mining and analytics** to support the ISU Extension and Outreach Indicators Portal as well as other Geospatial Technology Program activities.

CED co-sponsored the fourth annual **Bicycle Trail Tourism Conference** in Perry, Iowa. Nearly 100 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 hired Eric Christianson as **a local government specialist** to develop educational curricula, deliver educational programs, and provide facilitation, consultation, and technical assistance to a variety of audiences throughout Iowa. The main focus of this position is providing training and assistance for local planning and zoning officials. Christianson also delivers Township Trustee training, board development and leadership training, local government budgeting and finance, and other programs. The position is based in the ISU Extension and Outreach Linn County office and is primarily focused in northeast Iowa.

Six CED specialists participated in a Train the Trainer (T3) retreat to learn **Navigating Difference© cultural competency training**. In FY2017, these specialists traveled throughout the state providing T3 training to Extension and Outreach staff.

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, while food scientists and program leaders focus on providing safe and secure food supplies. For example:

- Extension programs reach segments of agricultural communities that are underserved or underrepresented and operate small farms, usually with limited resources. The vegetable production team has developed meaningful relationships with the Amish and Mennonite

communities in Kalona, Iowa, and Elma, Iowa, and consistently helped to address their crop production, nutrient management, and pest management challenges. Working with their community leaders, several field days and workshops have been organized. Over the years these activities have increased production efficiency and productivity of several crops: broccoli, cucumber, onions, pepper, squash, tomato, and watermelon, in Kalona, Iowa.

- Programming is focused on the hops industry and supporting producers in Iowa. Since 2014, there has been a 900 percent increase in hop production (5 acres to 50 acres). With the Iowa craft beer industry bringing in over $100.2 million in sales in 2014 the potential for these brewers to purchase locally grown hops is huge. As the craft beverage industry continues to flourish, the need for Iowa hops will continue to increase.

- 'Growing Together' promotes healthy food access for families with low income through a partnership between ISU's SNAP-Ed program, Master Gardener volunteers, ISU Research and Demonstration Farms and Iowa food pantries. In 2016, 26 Master Gardener volunteer teams worked with 47 food pantries in their communities to provide fresh produce throughout the growing season. A total of 73,465 pounds of produce, which equates to more than 220,000 servings of produce for food pantries, was grown and donated by the Master Gardeners. A total of 90 Master Gardeners were involved with the donation gardens, and they logged 500 hours of service.

- The **On-Farm Food Safety Team** (from College of Agriculture and Life Sciences, Human Science Extension and Outreach, and the Department of Food Science and Human Nutrition) have been leading two, million-dollar Food and Drug Administration grants focused on food safety for fruit and vegetable growers in Iowa and the North Central Region. Partnerships with 12 land-grant institutions in Illinois, Indiana, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, South Dakota, Ohio, and Wisconsin have been formed. Food safety educational information has been delivered to more than 2,000 growers in this region. Food safety needs assessments have captured the concerns of 1,200 growers. Four Produce Safety Alliance training sessions to educate leaders in food safety were held, and 39 Produce Safety Alliance grower trainings, reaching 800 growers, were also conducted. Through these efforts, 164 regional extension and grower educators can provide food safety training and technical assistance to fruit and vegetable growers. To further educate, two websites have been launched along with online tools that provide on-demand education to fruit and vegetable growers on food safety.

- More than 300 food hubs are operating in the United States, with at least 16 local food aggregators or distributors in Iowa alone. ISU Extension and Outreach Local Foods Program facilitates a statewide food hub managers working group and has developed a series of publications for that audience that address food safety,

production planning, cash flow management and more. In 2014, a project to explore food hub activity and make recommendations that would support development of food hubs in Iowa was launched. The study found substantial interest in furthering food hub development in Iowa, and the first statewide study of food hubs was conducted. The study found that in 2013, **thirteen food hubs in Iowa purchased $4.5 million in food from 459 Iowa farmers.** Overall, Iowa farmers sold more than $13 million in local food to wholesale and intermediate markets in 2013. Food hubs also reported employing 58 people, though most were part-time. The study suggests that even though food hubs are still an emerging sector, they are already having a substantial economic impact.

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, 2016, to June 30, 2017, the website averaged 9,359 visitors per day, with 3 months averaging more than 10,000 daily visitors. Overall, downloads of information sheets and decision tools reached 1.8 million for the 2017 fiscal year while more than 130 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 1,618 followers (an increase of 325 in the past year) and had 143,006 impressions during the past 12-month period.

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:

- Iowa producers had concerns about complying with the requirements of the antibiotic regulations as established in the FDA Guidance 209 and 213 policies. So six ISU Extension and Outreach swine specialists and the Iowa State Swine Extension Veterinarian collaborated with Iowa Farm Bureau, Iowa Pork Producers Association (IPPA) and the Iowa Beef Center (IBC) to develop and deliver workshops. The objective of the workshops was to help producers understand and prepare for the new requirement for treating animals with antibiotics and to help producers implement management strategies that reduce the need for antibiotics. Twenty-nine workshops and talks were presented to a variety of producers, agriculture professionals, and veterinarians, reaching 1,452 participants. As Iowa produces about one-third of the pork in the nation, health and safety is important to this industry. Over the past several years, our swine extension specialists have trained

more than 5,000 producers 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. A significant number of Iowa pork producers have continued to be trained through 2016 and now have the information to pass an audit, which will enable them to continue marketing their pigs through specific packers.

Iowa ranks fourth nationally in number of cattle on feed and produces over 2,000,000 head of feedlot cattle on 6,000 individual operations annually. Resources provided by the **Iowa Beef Center** give producers the information necessary to increase their herds and update their operations.

- The 2014 updated Beef Feedlot Systems Manual has been downloaded more than 11,000 times. In 2015, 11 workshops were held across the state to educate beef producers on the costs and benefits of various facility types. Six months later, more than one third of the 200 participants evaluated their financial risk, operating costs, cattle performance, and manure value for their operation based on what they learned, and one quarter modified their facilities to improve their environmental stewardship. The facility cost calculator created for this project has been downloaded more than 100 times. Better individual decisions made by feedlot operators on facility construction and operation help keep those operations viable and produce beef in the most economical and environmentally sustainable manner, keeping beef costs reasonable for beef consumers, and contributing to the economic sustainability of rural Iowa.

- Now, perhaps more than ever, longevity is the key to profitability in Iowa's beef cow herds when it comes to replacements that entered the herd over the past two years. In 2016, the Iowa Beef Center conducted the third part of a heifer development series focused on selection and management practices that enhance longevity of the beef female in the herd. This program was built on two previous heifer development programs, which also have been distributed on YouTube for on-demand use. As a result of this program, more than 90 percent of the 235 meeting participants increased their knowledge of heifer retention economics and new selection indexes. More than 37 percent of participants plan to implement udder scoring and foot scoring, and 30 percent plan to calculate the net present value of their own females. Since this program, the Net Present Value of Replacement Females decision tool has been downloaded more than 1,700 times, the Buy or Raise Replacement Heifer decision tool has been downloaded more than 5,400 times,

and the heifer development videos have been viewed more than 13,500 times. Change in producer knowledge as a result of this program will lead to an increase beef cow retention and increased profitability for cow calf producers, resulting in a strengthened Iowa agriculture and enhanced local economy.

- In response to growing concern about antibiotic resistance in human medicine, the Food and Drug Administration (FDA) developed rule changes to force more veterinary oversight and more judicious use of antibiotics in animal agriculture. The Veterinary Feed Directive (VFD) changes the way medically important antibiotics are purchased and used. More than 1,100 livestock producers, veterinarians and feed distributors in Iowa participated in workshops, webinars or podcasts to increase their knowledge of the new animal antibiotic use regulations, improve their management related to judicious use of antibiotics in animal production, and improve record keeping related to medication use. More than 80 percent of participants plan to change how they use antibiotics in animal production or improve their record keeping. They manage or impact more than four million animals.

ISU Extension and Outreach conducted **transition cow health programs** to increase awareness and operation profitability. While transition cow management encompasses only 20-30 percent of the herd at a time, it can ultimately influence the milk production and health of all cows in the herd. To assist Iowa's dairy producers in implementing better transition cow practices, an extensive 18-month program focused on transition cow practices and principles was delivered across the state: seven on-farm transition cow hands-on workshops were conducted; nine dairy day events were held; and three video modules were developed. In addition, 60 individual herd visits were conducted with 48 individual producers now working with transition cow projects. Survey results, which represent 20 percent of Iowa's dairy cows, indicated that more than half of the producers had made changes to their transition cow programs; producers gained increased production and lower veterinarian costs; and have benefitted from healthier calves and a decreased calf mortality rate. Overall, the program has resulted in $400 more income per cow, or the potential of $16 million gain for Iowa's dairy farmers.

ISU Extension and Outreach annually trains representatives from about 600 businesses and 2,400 employees who come from more than 90 counties in Iowa and the four 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. This past year's curriculum focused on equipment maintenance and selection to improve manure application uniformity. More than 70 percent of commercial applicators reported this information was useful to their business, with 30 percent reporting they

would improve hose and distributor layout on their equipment and 8 percent reporting this would prompt them to select new equipment. These changes are estimated to increase corn yield by approximately 3 bushels per acre, or increase manure value by approximately $2 million in the state of Iowa.

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 2016, ISU Extension and Outreach farm management specialists conducted 87 leasing meetings across the state, with more than 2,100 land owners, operators, and ag business professionals attending. A post-meeting survey found that 44 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 2017 found that typical cash rental rates declined by $11 per acre, confirming the leasing meeting survey result. The ISU Extension and Outreach Cash Rent Survey was downloaded 207,289 times in 2016. Sample cash lease forms were downloaded 199,536 times. Videos on topics related to leasing were available after the 2016 meeting series, and were viewed 3,176 in the first four months they were available.

The Pesticide Safety Education Program (PSEP) provides information through a variety of venues on the safe and effective use of pesticides. Emphasis is placed on protecting human health and the environment while also including information on successful and responsible pest management. The PSEP provides recertification programs throughout Iowa and in FY17 trained 10,934 Commercial/Noncommercial/Public Pesticide Applicators and 14,468 Private Pesticide Applicators through Continuing Instruction Course (CIC) programs. In FY17, the PSEP directly contributed $858,587,600 in economic impact in Iowa through these training programs, based on 2016 wage information from Iowa Workforce Development. In addition to recertification programs, the PSEP writes training manuals necessary for initial certification of both private and commercial pesticide applicators and other educational publications. In FY17 nearly 26,000 educational publications were distributed to the public, including pesticide applicator manuals, record keeping guides, pest issues, and other pesticide-related publications. The PSEP is also involved in other areas related to safety. One area includes revisions to the EPA Worker Protection Standard (WPS) regulation. Through the PSEP efforts, nearly 2000 individuals completed WPS training courses through ISU Extension and Outreach designed to protect those working around agricultural pesticides from potential exposure and to mitigate exposures that do occur.

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 FY17, 1,178 people from the United States and 109 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 $19 million in retained or increased sales, $1.5 million in cost savings, $4.5 million in increased investment, and 35 jobs created or retained.

ISU Extension and Outreach hosted 14 **Crop Advantage Conferences** across Iowa in January 2017; 1,960 farmers and agribusiness professionals attended. Participants could be categorized as 67 percent farmers, 27 percent agribusiness, and 6 percent other. The majority (55 percent) of the attendees farmed between 250 to 1,000 acres and 37 percent farmed more than 1,000 acres. One focus of the 2017 program was to increase farmer awareness of the impact of Palmer amaranth on crop production. Prior to 2012, Palmer amaranth had not been identified in Iowa. In 2016, the infestation of Palmer manifested due to contaminated seed used to plant Conservation Reserve Program pollinator habitat. As of June 2017, nearly half of Iowa counties had been positively identified for having Palmer amaranth. The major concern with this weed is its extremely aggressive growth that can limit soybean yields by up to 80 percent. Results from the 2017 Crop Advantage program showed 44 percent of Crop Advantage attendees participating in the Palmer amaranth sessions went from little or no understanding of how to identify this new pest prior to the meeting, to a moderate or better level for identifying Palmer amaranth. Results also showed that farmers increased their ability to develop an effective management program for Palmer amaranth. Participants show a definite recognition that they must scout and be vigilant in managing this weed before it spreads

In the summer of 2017, five events were held as part of **Nitrogen and Water Week**, hosted by ISU Extension and Outreach. The workshops, attended by 118, offered information about water quality research being conducted by Iowa State University, how water quality data is collected and how agronomic practices effect drainage water quality. By learning about and adopting in-field and edge-of-field management practices and methods for determining nitrogen application rates, farmers can maximize profitability and reduce nitrate loss to Iowa's water bodies

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 is the youth program of America's Cooperative Extension Service and is the nation's largest youth development organization.) 4-H connects with almost 1 in 5 Iowa K-12 students to retain them as future young professionals in rural Iowa, improve their college and career readiness, provide them with service opportunities in their communities, and engage students affected by the achievement gap.

4-H Youth Development addresses the STEM literacy gap; Last year, 34,006 youth participated in STEM-related programing. 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. In the "*Iowa's Re-Envisioned Economic Development Roadmap,*" prepared by Battelle Technology Partnership Practice and released in December 2014, the creation of a K-20 industry-driven career development partnership with the education community was cited as critical. "To provide Iowa with a robust and predictable workforce pipeline in demand by Iowa businesses requires a systematic and pro-active industry-driven career development partnership with K-20 education. The partnership must focus on and improve upon the transitions of students into middle- and high-skill career opportunities through workplace learning from technical education and apprenticeships (for middle-skills jobs) to increased capacity of colleges and universities to provide career awareness, experiential learning and connections to Iowa employers (for high-skill jobs), as well as retraining opportunities for recent graduates who were not well-served in the past to gain the skills to compete for career opportunities."

4-H has partnered with Iowa State University's Colleges of Business and Design to emphasize STEM with a business development component. In partnership with the ISU College of Business, 4-H has developed a program called **Cy's Pizza Pies,** a business simulation program introducing youth to business opportunities and entrepreneurship. The program has variations for grades 2 through 12 and session ranging from 45 minutes to ½ day. This was the first year of the program, which was utilized for 4-H programming and reached 40 youth.

Further advancing Iowa State's land-grant ideals and vision around science, technology, and human creativity, more than 12,000 youth in the past year were exposed to the mobile **Forward Learning Experience bridging 21st Century Skills, STEM and creative problem solving.** Iowa 4-H youth and students saw and experienced first-hand emerging design technologies such as virtual reality, 3D digital and physical prototyping, and circuit bending. This provided 4-H youth and students in all corners of the state a vision of their future as 21st century citizens positively impacting their communities and world around them using STEM skills and creative thinking. When asked, "Do you like *STEM MORE* than before," in initial program evaluations, the most common responses were "Quite a bit" and "A great deal." The Forward Learning Experience visited school classrooms, 4-H camps, STEM festivals, science nights, county fairs and maker fair events across Iowa.

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) enhances the lives of low- and moderate-income workers by augmenting wages and, in turn, this flow of income makes a substantial economic impact in local communities. The

credit encourages and rewards work as well as offsets payroll and both state and federal income taxes. 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 2017 tax season, Human Sciences Extension and Outreach worked with community partners to recruit and train 47 volunteers to provide free tax preparation services to low- and moderate-income families through the **Volunteer Income Tax Assistance (VITA) program**. In 2017, VITA volunteers helped 1,278 low- and moderate-income Iowans complete their 2016 income tax returns. Special efforts are made to increase awareness of the EITC and VITA programs in rural Iowa. As a result, 430 filers qualified for the EITC and received $737,228 in the 13 counties that participated in the Human Sciences 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. In Iowa, an estimated 171,552 children under the age of six are in childcare and preschool programs (Bureau of Labor Statistics, 2017). Throughout Iowa, there are 3,886 licensed childcare center programs and 4,533 registered childcare home programs, with revenue of $447.6 million. Non-regulated home childcare is estimated to employ an additional 3,000 or more individuals. The projected average growth rate of childcare professionals from 2014-2024 is expected to increase nationally by 5 percent (Bureau of Labor Statistics, 2017, Child Care Aware, 2017).

Childcare is labor intensive and is expensive. Iowa families can expect to pay $8,219 to $13,008 annually per child. Despite high fees, Iowa childcare teacher and provider wages remain low. The annual mean full time wage is $20,410, which falls within the lowest ranking of state median wages for childcare workers, significantly below 40 other states (Bureau of Labor Statistics, 2016). The challenges of low wages are compounded by a critical lack of health and retirement benefits. High turnover and reduced stability are the result. This instability also affects the quality of care and early childhood education for Iowa's young children and creates a continuously high demand for entry-level training. State budget cuts and declining rural population often means that training can be hard to access, especially in rural areas.

Iowa's young families need reliable childcare to be able to work and contribute to Iowa's economy. 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.

During FY 2017,

- Human Sciences Extension and Outreach training programs include on-site and online learning experiences for entry level and experienced early childhood professionals. The educational goals are to: (1) increase understanding and practice of research-based best practices to improve quality care and education for young children and (2) provide individuals with the skills and training they need to be successful and remain in the early childhood education field.

- **173,279** hours of educational programming was provided to **20,525** early care and education professionals.

- In follow up evaluations, **18,906** individuals (88% percent) reported or demonstrated new knowledge, skills, or program improvements. Evaluations show that teachers and caregivers significantly increased understanding in child development, early learning, managing children's behavior, nutrition, and health and safety practices.

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. Latino youth are at a much higher risk than other ethnic groups for low academic achievement, school dropout, and other negative health behaviors such as substance use. Through "**Juntos Para Una Mejor Educación (Together for a Better Education)**," Human Sciences Extension and Outreach worked with local school districts and community organizations to bring together 112 community volunteers, 193 Latino youth, and 177 Latino parents to assist youth in graduating from high school and pursuing higher education.

- Pre/post evaluation data reveals that after participating in Juntos, 109 parents communicated more with their children about homework and goals after high school, and were more comfortable contacting school staff about their children's education. Parents were more aware of high school graduation requirements, and options for financing higher education.

- Ninety-four youth set goals for themselves after high school. Longitudinal data based on 92 youth who participated in additional "wrap-around" components revealed youth increased their sense of self-efficacy, belonging and safety at school, commitment to doing well in school and decreased their use of marijuana, cigarettes and alcohol. Youth improved problem solving and critical thinking skills, and empathy for and acceptance of others. School absenteeism and tardiness decreased.

Human Sciences Extension and Outreach specialists have taught the **ServSafe® food safety certification** program for almost 25 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. Human Sciences Extension and Outreach partners with the Iowa Restaurant Association to offer this training throughout the state. Participants have included those from commercial retail foodservices, such as restaurants, and institutional operations such as hospital and schools. A partnership with the Iowa Department of Human Services has supported attendance of childcare providers at these trainings, with 100 scholarships awarded each of the last four years. In the last year, more than 2,000 Iowans participated in ServSafe® classes taught by Human Sciences Extension and Outreach, with approximately 80 percent successfully earning the Certified Food Protection Manager credential. Ten classes in Spanish were offered at various locations around the state to address needs of new Iowans. 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 compromised immune systems; food safety training can avoid costly medical expenses. Iowa's Food Code requires at least one supervisory employee in licensed foodservices be certified in food safety through an approved program. Human Sciences Extension and Outreach serves Iowans by offering approved trainings throughout the state.

Appendix 3: END OF YEAR REPORT: JULY 2017
IOWA STATE UNIVERSITY RIF PROGRAM

EXECUTIVE SUMMARY

GIVF/RIF Commercialization Program

The projects pair ISU faculty with Iowa companies to create or improve products or processes. Each project lasts two years as permitted by Regents policy. 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, 139 projects have been funded through the Commercialization Program. One hundred twenty seven of these projects are complete and many show excellent progress in improving the competitiveness and profitability of the Iowa companies involved. Forty seven startup companies have been assisted; including **28 new companies that were started in the first eleven years as a direct result of the GIVF/RIF funding; one of these startups is now positioned to begin commercial installation of its wastewater treatment system, which addresses a huge need of rural communities in particular. This company has also received angel investment and nearly $1,000,000 in state and federal funding**. In total, **more than 90 Iowa companies have participated** in the program.

Surveys are conducted by CIRAS one year after project completion (Note: full 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
FY15-FY16	FY17	4*	4	N/A	$1,120,000	$280,000

*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 FY17**

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*
FY18+	7	7	1	5	0	$0
FY17	9	12	7	7	3	$ 425,000
FY16	15	10	3	18	5	$ 1,070,000
FY15	14	12	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.

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, Plant Sciences, etc., and position Iowa State to more rapidly propel technologies toward market opportunities. We accomplish 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 153 projects have been funded through the POCI model from FY07 – FY17; 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 FY17++

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**
FY18+	7	7	1	5	0	$0
FY17	9	12	7	7	3	$ 425,000
FY16	15	10	3	18	5	$ 1,070,000
FY15	14	12	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	FY16 RIF Projects (To finish May 31, 2017)	Award Amount
Namrata Vaswani	Video Denoising—Phase II	$50,000
Tim Day	Identification of a Drug that Prevents BRD at the Feedlot—Phase II	$50,000
Steve Carlson	Plant extracts that Efficiently Enhance Muscle Growth in Swine—Phase II	$25,000
Al Jergens	Electronic Canine Collar Advancement thru Multi-purpose, Proof-of-Concept Trials	$44,500

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
Martin Thuo	No Heat Soldering— Phase II	$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
Keith Vorst	Technology for Real-Time Detection of Contamination in Food Processing Systems and Packaging for Value-added, Waste-Stream Diversion	$50,000
	FY17 RIF Projects (To finish May 31, 2018)	
Ratnesh Kumar	In-Situ Wireless Soil Moisture and Salinity Sensor and Extension for Nitrate and Other Nutrients/Ion Sensing—Phase II	$50,000
Keith Vorst	Technology for Real-Time Detection of Contamination in Food Processing Systems and Packaging for Value-added, Waste-Stream Diversion—Phase II	$50,000
Wenyu Huang	Co-Production of High-Value Chemicals with "Drop-in" Biofuels from Lignocellulosic Biomass Using a Novel Liquid-phase Refinery Process—Phase II	$50,000
Eric Cochran	Safe and Convenient Chemical Purification System	$50,000
Martin Thuo	Metal Separation for Recovering Rare-earth and Specialty Metals from Electronics Waste	$50,000
Sri Sritharan	Design Certification of Hexcrete Wind Turbine Tower Cells	$25,000
Manjit Misra	A Non-Vertical Dynamic Flow Sensing Technology for Bulk Materials	$23,550

RIF FUNDING: PROGRESS REPORT

Report Type: Final

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

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

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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: Kin Gwn Lore, Adedotun Akintayo, Soumik Sarkar, LLNet: A deep autoencoder approach to natural low-light image enhancement, Pattern Recognition, Volume 61, January 2017, Pages 650-662.
4. Conference paper: Guo and Vaswani, Video denoising via online sparse and low rank matrix decomposition. SSP Workshop 2016.
5. Journal paper of Guo and Vaswani on Video Denoising via Online Sparse and Low-Rank Matrix Decomposition will soon be submitted to IEEE Signal Proc. Letters.
6. AISTATS paper 2016 on Online and Offline Robust PCA: Novel Algorithms and Performance Guarantees included some experimental results from this work.

Invention disclosures: None

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

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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 have 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 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 and it has been deployed on a mobile GPU (Tegra K1) onboard a Turtlebot demonstrating which demonstrates its significant application potential. The team is currently discussing with Rockwell Collins scientists to move towards hardware implementation of the proposed algorithm and other possible future research projects.

PI Vaswani and her team worked on more exhaustive comparisons of their proposed denoising approach. More videos were tested. They showed that the proposed approach is significantly better than existing work for videos with very large noise and especially when the large magnitude noise was sparse. More exhaustive comparisons for low-light videos were also performed.

PI Sarkar's team was involved in detail performance evaluation of the proposed techniques based on test videos provided by Rockwell Collins.

RIF FUNDING: PROGRESS REPORT

Report Type: Final

Title: Identification of a Drug that Prevents BRD at the Feedlot (Phase II)

PI: Tim Day

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

Project Goal: The goal of this study is to determine if an experimental non-antibiotic drug prevents BRD at the feedlot.

Publications/presentations based on project: none

Invention disclosures: ISURF 04535, patent application submitted.

External funding applied for (indicate received/denied/pending): AeroGenics has provided $50,000 in in-kind support (donation of cattle) for the Phase II project. AeroGenics will also be paying for a small study in the Fall of 2017.

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

In the Fall of 2016 we performed an efficacy study to demonstrate that our anti-inflammatory drug (provisional patent to be filed very soon) prevents BRD at the feedlot. AeroGenics provide 64 high-risk (high risk for developing BRD) calves and half were given the drug and half were given a "placebo". Less than 50% of the drug-treated calves developed BRD while 100% of the "placebo" group developed BRD. Boehringer Ingelheim directly monitored the study and we envision that a licensing agreement will be forthcoming in 2017, once our provisional patent is filed. We worked with ISURF and McKee, Vorhees & Sease (Des Moines patent attorneys) for filing the provisional patent that was filed in the end of 2016.

Based on our conversations with Boehringer Ingelheim, they would like us to do a small experiment that will bolster our patent. This experiment is planned for the Fall of 2017. Once completed, we will add the new data to the non-provisional patent that will be filed by the end of 2017. Boehringer Ingelheim has indicated that, once we file the non-provisional patent, they would like to partner with AeroGenics and ISU and license the drug in order to begin the drug development process.

RIF FUNDING: PROGRESS REPORT

Report Type: Final

Title: Plant extracts that efficiently enhance muscle growth in swine (Phase II)

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; prior art was identified and thus it was determined to be non-patentable

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

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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, myostatin gene expression, and muscle fiber density in growing pigs. These two diets are: (1) kale extracts plus ground mustard seed; and (2) a combination of three cruciferous vegetable extracts plus ground mustard seed. The latter diet also enhanced serum sulforaphane production which has been shown to decrease myostatin expression and thus promote muscle growth.

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.

Phase II studies were performed in January of 2017 and concluded in February of 2017. The studies explored kale extracts plus ground mustard seed and a combination of three cruciferous vegetable extracts plus ground mustard seed as feed additives that could enhance muscle accretion in swine. The results showed a mildly beneficial effect for the extracts. However, the prior art and the non-patentability will likely prevent the commercialization of these extracts.

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 mangement 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 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.

RIF FUNDING: PROGRESS REPORT

Report Type: Interim

Title: In-Situ Wireless Soil Moisture and Salinity Sensor and Extension for Nitrate and other Nutrients/Ion Sensing (Phase I and Phase II)

PIs: Ratnesh Kumar and Liang Dong

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

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Publications/presentations based on project: Several industry presentations have been made to Solum/Climate Corporation/Monsanto, John Deere, Pionner, Raven Industries, TechAccel, IntelliFarm; the work was also presented at the conferences and journal articles:

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. Wang, 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.
3. M. A. Ali, H. Jiang, N. K. Mahal, R. J. Weber, R. Kumar, M. Castellano, "Microfluidic Impedimetric Sensor for Soil Nitrate Detection Using Graphene Oxide and Conductive Nanofibers Enabled Sensing Interface", Sensors & Actuators: B. Chemical, Volume 239, February 2017, Pages 1289–1299.
4. S. Tabassum, Y. Wang, J. Qu, Q. Wang, S. Oren, R. J. Weber, M. Lu, R. Kumar, and L. Dong, "Patterning of nanophotonic structures at optical fiber tip for refractive index sensing", 2016 IEEE Sensors Conference, Orlando, FL, Oct. 2016.
5. Z. Xu, X. Wang, R. J. Weber, R. Kumar, and L. Dong, "Microfluidic Eletrophoretic Ion Nutrient Sensor", 2016 IEEE Sensors Conference, Orlando, FL, Oct. 2016.
6. M. A. Ali, S. Tabassum, Q. Wang, Y. Wang, R. Kumar and L. Dong, "Plasmonic-Electrochemical Dual Modality Microfluidic Sensor for Cancer Biomarker Detection", 2017 IEEE MEMS Conference, Las Vegas, Jan. 2017.
7. Z. Xu, X. Wang, R. J. Weber, R. Kumar, and L. Dong, "In-Situ Soil Nutrient Detection Using Chip Scale Electrophoresis", IEEE Sensors Journal, May 2017.
8. S. Tabassum, R. Kumar, and L. Dong, "Nanopatterned Optical Fiber Tip for Guided Mode Resonance and Application to Gas Sensing", IEEE Sensors Journal, submitted, March 2017.
9. S. Tabassum, R. Kumar, and L. Dong, "Plasmonic Crystal based Gas Sensor towards an Optical Nose Design", IEEE Sensors Journal, submitted, March 2017.
10. K. Singh, M. Juetten, R. Weber, and R. Kumar, "A Bistable Vibration Energy Harvester with Synchronized Extraction and Improved Broadband Operation through Self-Propelled Feedback" TechConnet, May 2017, Washington DC.

Invention disclosures: Four invention disclosure and patents have been filed on

1. ISURF 04183: Soil moisture and salinity sensor with its wireless interface---Patent filed
2. ISURF 04354: Vibrational Energy Harvesting using Bistable Piezoelectric Cantelever---Patent filed
3. ISURF 04453: Nano-patterning on Fiber Tip for gaseous/aqueous species detection---Provisional Patent filed
4. ISURF 04454: Soil Nutrient Sensing---Provisional patent filed

The invention 4183 has been **licensed by Raven Industries**. Paperwork for the licensing of the invention 4454 has been sent to Raven and is being finalized. Raven is also looking into the invention 4453.

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

1. **One NSF funding received, April 2016-Oct. 2017,** "PFI: AIR - TT: In-Situ Wireless Soil Sensor for Moisture, Salinity and Ions", $200K.

2. **NSF proposal submitted, March 2016, (not funded),** "NSF, INFEWS/T3: Reducing Energy Demand and Water Discharge Pollutants in Agriculture Food Production: Sensors, Models and Socio-Economics", Aug. 16, 2016-Aug. 15, 2020, in amount of $3M.
3. **NSF proposal submitted, March 2017 (pending),** "NSF, INFEWS/T3: Reducing Energy Demand and Water Discharge Pollutants in Agriculture Food Production: Sensors and Models", Aug. 16, 2017-Aug. 15, 2021, in amount of $2.35M.
4. **Gift from Texas Instruments, June 2017-Dec. 2017,** For research on impedance spectroscopy for soil ion separation, $50K.

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 was prototyped that corrected the hardware and software bugs. A demo to Raven Industries was presented on ISU campus in Sept. 2015. Raven invited us back for another demo at their site in Sioux Falls, SD in Nov. 2015. In Spring 2016, Raven licensed our soil moisture sensor technology.

Following the licensing, Raven visited us in Fall 2016 when we gave them an updated demo, and also presented the work on soil nutrient sensing and plant gas sensing. We then provided the hardware and software designs of the soil moisture sensor to Raven, who has assembled a prototype at their end, and now getting ready to test the design. We will be shipping them the updated software in next couple of weeks. Our Phd student, Bhuwan Kashyap, supported by RIF, is interfacing with Raven to help complete the know-how and technology transfer.

Our impedance spectroscopy approach to soil moisture and salinity sensing was located by **Texas Instruments** in their on-line search. They invited us for a discussion, as they want to see it applied in a non-agricultural domain, namely, for measuring fluid level in automobiles. To investigate this, TI offered a summer internship this summer to Bhuwan Kashyap at their Kilby Lab in Dallas. Also to continue the research in Fall 2017, TI has provided us an unrestricted gift of $50K. This is especially encouraging since TI can be valued partner for our sensors related work, where we are using TI processor-cum-transceiver.

The development work on soil Nitrate sensor is also progressing, and is led by the Phd student Zhen Xu. A paper based on this work was presented at the IEEE Sensors Conference in Oct 2016, and later a journal version was accepted at IEEE Sensors Journal in May 2017. We have completed the design and testing of the sensing unit which can analyze a soil solution sample to measure the concentrations of various ions, including nitrate. The results have been encouraging---we were successful in separating multiple different ions in a given soil sample. We have also designed and tested the microfluidic system which can autonomously extract the soil solution from soil sample. The work to integrate the sensing and solution extraction units is currently ongoing, and expected to be completed by the end of summer.

We are also working on developing a sensor for the detection of gaseous molecules excreted by plants under biotic and abiotic stresses. This work is being done by a 3rd Phd student, Shawana Tabassum. We have developed a method to be able to etch a nano-pattern on the tip of an optical fiber that can interact with the gas species of interest, and provide a response in form of a change in its transmitted and/or reflected spectrum. The work is currently in its design and development phase, and upon which prototyping will follow.

To see the working of the nutrient sensor and optical gas sensor, Raven visited us on Jan 9 2017, where we demonstrated the nutrient and the gas sensor. We presented another update to Raven on May 4, 2014. Subsequent to this, Raven made a decision to move forward with licensing our nutrient sensor. The paperwork is in progress, and being finalized.

During this period, we also signed NDAs with Pioneer, TechAccel and IntelliFarm, and made presentations in Oct 2015, March 2016 and April 2016, respectively. We also attended TechConnect 2017 in May 2017 in Washington DC, where we published our work on energy harvesting (4354). Additional industry connections have been made, including 3M Cargill and a few others (Atacama, Rassini, Propel[x]).

RIF FUNDING: PROGRESS REPORT

Report Type: Final

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 struggled with recruitment and adherence shortcomings, leading to an underpowered study. Participants completing the study experienced weight loss, and improved metabolic blood markers; however, the efficacy of HMB could not be determined due to lack of power. Weight loss obtained in this study did not reduce inflammation or lower susceptibility to an inflammatory stimulus.

RIF FUNDING: PROGRESS REPORT

Report Type: Interim Report

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

PIs: Keith Vorst and Greg Curtzwiler

Company Partners (if applicable, company names only):
Amcor Rigids
Dart
Peninsula Packaging
Niagara Bottling
IdeoPak
American Packaging Company
Johnsonville Sausage Co.

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.

Speaker/Presenter
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, Greg W., Williams, Eric B., Maples, Austin L., Davis, Nathan W., Bahns, Ted L., De Leon, J. Eliseo., Vorst, Keith L. Ultraviolet protection of recycled polyethylene terephthalate. J. Appl. Polym. Sci. 134 (2017) 45181.
- Monge-Brenes, Ana-Lorena, Curtzwiler, Greg W., Vorst, Keith. Vitamin K1 and beta-carotene retention in fresh cut Arugula when packaged in post-consumer recycled polymer packaging. In Preparation.
- Curtzwiler, Greg W., Williams, Eric B, Hurban, Emily., Green, Joeseph., Vorst Keith. Influence of post-consumer recycled content on extruded polyethylene film properties. In Preparation.

External Funding:

2017 Proof of concept for test markets. Determination of shelf-life and destructive degradation wavelengths in sausage packaging. Funded by the Johnsonville Sausage Co.

2016 INFEWS/T3: Enabling Innovative Systems Solutions with High Voltage Atmospheric Cold Plasma at the Intersection of Food, Energy, and Water, (National Science Foundation (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 Forming Processes and Shelf-life Extension of Fresh-Cut Produce. Funded –Iowa State University Polymer and Food Protection Consortium (funded).

Invention disclosures:
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

1.) **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 and high density polyethylene, which is known to cause a variety of degradation reactions in the polymer, produced a multitude of degradation byproducts/molecular structure rearrangement that reflect or absorb UV light and can be controlled though blending, additives and monitoring during conversion. Work completed at ISU mounted with in-line sensors (UV-Vis, IR, X-ray, fluorescence), with room for three more optical sensors (i.e.- Raman, NIR, etc.) demonstrated optimized blends and compounds for increased material performance. The current system has successfully collected full UV-Vis 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 and high density polyethylene containing known amounts of post-consumer recycled material (PCR) were run through several sensor array configurations such as inline UV-Visible light spectrometer (UV-Vis) and energy dispersive x-ray fluorescence (ED-XRF) and infrared (IR). Each sensor collected unique data signals which identifies various classes of chemical compounds and heavy metals present in the polymer matrix. Proof of concept work was performed in the Iowa State University Packaging Lab in conjunction with a commercial extrusion monitoring system and has demonstrated the potential integration into existing packaging manufacturing systems. Corporate partners have been engaged to facilitate installation of the beta system on commercial extrusion and packaging lines to demonstrate scaleability and reliability of the system in real-world applications (Table 1).

Table 1. Task Progress

Objective	Task	Milestone or Type	Milestone Verification	Anticipated Date
1	Manufacturing trial for produce and light sensitive packaging	Milestone	Validation of shelf-life extension and reduced nutrient decay in bottles juices and salad kits	Completed
2	Cost analysis of feedstock, and thermoform container monitoring	Milestone	Develop cost models with ISU/IdeoPak for licensing	Completed
3	Develop marketing and promotional material using CyBiz	Milestone	Presentation ready models with product categories for strategic partners	Started May 2017
4	Product line identification and field of use for partners companies	Go/No Go	Identify field of use to exercise patent license	Completed with Johnsonville Sausage Co.
5	Roll out product to select markets	Go/No Go	Product claims validated and used in end markets with strategic partners	License Agreement to Develop product line

RIF FUNDING: PROGRESS REPORT

Report Type: Interim

Title: Co-production of Higher-value Chemicals with "Drop-in" Biofuels from Animal Manure Using a Novel Liquid-phase Refinery Process (Phase II)

PI(s): Wenyu Huang; Danny Anderson

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 economic feasibility of co-production of high-value chemicals and "drop-in" biofuels from animal manure.

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 the levulinic acid to β-acetylacrylic acid through a novel catalytic process. β-acetylacrylic acid is a high-value chemical that sales at $20~100/gram currently. We also plan to file another patent on this novel manure processing technology.

External funding applied for (indicate received/denied/pending):
We applied five SBIR/STTR grants so far and all of them were rejected.

- DOE, STTR; Funding period: 02/22/2017 – 02/21/2018. Total Award Amount: $150,000. Huang group award: $90,000 (includes overhead). "*Co-Production of Value-Added Chemicals and NPK Fertilizers from Animal Manure*" Wenyu Huang, co-PI (subcontractor); Daniel Andersen, co-PI (subcontractor); Esstar Bio Technology LLC, PI.
- NSF, STTR; Funding period: 07/01/2017 – 06/30/2018. Total Award Amount: $225,000. Huang group award: $131,499 (includes overhead). "*Cost-Efficient Production of Medium-Chain Chemicals from Animal Manure*" Wenyu Huang, co-PI (subcontractor); Daniel Andersen, co-PI (subcontractor); Esstar Bio Technology LLC, PI.
- NSF, STTR; Funding period: 07/01/2017 – 06/30/2018. Total Award Amount: $225,000. Huang group award: $131,499 (includes overhead)."*Cost-Efficient Production of Medium-Chain Chemicals from Animal Manure*" Wenyu Huang, co-PI (subcontractor); Daniel Andersen, co-PI (subcontractor); Esstar Bio Technology LLC, PI.
- DOE, STTR; Funding period: 02/22/2016 – 08/31/2016. Total Award Amount: $90,000 (includes overhead)."*Catalytic Transformation of Cellulosic Waste Streams to Dicarboxylic Acids and Diols*" Wenyu Huang, PI (subcontractor); Esstar Bio Technology LLC, PI.
- USDA, SBIR; Funding period: 06/01/2016 – 01/31/2017. Total Award Amount: $33,000 (includes overhead)."*A Novel Liquid Phase Refinery Process for the Conversion of Agricultural Biomass to "Drop-in" Biofuels*" Wenyu Huang, PI (subcontractor); Esstar Bio Technology LLC, PI.

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

During Phase II of this project, we successfully achieved all milestones. Huang group successfully converted a variety of raw animal manure samples from pork, chicken, and beef to value added product—levulinic acid (LA). We successfully obtained good yields of LA from these waste feedstocks (0.006-0.016 ton of LA per ton of manure). Using a market price of LA ($6300/ton), we estimate the sales of LA will solely contribute approximately $38-100 additional revenue per ton of animal manure.

Meanwhile, Andersen group analyzed nutrients distribution in the products. We found that liquid product mainly includes nitrogen and potassium nutrients (very little phosphorous), while solid product mainly includes phosphorous. The separation of nitrogen and phosphorous nutrients are desired because excessive phosphorous

nutrient has been put into lands, therefore needs to be removed. This technology will provide an effective way to generate nitrogen-rich and phosphorus-rich compost products for various fertilizer applications. Currently, the farmers ask for $15 per ton of manure taken away from animal farms. Our technology produces LA ($38-100) and nutrient rich composts (~$15), suggesting the process is highly likely to be profitable.

In collaboration with CyBIZ Lab, we conducted more techno-economic analysis. We found that the production scale will significantly impact the Minimum Selling Price (MSP) of LA. The MSP value of LA linearly decreases at <400 ton/day processing scale, while keeps relatively stable in the range of larger scale. We estimate an MSP of LA at $719 per ton from 400 ton/day processing capacity facility, which is remarkably less than the current market price ($6300/ton), confirming that the manure processing utilizing this technology will be potentially profitable.

We plan to file a patent disclosure to this novel manure processing technology. In addition, we are going to publish papers regarding this and the conversion of LA to β-acetylacrylic acid.

RIF FUNDING: PROGRESS REPORT

Report Type: Final

Title: No Heat Soldering, Phase I and Phase II

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:

1. "Development of Heat-Free Solders derived using Particles Structure-driven Undercooling" Materials Science & Technology Conference, Salt Lake City, UT, Oct. 23-27 2016
2. 'Heat-free solder for wearable/flexible electronics' International Conference on Materials for Advanced technologies, Singapore, June 18-23 2017
3. 'Lessons from a droplet' University of Korea, June 16 2017

Invention disclosures: Contributions to ISURF #04335, new disclosure in preparation
A new provisional IP was filed in June 2017. This IP is related to methods to readily apply the undercooled metal particles as conductive inks and development of a chemical method to join these particles.

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
SAFI-Tech PI, Ian Tevis, with Prof. Martin Thuo: NSF SBIR Phase I – Denied
SAFI-Tech PI, Ian Tevis, with Prof. Martin Thuo: NSF SBIR Phase II – Pending
Angel Investors have pledged up to $500,000 need for the seed round. Term sheets are currently under with the lawyers

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

Project Milestones

1. SAFI-Tech scaled the production of Field's metal to 50g by introducing heat into the processor. These undercooled particles show high purity (>85 %) and stability, with the metal remaining liquid up to -37 °C.
2. A higher temperature solder (melting point over 200 °C) was formulated and stabilized into liquid micro-particles. This new solder has been used to solder copper and form electrical contacts with Aluminum. The ability to solder aluminum is a unique advance in the soldering technology.
3. The focus of this milestone was shifted to copper instead of aluminum because of its relevance in electronics. A custom organic flux with moderate flux activity was used to join two copper sheets to make a conductive joint. Flux allows pressed undercooled particles to wet the surface of the copper.

Business Milestones

1. CyBIZ lab worked with SAFI-Tech to identify customers who can use our technology, identify potential competitors, and assess possible markets. A list of over fifty 3D printing companies was delivered to SAFI-Tech. SAFI-Tech has completed the ISU's StartUp Factory program and new customers have been identified, with 3 major corporations discussing NDA and MTA to facilitate collaboration which would eventually translate to adoption of our technology. SAFI-Tech was awarded a NSF SBIR Phase I grant based upon undercooling technology and preliminary results from the RIF grant helped secure that funding.
2. SAFI-Tech has pivoted from the syringe application system to the direct write and paste application systems for convenience.
3. Investors have been engaged to raise the seed round and a second investor has been approach in preparation for the series A fundraising.

Deliverables

1. SAFI-Tech has developed a paste/flux and application method for cold soldering copper sheets using Field's metal. The joined sheets are mechanically (only limited by the mechanical strength of the Field's metal) and electrically robust. Pastes and ink formulations have been developed for the application prototypes for "traditional" soldering and direct writing of conductive lines.
2. Prototype demonstrations of screen printing of undercooled particles, direct writing of conductive lines on paper, and direct paste application. The direct paste application demonstration helped SAFI-Tech in convincing a NSF SBIR program manager to support a Phase I grant application.
3. Application of the heat-free solder in fabrication of MEM force sensors, Wheatstone bridges, and in the assembly of a radio kit was achieve.
4. Longevity studies on the formulated particles is on-going and this demonstrates that the loss in the total yield (over 8 months at the moment) is <5 % under an appropriate solvent. This demonstrates that the particles can survive ambient storage conditions.

RIF FUNDING: PROGRESS REPORT

Report Type: Interim

Title: Safe and Convenient Chemical Purification System

PIs: Eric Cochran,

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

Project Goal:

Develop an innovative chemical purification system for laboratory scale research that is safe, fast, economical, standalone and portable.

Publications/presentations based on project: None

Invention disclosures: ISURF 04287

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

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

Our research team at ISU, in collaboration with Polymer Advantage, LLC, applied for NSF SBIR funding for 2017. We received some good comments and suggestions from the reviewers, however the project was not chosen to be funded. We will apply again for 2018 NSF SBIR funding. During the semester, two undergraduate students were hired to complete the computer aided design of the purification apparatus. This included the replacement of our current and not so user-friendly column system with an innovative and easy to use/install system (columns and chemical refilling system). The design was completed and we will now start the assembly of the prototype purification system. This requires us to fabricate custom parts, purchase already made parts, *i.e. control panels columns, tubing, column packaging etc.,* and assemble the system. After this has been completed, we will start field trials.

RIF FUNDING: PROGRESS REPORT

Report Type: Interim

Title: Metal Separation for Recovering Rare-Earth and Specialty Metals from Electronics Waste

PIs: Martin Thuo

Company Partners (if applicable, company names only): Sep-All, LLC

Project Goal: Scale the processing capability with increase in purity of the separated materials.

Publications/presentations based on project:
"Dumpsites as 21st century mines: Affordable recovery rare-earths and critical materials from e-waste" 2017 ACS Sustainable Chemistry & Engineering Lectureship Awards: Symposium in Honor of Jinlong Gong, San Francisco, CA April 2-6 2017 (invited talk)

Invention disclosures:

External funding applied for (indicate received/denied/pending):
Sep-All PI, C. Frankiewicz, with Prof. Martin Thuo: NSF SBIR Phase I – Denied
Sep-All PI, C. Frankiewicz, with Prof. Martin Thuo: NSF SBIR Phase I – pending

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

1. Sep-all scaled the processing from a few mg to 50 g processing scale and optimized the processing conditions to allow rapid separation times ranging from 0.5-3 hrs.
2. Industrial alloys, brass and pyrite, were separated into their constituent components using our method. Similarly, mixed materials (polymers, ceramics and/or metals) were also separated in up to 100 g scale. The separated materials were obtained either in their oxidized precipitates, as chelates, or in the reduced pure form.
3. Depending on the native composition, the purity of obtained materials ranged from 80-100 %. During the separation process, we observed that when a target element could be converted into a self-assembled particles, they were of higher purity.

Business Milestones

1. A business canvas and pitch deck (presentation) has been prepared with the help of the ISU startup factory. The business model and path to profitability has also been modelled to allow for better projection of rate of growth of the business
2. Sep-All has completed the ISU startup factory program and is working with a CyBiz intern to continue the customer discovery process, especially for a new proprietary product that has emerged from the scaling process. For the separation process, customer discovery has been concluded and various partners and potential customers have been contacted. Three new potential customers have been approached and two MTA and NDA are being discussed to allow for further development of the process.
3. Based on price and/or supply risk, Sep-all has recently pivoted to a more focused recovery of gold (motherboards), rare-earths (magnetic components) and indium (displays) from electronic wastes.

Deliverables

1. Sep-all has demonstrated that the purification process can be scaled from a few grams to tens of grams and for multi-phase materials, this can be scaled to 100 g. The process has been optimized to allow for rapid purification and density-based separation of different components has been demonstrated for multi-phase materials.
2. The business model/path to profitability has been mapped out indicating that Sep-All will be profitable in the near future based on the current market prices and projected ease of scalability.

RIF FUNDING: PROGRESS REPORT

Report Type: Interim

Title: Design Certification of Hexcrete Wind Turbine Tower Cells

PIs: Sri Sritharan

Company Partners (if applicable, company names only): HZ Windpower Iowa and Barr Engineering

Project Goal: Certification of components for hexcrete wind turbine towers to facilitate adoption of Hexcrete technology for tall wind turbine towers.

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):

This project began June 1, 2017.

RIF FUNDING: PROGRESS REPORT

Report Type: Interim

Title: A Non-Vertical Dynamic Flow Sensing Technology for Bulk Materials

PIs: Manjit Misra

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

Project Goal: To develop and test a sensing technology for non-vertical flows.

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):

This project began June 1, 2017.