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JOINT COMMITTEE ON FINANCE

MEMORANDUM

To: Members
Joint Committee on Finance

From: Senator Alberta Darling
Representative John Nygren

Date: November 15, 2017

Re: UWS Report to JFC

Attached is a report on industrial and economic development funds from the University of Wisconsin System, pursuant to s. 36.25(25)(c), Stats.

This report is being provided for your information only. No action by the Committee is required. Please feel free to contact us if you have any questions.

Attachments

AD:JN:jm

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NOV 15 2017
JT. Finance

DATE: November 15, 2017

TO: Senator Alberta Darling, Co-Chair, Joint Committee on Finance
Representative John Nygren, Co-Chair, Joint Committee on Finance

FROM: Ray Cross, President

RE: 2015-17 Report on Industrial and Economic Development Funds

With an economic impact of over $15 billion annually, the University of Wisconsin (UW) is continuously engaged in economic growth for the state. One of the tools that the UW uses to ensure that its research mission translates into economic success is the Industrial and Economic Development Research Fund (IEDRF).

The funding for this program is distributed through the Applied Research Program, the Industrial and Economic Development Research/State Economic Engagement and Development (SEED) Program, and the Center for Dairy Profitability. These programs are intended to promote technology transfer and collaborative projects that stimulate economic development in Wisconsin. As a result of IEDR/SEED research, some collaborating companies will achieve cost savings, plan to hire additional staff, or are in better positions to manufacture and market their products. This provides an economic boost directly to the State of Wisconsin.

Wis. Stats. s.36.25(25) (c), requires the University of Wisconsin System to report biennially to the Joint Committee on Finance regarding projects funded as part of the industrial and economic development research program in the previous fiscal biennium and the relationship of the funded projects to the state's economy. The enclosed report is submitted for your review.

If you require any additional information regarding the 2015-17 Report on Industrial and Economic Development Funds, please contact Gillean Kitchen (gkitchen@uwsa.edu or 608-263-7879).

Enclosure

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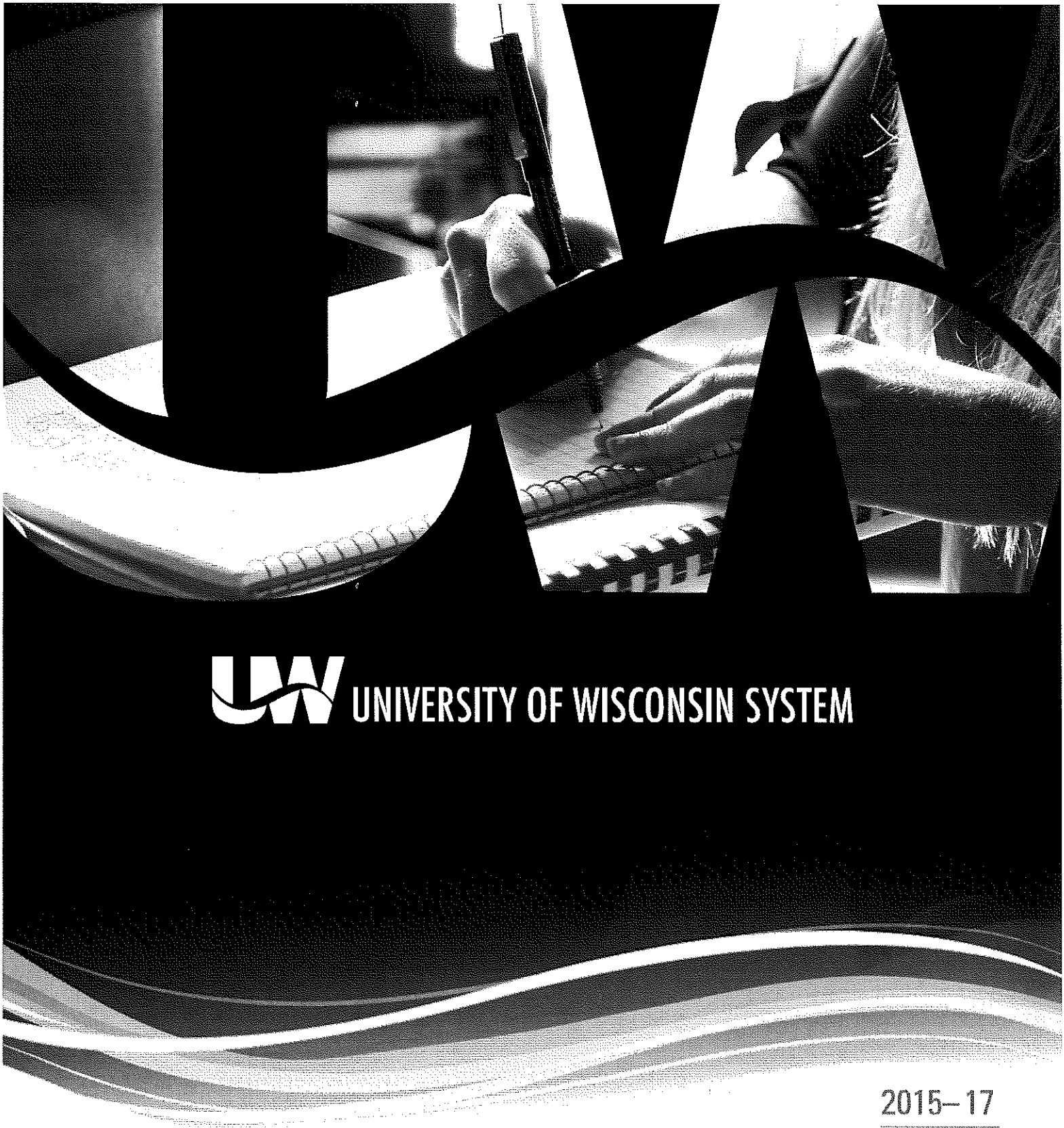

UNIVERSITY OF WISCONSIN SYSTEM

2015–17

INDUSTRIAL AND ECONOMIC DEVELOPMENT RESEARCH FUND REPORT

2015-17 Industrial and Economic Development Research Fund
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Industrial and Economic Development Research Fund

Background

The Industrial and Economic Development Research Fund (IEDRF) was established in 1987 to enhance the relationship between UW System institutional research and Wisconsin industrial practices in an effort to promote the state's economic growth. It has supported projects which have assisted a large number of Wisconsin enterprises. Many of these projects continue to improve the competitive position of Wisconsin businesses.

This report describes the activities supported by the IEDRF for the 2015-16 and 2016-17 fiscal years. The report is divided into three narrative sections and eight appendices. The first narrative section details the Industrial and Economic Development Research Program (IEDR), which has also been referred to as the SEED (State Economic Engagement and Development) program since 2014. This program provides grants to faculty and staff at UW-Madison. The second section provides an overview of the Applied Research Program, administered by the UW System Office of Academic Affairs. These funds provide grants to faculty throughout the UW System. The final section describes the activities of the Center for Dairy Profitability, an on-going UW-Extension and UW-Madison project that addresses economic challenges to Wisconsin's dairy industry.

Both the IEDR/SEED program and the Applied Research Program provide grants which are competitively awarded. Researchers are encouraged to submit technically innovative proposals that are of interest to a broad economic sector and will immediately benefit Wisconsin's industrial and economic development. All projects are selected based on a combination of scientific merit and the potential for technology transfer. Grant summaries are provided in the appropriate sections.

Eight appendices are attached which list all grants, investigators, campuses or departments, and the amounts funded by the IEDR/SEED and Applied Research programs. Appendix G notes extramural grants awarded in support of the work done by the Center for Dairy Profitability as well as the Center's publications.

IEDR/SEED Program – UW-Madison

The Office of the Vice Chancellor for Research and Graduate Education administers the IEDR/SEED program for the University of Wisconsin-Madison. The IEDR/SEED program seeks to stimulate and enhance research collaborations between UW-Madison and Wisconsin firms and to promote economic development in the state. University faculty and staff researchers submit proposals that are subject to a competitive selection process. A selection panel comprised of faculty and representatives from the technology transfer, research policy, and industrial contracts offices, select technically innovative projects that will benefit Wisconsin businesses. The panel reviews each proposal for scientific and technical merit, while also taking into consideration the impact the research will have on the identified sector of the

Wisconsin economy. Applicants for this program must have a financial or management interest in a company that has spun out of research performed at UW-Madison.

The IEDR/SEED program funded 5 projects during the fiscal year ending June 30, 2016 ($625,000) and 6 projects during the fiscal year ending June 30, 2017 ($716,834). Research titles for individual projects are listed in this report. The following points highlight some noteworthy facts and outcomes resulting from IEDR/SEED research program:

- Over the 2015-2017 biennium, IEDR/SEED funding supported collaborative research between UW-Madison scientists and Wisconsin businesses in Dane, and Jefferson counties.

- Faculty indicated that IEDR/SEED funding fundamentally demonstrates state and university commitment to translational research, solidifies research collaborations with companies, and leverages awards into further funding opportunities. Several faculty members noted the scarcity of such funding to directly support product development, making it unlikely that the research would have been undertaken without support from IEDR/SEED. Some specific feedback received includes:

    - The work completed under this project has had several important impactes on our spinoff company, including: Creating and/or retaining 3 full-time jobs, enhancing specific technical expertise of our staff, and increasing the likelihood of our products being commercialized. (Dr. Adel Talaat)
    - The AmebaGone products benefit from collaborations with experts in the Bacteriology, Plant Pathology, Animal Sciences and Ophthalmology Departments at UW-Madison. Our close collaboration with academic experts keeps us abreast of the latest understanding of agricultural, animal and human pathogens. (Dr. Marcin Filutowicz)
    - Since its inception, Thalchemy has been aggressively developing new and exciting technology for the task of always-on sensory processing using proprietary neural algorithms. The SEED grant enabled new research and development in the field of brain-inspired computer and neural networks, and the advancements and findings of the research have effectively enabled Thalchemy to broaden its product portfolio to include state of the art hot-word and command detection capability with industry-leading energy efficiency. (Dr. Mikko Lipasti)
    - A recent acquisition of NeuWave Medical by Ethicon (Johnson & Johnson) demonstrates a continuation of the medical valu of microwave ablation to the State of Wisconsin. This work supports NeuWave's product development, enabling more accurate and precise treatments. These developments could enable a wider range of procedures, where the need to avoid damaging nearby structures is essential. The platform would also extend minimally invasive cancer therapies using microwave ablation to other Wisconsin-based entities, particularly Marvel Medtech, which is focusing on interventional image-guided therapy in breast cancer. (Dr. Walter Block)
    - The development of the KOALA-iPSC differentiation assay is an essential first step towards developing the technologies and methods required to produce a

commercially successful KOALA product. Translation of this technology will occur in a Madison start-up (Salus Discovery, LLC) which has licensed a suite of patents on KOALA. (Dr. David Beebe)
    - We are working with Madison College to incorporate the KOALA iPSC differentiation kit into the curriculum of the Stem Cell Technologies certificaiton program. (Dr. David Beebe)

- Data from IEDR/SEED projects allowed several faculty to apply for and receive large research grants directly from federal agencies and subcontracts with partnering companies, who received SBIR grants.
- As a result of IEDR/SEED research, some collaborating companies will achieve cost savings, plan to hire additional staff, or are in better positions to manufacture and market their products. This provides an economic boost directly to the State of Wisconsin.

- In addition to faculty and academic staff, several graduate and undergradaute students, as well as postdoctoral fellows worked on these projects. Many of these trainees received training for high-tech jobs and left UW-Madison with job offers in technology companies.

- Researchers have already submitted or published six research papers in peer-reviewed journals and conference proceedings. Additional papers are either in progress or planned.

Applied Research Programs - UW System

The UW System Office of Academic and Student Affairs, in collaboration with WiSys, offers three Applied Research grant programs to UW System faculty and academic staff. WiSys administers these grant programs on behalf of UW System. UW System makes final decisions on grant funding. WiSys supports the creation and transfer of innovations from the University of Wisconsin System to the marketplace with the aim of building a culture of innovation for a better future. WiSys is a 501 (c)(3) supporting organization of the UW System that, along with UW System, provides research support for 11 four-year universities, 13 freshman-sophomore UW College campuses, and the statewide UW-Extension.

The goals of the Applied Research programs include developing advanced human potential and the knowledge economy that employs that potential. In particular, the Applied Research Grant (ARG), the Applied Research-WiSys Technology Advancement Grant (AR-WiTAG), and the Prototype Development Fund (PDF) programs help to promote technology transfer and economic development throughout Wisconsin and provide for broader impact beyond the state. The purpose of the ARG and AR-WiTAG programs is to encourage faculty and academic staff to apply their expertise and scholarship to the economic development of Wisconsin. The PDF grant program supports research and development intended to advance the commercial potential of technologies developed through the UW System and assigned to WiSys.

The ARG and AR-WiTAG programs are competitive. Principal investigators from UW System institutions submit proposals documenting their realizable applied research goals and

objectives, a detailed work plan, and funding requirements to achieve outcomes that may result in societal and/or economic impact to the state including intellectual property protection, technology transfer, business expansion and profitability, and job creation. A panel comprised of representatives from the private sector with expertise in business and technology, a representative from WiSys, and a representative from the UW System Office of Academic and Student Affairs reviewed and rated proposals.

In 2016-17, the grant programs received 40 applications for funding, requesting a total of more than $1,750,000. Six (6) ARG proposals were funded by UW System Administration in the total amount of $263,489. Six (6) AR-WiTAG proposals were funded by UW System Administration in the total amount of $252,235. UW System Administration provided further funding to support one (1) Prototype Development Fund grant totaling $10,793. In addition, UW System Administration provided WiSys a stipend of $85,202.79 to cover patenting and licensing costs for technologies developed with the support of the Applied Research grant programs.

In 2015-16, the grant programs received 25 applications for funding, requesting a total of more than $1,000,000. Six (6) ARG proposals were funded by UW System Administration in the total amount of $256,172. Six (6) AR-WiTAG proposals, one of which was collaborative, were funded by UW System Administration in the total amount of $290,294. In addition, UW System Administration provided a stipend of $70,171.51 to WiSys to cover patenting and licensing costs for technologies developed with the support of the Applied Research grant programs. The above funding from the 2015-16 Applied Research programs resulted in three new inventions and the filing of four U.S. and one international patent application as well as the issuance of one U.S. patent. In addition, industry collaborations with three commercial partners were secured.

In summary, the UW System funded $1,072,983 in applied research over the two-year period.

A. Applied Research Program (ARG) Awards, Fiscal Year 2016-17

See Appendix E for a list of investigators, departments, and amounts of the awards.

1. Homogenous Electrocatalytic Reduction of Carbon Dioxide Using Earth Abundant Metals,
   (PI: Brian Barry, UW-Platteville)
   Carbon dioxide concentrations in our atmosphere have reached ~400 ppm, which is up from pre-industrial levels of 280 ppm, and will continue to climb. This drastic increase in greenhouse gas levels has resulted in unprecedented rates of climate change, threatening humanity's way of life. The team has recently discovered a high-performance, robust, scalable catalyst which can perform electrocatalytic reductions of CO_2, converting it to the syngas carbon monoxide. This project will aim to build upon this success by optimizing this catalyst design and producing a water-soluble iteration.

2. Development of Bio-based Antimicrobial Food Packaging by Incorporating Antimicrobial Molecule-Nanoparticles Systems in Starch,
   (PI: Min Lin DeGruson, UW-Stout)

This project aims to develop starch-based antimicrobial films by incorporation antimicrobial-nanoparticle systems with improved mechanical and barrier properties, along with a controlled release rate of antimicrobial agents to food surface for the inhibition of foodborne pathogens and fungi in food. The research also aims to develop starch-based films utilizing modified nanoparticles with antimicrobial agents; evaluate mechanical and barrier properties of starch-based films; and evaluate the release and antimicrobial properties of starch films loaded with antimicrobial-nanoparticle systems into food.

3. Preparation of Metal-Organic-Frameworks (MOFs)-based Nanoporous Membranes for Carbon Dioxide Separation Application,
(PI: Mohammad Gulam Rabbani, UW-Platteville)
This proposal outlines a research plan that is designed to prepare a nanoporous membrane to separate carbon dioxide (CO_2) from different gas mixtures, such as landfill gas, isoprene gas, flue gas, etc. The membrane will be prepared either by allowing the in situ growth of metal-organic-frameworks (MOFs) on macroporous glass frits or by the combination of nanoporous MOFs and functional matrixes, which results in membrane composites. The efficiency of the resulting membranes in gas separation will be tested both in laboratory as well as at industrial facilities at Dubuque landfill for landfill gas and Algoma Algal Biotechnology (AABT) for isoprene gas. The membrane-based separation of CO_2 offers a simple and easy way to make the landfill gas and isoprene gas cleaner and a more efficient source of energy.

4. Experimental Testing of Computationally Designed Inhibitors of Rhinovirus Infectivity,
(PI: Jonathan Gutow, UW Oshkosh)
The objective of this project is to perform cell culture assays to determine whether four compounds designed by the PI and his co-inventor can reduce the infectivity of human rhinovirus 16. This is one of the viruses that causes the common cold.

5. Scientifically Authentic Video-based Experiments (SAVE),
(PI: Matt Vonk, UW-River Falls)
The proposed research aims to create multi-dimensional arrays of interactive videos. The short videos will depict real events with high clarity and integrated analysis tools (online rulers, stopwatches, protractors, etc.) so that students can analyze the videos for themselves. The research also aims to improve HTML5 code of the current video player to incorporate these new features, improve the design of the user interface, and to develop a comprehensive marketing plan for the project.

6. Development of Ceramic-Based Water Filtration Materials for the Removal of Arsenic and Virus,
(PI: Shangping Xu, UW-Milwaukee)
The primary goal of the proposed research is to develop high efficiency ceramic water filtration materials that are suited for the removal of arsenic and virus under a wide range of pH conditions using synthesized metal (i.e., iron, zinc and aluminum) oxide nanoparticles. The ceramic materials prepared will be either in granulated or disk form. The granular form can be used for water filters, while the disk form can be used for point of use purpose (e.g., clay pot filter). Kohler Co. has expressed strong interests in commercializing the disk form of such ceramic water filters.

B. Applied Research-WiSys Technology Advancement Grant (AR-WiTAG) Awards, Fiscal Year 2016-17

See Appendix E for a list of investigators, departments, and amounts of the awards.

1. Development of Optimized Economical Metal Oxide Nanowire and Chalcogenide Quantum Dots for Displays, Solar and Water Splitting: Processing, Fabrication and Purification Technologies,
   (PI: James Hamilton, UW-Platteville)
   Next generation use of nanomaterials like nanowires and quantum dots is hampered by expense and fundamental limitations on processing and exfoliation to individualize and purify the nanomaterial so it can be used, for example, as a point source of light in a Quantum Dot Display or a uniform, high surface area nanowire films. In this project, the PI proposes to develop optimized and economical purification and manufacturing technologies for pure and mixed metal oxide and chalcogenide materials based on solution phase processing of thermodynamically stable solutions that can be identified using proprietary and unique characterizations and analysis equipment that has been built in the laboratories.

2. Development of a Semiconductor Quantum Dot Computer Aided Design Simulator,
   (PI: Wei Lei, UW-Platteville)
   The objective of this research is to develop a primary semiconductor quantum dot (QD) computer aided design simulator to calculate the QD electronic and optical properties. If the project is successfully accomplished, it may lead to the first commercial QD simulator on the market. The simulator will fully consider the QD material compositions and irregular shapes due to the current fabrication technology. The models of the simulator are based on K-P theory to take account of band mixing and strain effects. Finally, the problems are solved strictly by finite element method. To facilitate the customer applications, a graphic user interface (GUI) will be implemented.

3. Novel Chiral Organocatalysts for Synthetic Organic Reactions,
   (PI: David Lewis, UW-Eau Claire)
   New chiral organocatalysts based on camphor will be prepared and tested in three major carbon-carbon bond-forming reactions: the Diels-Alder cycloaddition, the Michael addition, and the Friedel-Crafts alkylation. These organocatalysts have two common structural features: 1) a secondary bornylamine moiety and 2) an aromatic ring with sufficient conformational flexibility to permit it to π stack with an electrophilic group.

4. Design and Construction of a Prototype Flow Reactor for Oxidations of Alcohols and Olefins,
   (PI: Robert McGaff, UW-La Crosse)
   The proposed project has three major research objectives. The team will prepare supported (immobilized) versions of a catalyst compound that has been discovered in their research laboratory. The PI will test these supported catalysts in oxidation reactions of industrial importance: transformations of alcohols into aldehydes and ketones and of olefins into epoxides. Catalyst-support combinations found to be effective in catalyzing these transformations will then be employed in a prototype flow reactor. Analysis of catalytic

reaction products will be accomplished via gas chromatography-mass spectrometry. The flow reactor itself will be constructed from a peristaltic pump, a chromatography column, and inexpensive low-pressure fittings and valves.

5. Short Circuiting Bacterial Communication to Prevent Plant Disease,
(PI: Sabrina Mueller-Spitz, UW Oshkosh)
The major research objective for this project is the identification and development of novel enzymes for the prevention of crop loss due to bacteria colonization. The enzymes will interfere with quorum sensing by destroying the quorum molecules (acyl homoserin lactones) before they can be sensed by other bacteria, slowing or preventing bacterial destruction of the harvested crops. By analyzing the DNA sequences of bacteria in the team's collection, they have identified 26 likely target enzymes and another 316 possible target enzymes from these bacteria. The PI will transfer these genes to an *Escherichia coli* for rapid growth and production of the enzymes. The team will then use a screening process to detect quorum quenching (QQ) activity in cultures of the bacteria using GX-MS and LC-MS to look for loss of the quorum molecule and detect breakdown products. The most promising bacteria will be cultured in larger amounts and the enzymes will be purified to further study their activity. At that point, the PI will also investigate the heat and pH tolerance of the enzyme to ensure they have produced an enzyme suitable for application to harvested crops.

6. Thermostable Attachment of Capture Probes to SPR Sensors, for Use in Temperature Gradient SPR Measurements,
(PI: Aric Opdahl, UW-La Crosse)
The activities of this project are aimed at developing a new type of surface plasmon resonance (SPR) sensing measurement that provides the complete temperature dependence of sensor binding interactions in a single measurement. The key innovation is a sample handling system that applies a temperature gradient across the sensor surface. A practical requirement of this method is that the capture probes (e.g., DNA or protein) must remain securely attached to the sensor at high temperatures. The goal of this project is to develop a method that can be used to provide strong attachment of a wide range of probes. Experiments will test multipoint anchoring and cross-linking strategies, for both two-dimensional monolayers and three-dimensional hydrogel networks. Attachment strength will be assessed by in situ desorption measurements of probes, performed using SPR.

C. Prototype Development Fund (PDF) Awards, Fiscal Year 2016-2017

See Appendix E for a list of investigators, departments, and amounts of the awards.

1. Prototype Development of Requirement-Driven Interactive Degree Planner,
(PI: Sobitha Samaranayake, UW-Whitewater)
The objective of this project was to expand the existing version of the Interactive Degree Planner (IDR) software platform that provides for the creation of optimized degree plans for use by college students and their advisors by developing a structured database representative of the course prerequisites, degree requirements, and course offerings for the associate degree program for computer science at the University of Wisconsin-Rock County for evaluation.

The team was able develop a prototype of an interactive degree planner software that assists a college student in planning one or more semesters by suggesting courses based on degree requirements, course prerequisites, and course rotation. The software developed as part of this project allows students to plan courses for semesters based on students' interests and course schedules. This process allows students to customize plans for as many future semesters as they wish to consider, and then invoke the team's automated planner to complete the degree plan for any remaining semesters. Furthermore, the system provides a mechanism for the student to schedule courses for the current semester by providing a list of all possible schedule times of the suggested/selected courses for the current semester and a scheduling grid for visualization of selected course times.

D. Applied Research Program (ARG) Awards, Fiscal Year 2015-16

See Appendix F for a list of investigators, departments, and amounts of the awards.

1. Upgrading Organosolv Lignin to Small Aromatics by Catalysts in Presence of Green Solvents,
(PI: Malek Alkasrawi, UW-Stevens Point)
This project aimed to make low molecular weight aromatic compounds by catalytic cracking of lignin. Lignin is an amorphous polymer, which is abundant in all plant biomass. It is the most complex of lignocellulosic biomaterials and this complexity has led lignin to be treated as waste stream. It is most often burned to produce energy. However, lignin is rich in aromatic compounds, which represent a potential source for value-added chemicals/fuel additives upon upgrading. Lignin is the only biological source of aromatic ring chemistry and therefore has significant untapped opportunity to replace aromatic petrochemicals found in everything from plastics to solvents to fuels. Unlocking this potential value is envisioned to create new opportunities in the green chemicals derived from Wisconsin's forest products. Working collaboratively with partners at Bio-Energy Research Center, Montana State University – Northern in Havre, MT, and the American Science & Technology LLC in Wausau, WI, the PI aimed to bring these products to market by upgrading lignin into new green chemicals, optimize the process for scale up, and investigate suitable routes for commercialization.

   The main objective was to synthesize the catalyst that targets to C-O and C-C bonds that makes up the rigid polymeric structure of lignin. The new catalyst was successfully synthesized and cleaved the model compound. The second target that was achieved was softening the lignin structure and opening the complex structure for further fractionation. This step was done successfully in the Parr reactor at optimized conditions of 340°C, 5 bar and for 1 h using the same catalyst. The softened structure of lignin was treated further with the same catalyst for 5 h using the same conditions to monomeric aromatic compounds. Most of these compounds were benzene, Toluene and Vanillin. All project objectives were achieved successfully. However, by conducting further economic analysis it was determined that the lignin production cost from organosolv process is between $1000-15000/t, which is high in cost. Therefore, the team investigated an alternative and most cost-efficient process for production of high quality lignin from lignocellulosic. The team

utilized the nickel catalyst to separate the lignin from wood at a first stage, followed by lignin softening and fractionation at a second stage. Interestingly, the nickel catalyst separated the lignin from wood structure at conditions of 160oC for 15min. The separated lignin was treated again at optimized parameters at 340°C, 5 bar for 5h and the team was able to obtain the same results compared to the organosolv lignin. Another interesting finding was that in the end, there was no need to separate the lignin as the team discovered they could use the wood directly at 340°C, 5 bar for 5h. Surprisingly, the lignin fractionated into high value chemicals but at a slightly lower yield.

2. Preserving the Power of Plants,
(PI: Chip Beal, UW-Superior)
UW-Superior First Nations Center, in collaboration with area First Nation communities/tribes and small growers, aimed to continue Phase II of this project by further establishing and expanding experimental plots and food stations as well as satellite outlets at food markets, restaurants, and cafes. The goal of the project was to preserve the food and medicinal values of native plants of the region and the traditional Ojibwe knowledge for their cultivation and use. A key objective was to host a series of workshops affiliated with each experimental site that indicated to participants the properties of the natural food plants and their suitability for cultivation in individual garden plots and for small organic farmers interested in expanding their product line and markets. This was a multi-year project with a wide range of stakeholders from tribal organizations to indigenous schools, food farms, and alternative food markets and restaurants.

   This project provided further evidence in regard to the efficacy of methodology used and validated the expansion of additional species in existing experimental sites as well as provided for a number of ethnobotany workshops and related field guides. Briefly, it was determined that permaculture and similar naturalized methods are the best cultivation practices for preserving the wild nature of native plants. A mix of long term and short-term plants is best: leek, ginger, and fern require five to seven years with a large upfront investment in space and plants to produce sustainable market harvest; bergamot & wild mint grow readily in cultivated settings and produce marketable harvest within one year. The project also resulted in existing experimental sites adding further species including Gitigaan Maa'ishkam and Four Corners Elementary School both near Superior, WI; Lac Courte Oreilles, Hayward, WI; Red Cliff Reservation, Bayfield, WI; and Fond du Lac Reservation, Cloquet, MN. Furthermore, two new experiment sites were added: a private grower from the Bad River Indian Reservation, Odanah, WI and the Fond du Lac Ojibwe School, Cloquet, MN. Six small and eight larger ethnobotany workshops were held during the project and attended by approximately 227 adults and 156 youth from WI, MN, IA, ND, SD & MI. Topics addressed included: cultural importance, identification, cultivation methods, harvesting, preserving, uses, preparation, and steps to bring products to market. Field guides were revised and distributed to growing sites and school sites (teachers and library), as well as participants in the above workshops.

3. Scale-up of Hollow Si Lithium-ion Battery Anode Materials for High Performance Electric Vehicles,
(PI: Junhong Chen, UW-Milwaukee)

The objectives of this research project were to scale up the synthesis of a hollow Si anode material invented by the PI and to demonstrate its lithium-ion battery performance through pouch cells. The hollow structure of the Si helps alleviate the huge volume expansion upon lithiation, which significantly improves the cyclic performance of Si and makes it possible for practical applications. As part of the project, a new furnace system was to be set up to enhance the production rate of hollow Si by 100 times. The pouch cell prototype was expected to deliver a capacity of at least 30% higher than the current technology and was intended to facilitate the commercialization of hollow Si through a collaboration with Johnson Controls.

Over the course of the above project, two types of furnace systems were set up to obtain gram-grade samples. Due to the limitations of the furnace size, the resulting hollow Si was determined to be approximately 0.5-0.8g/ batch. The quality of the 'as-prepared' hollow Si was confirmed by X-ray diffraction and Raman spectroscopy. With the hollow Si (15 wt. %), a Si/graphite anode was fabricated and assembled with a lithium nickel manganese cobalt oxide (NMC) cathode to make a pouch cell. The 'as-obtained' pouch cell exhibited 91% of the designed capacity. The cyclic performance of the pouch cell, however, was much poorer than originally expected. This is likely due to the insufficient pressure for the anode processing after drying the coated slurry on the Cu foil.

4. Scaling-Up Hazelnuts in the Upper Midwest,
(PI: Jason Fischbach, UW-Extension)
This project aimed to generate rooted lines via micro-propagation of four selected hazelnut genotypes for evaluation in field-scale trials. This was envisioned to be a key step toward possible commercialization of the selected germplasm.

Vegetative hazelnut propagation continues to be a challenge due to very slow pace of the "isolation" phase of micropropagation. Isolation is the first step to micro-propagation where a small vegetative bud is placed on agar to initiate root and shoot growth. Once isolated, the growing shoots can be harvested to establish additional agar cultures and begin to exponentially generate new plantlets. The team has partnered with Knight Hollow Nursery which has been working with a number of genotypes, including the top eight hybrids, and has made progress in developing the clonal liners. Field trials have been established in Wisconsin at Verona, Bayfield, and Spooner and in Minnesota at St. Paul and Staples. These joint performance trials are being populated with material from breeding programs across the country and will allow the team to compare their selections to other candidate selections. While the studies are ongoing, through this project the team has proceeded one step further in providing improved germplasm to growers in the Upper Midwest. Through vegetative propagation, the team is able to generate sufficient clonal material to populate production trials and eventually scale up the Midwest industry.

5. An Approach to Next-Generation Lithium-Based Batteries,
(PI: Junjie Niu, UW-Milwaukee)
The PI aimed to apply a new approach to scalable synthesis of Li-S battery with high cyclability and high capacity using a low-cost, industrially available carbon matrix as support. The nanostructured C-S composite consists of sulfur nanoparticles encapsulated in the porous carbon matrix using novel pretreatment methods. A nanosized battery consisting of

the C-S nanocomposite was to be constructed. In parallel, in situ transmission electron microscopy imaging was used to quantitatively track in real-time the electromechanical reaction-induced chemo-mechanical degradation. The experiments and in situ TEM observations informed and guided one another, offering a fundamental understanding of the degradation mechanisms of the nanocomposite electrode, which was to lead to an optimized nanostructure design, validated by the high-performance of coin cells. The multidisciplinary nature of the research hoped to foster transformative progress for understanding a broad range of electro-chemo-mechanical processes beyond lithiation. The PI anticipated that the proposed research would accelerate the commercialization of high-performance, low-cast and industrial cathode electrodes for the next-generation Li-S batteries.

In order to overcome the challenges of sulfur cathode (poor conductivity, shuttle effect, and volume expansion), the team investigated and successfully achieved almost all of the following strategies over the course of the project:

- Synthesis of the sulfur-carbon composite based on the reaction between EDA-S precursor and hydrochloric acid using a simple chemical method;
- In situ TEM characterization of the chemo-mechanical degradation diagnosis of the nanoelectrodes;
- The initial specific capacity of the battery was 1267 mAh/g and it could be retained approximately 750 mAh/g after 50 cycles at 0.5C. Moreover, the columbic efficiency was determined to be as high as 100%.
- The team published partial results in one of the top journals, *Nano Letters* (IF=13.8), in 2016.

6. Direct Methanol Fuel Cells with Ionic Liquid Replacing Polymer Electrolyte,
(PI: Yijun Tang, UW Oshkosh)
The project aimed to replace the conventional polymer electrolyte in a fuel cell with a new material, ionic liquid. A model fuel cell with ionic liquid electrolyte was fabricated. Some parameters of the fuel cell model were measured. The performance of the fuel cell model was evaluated and compared to a conventional fuel cell.

Two versions of model fuel cells were created by modifying conventional fuel cells. A cost-effective version (mainly made of plastic) was used substantially in this project. On the other hand, the more expensive version (made of metal and graphite) was more complicated in structure, but it had a few attractive traits and is a good choice for further research. Those traits include: (1) it is sturdier and can be reused and (2) methanol fuel can be pumped into the fuel cell as long as an automatic flow pump is connected to the fuel cell. One of the biggest and unexpected challenges in improving the performance of the model fuel cell was the issue of leaking. For conventional polymer-based fuel cells, leaking is not a problem. The polymer sheet is placed between two electrode plates. The pressure applied to those two electrode plates seals the fuel cell very well because of the elasticity of the polymer. For the model fuel cell created in this project, a rigid compartment was used to hold the ionic liquids. Pressure did not solve the leaking problem. Instead, various gaskets, gels, and glues were tried and used. Further development will be needed in order to optimize design and test efficacy.

E. Applied Research-WiSys Technology Advancement Grant (AR-WiTAG) Awards, Fiscal Year 2015-16

See Appendix F for a list of investigators, departments, and amounts of the awards.

1. Isolating High-Value Aromatics from Lignin Stockpiles: A 'Bottom-Up' Approach Made Possible Via Increased Solubility and Novel Catalyst Design,
(PI: Brian Barry, UW-Platteville)
Polymeric lignin is the most abundant, renewable source of valuable aromatics known. Furthermore, it is stockpiled as *waste* by the paper and biofuel industries on the order of 100 million tons per year. Many are attempting to cash in on its potential value but are all taking similarly flawed routes to do so. The PI aimed to develop a highly novel plan to extract pure, isolated chemical species from this polymeric source. This included the development of novel catalysts capable of selectively cleaving bonds to produce singular products and the development of solvent systems that drastically improve the solubility of lignin allowing the use of novel, homogeneous catalysts.

   Overall, the team is very pleased with the progress that their research team made over the past year. In regard to the team's efforts in improving lignin solubility, for this portion of the project the team sourced lignin from a Wisconsin-based company, Refined BioProducts LLC. Every method of producing lignin results in a unique lignin product and the 'Organosolv' method used to produce the lignin at Refined Bioproducts resulted in a product that the team was able to dissolve at concentrations well above minimum desired thresholds with many common solvents such as THF. This surprising result allowed the team to shift most of its efforts towards catalyst development, as they are confident this particular type of lignin produced at Refined BioProducts is far superior to the most common commercially available lignins (Kraft lignin and lingo-sulphonates) because of their bottom-up approach. The team also successfully replicated and stockpiled various ligands (chemical used to coordinate to metal atoms and control the metals reactivity) and their subsequent metal complexes. Catalytic testing on these initial complexes (analogs of catalyst presented in proposal) all resulted in unexpected chemistry occurring at and involving a lone-pair of electrons located on the imine nitrogen atoms. Although it was an undesirable result, it informed the team's designs for the next generation of analogous ligands and resulted in what they believe is a much better catalyst. The team has redesigned the catalyst and successfully produced new complexes that attain the desirable features of the initial ligands, but result in the occupation of the active nitrogen lone-pairs, forcing the chemistry to occur at the metal-center as desired. The team is very excited to share their new designs and catalysts to the scientific community and to get to test these catalysts on lignin.

2. Developing a Viable Commercial Field Color Test Kit for Synthetic Cannabinoids,
(PI: Charles Cornett, UW-Platteville)
This project aimed to develop and commercialize a color test kit for the in-field detection of synthetic cannabinoids by law enforcement agencies. The team's previous work in developing such a test kit for synthetic cathinones resulted in the publication of an international patent application based on intellectual property developed in the laboratory and supported by WiSys. In addition to the commercial interest in the cathinone project, industry inquiry has included desires for a test(s) to detect this separate class of emergent drugs: the

synthetic cannabinoids. This project aimed to use a variety of well-known, but hereto unapplied, processes to alter the core composition of the synthetic cannabinoid to create the first stage of a two-stage test. The second stage of the test aimed to utilize existing technology to interact with the chemical product of the first to produce the second resulting color of the two-stage test. The goal was the development of a robust color test for commercialization and law enforcement use.

Methods to oxidize the synthetic cannabinoid core to produce a colored compound or to produce a compound that could interact with WuCo2 to provide a color change were inconclusive. Other chemical methods were also investigated. In the end, the team found that by adding a mixture of mesityl oxide, ethylene glycol, and hydrochloric acid to a synthetic cannabinoid model compound, followed by the WuCo2 reagent, led to a noticeable color change compared to a control and other model compounds found in other illicit drugs. This result is very promising and has a high potential to be developed into a marketable product for law enforcement officers.

3. Further Characterization of "Green" Thermosetting Resins: Material Data Sheets and Degradation Kinetics,
(PI: John Droske, UW-Stevens Point)
A series of "Green" thermosetting resins have been synthesized at UW-Stevens Point and patents have been filed with support from WiSys (US 2013_0289233 A1 and US 2011/0269903 A1). In 2013, a short, productive collaboration between UW-Stout and UW-Stevens Point was initiated in an effort to further characterize the materials. The joint effort resulted in extensive data on the curing kinetics. These have been summarized in two articles (one published and one in preparation), three poster presentations, and four oral presentations. This project aimed to further characterize the materials to advance their potential commercial use in the plastics and medical markets. In particular, the project was focused on the preparation of industry-standard "Material Data Sheets" for two of the resins and on further examining the degradation processes of the material. "Material Data Sheets" typically are the first information requested by industries to evaluate a material for potential applications. In addition to the two data sheets, the materials were further characterized in an effort to more fully understand the breakdown products that form during composting and/or hydrolysis of the crosslinked resins. This latter characterization is especially important for biomedical and sustainable "green" applications of these materials, as it may be necessary to document that the materials break down to biocompatible components. Determination of the breakdown products to assess if the materials can be reclaimed for reuse was also of particular interest.

This work produced four important results: 1) successful scale-up of the resin synthesis from lab scale (5 to 20 grams) to batch quantities (500 grams or more), 2) processing of the uncured resins to molded cured samples and subsequent extensive testing of the uncured resins and cured samples, 3) the preparation of two Material Data Sheets based on the testing in "2" above, and 4) characterization of the by-products of hydrolysis of the cured resin by GC-MS and LC-MS (only two products were obtained after hydrolysis of cured resins at 180 °C: the diol monomer was obtained unchanged, while, interestingly, the mercaptosuccinic acid monomer was recovered as mercaptopropanoic acid, due to monodecarboxylation during hydrolysis). All four of these results are directly related to

commercialization of these resins. All of the proposed objectives were achieved, and additional characterization was also performed.

4. Silicon Nanomembranes for Piezoresistive MEMS Pressure Sensors,
(PI: Gokul Gopalakrishnan, UW-Platteville)
Micro-electromechanical systems (MEMS) used to detect changes in pressure have been projected to be the top MEMS device by revenue this year, due to expanded incorporation into automotive, industrial, medical, military, and consumer electronics applications. Single crystalline silicon membranes with thicknesses greater than a micrometer are the most commonly used deflecting elements in piezoresistive MEMS pressure sensors. Such membranes have been difficult to fabricate inexpensively with lower thicknesses, limiting their sensitivity and thicknesses down to only a few nanometers. Preliminary measurements and calculations show that devices based on a 100 nm-thick membrane have a pressure sensitivity exceeding typical values of similarly sized commercially available MEMS sensors by a factor of one hundred. For this project, the PI aimed to use this technique to optimize the fabrication procedure for MEMS pressure sensor devices that combine the benefits of the strong piezoresistivity of single-crystal silicon with the high geometric sensitivity of thin nanomembranes. This project aimed to characterize the effects of chemical etch parameters on biaxial strains in pre-annealed nanomembranes, develop a thermal annealing process to improve robustness and fatigue lifetime of sensors, investigate the effects of heat treatment on biaxial strain and crystallinity of membranes, and adjust strains through etching and thermal annealing to optimize device sensitivity and lifetime.

5. Design and Synthesis of Nanoporous Organic Polymers to Construct Nanoporous Membrane Composites for Gas Separation Applications,
(PI: Mohammad Gulam Rabbani, UW-Platteville)
Landfill gas which is produced from the municipal solid waste in landfills under anaerobic digestions has recently attracted considerable attention as a source of renewable energy because it offsets the need for non-renewable resources such as oil, coal, and gas. This proposal outlined a research plan that was designed to prepare nanoporous membrane composites to separate carbon dioxide (CO_2) from landfill gas. The membrane composites were to be prepared by the combination of nanoporous organic polymers and functional matrixes. The efficiency of the resulting membranes in gas separation were tested both in laboratory as well as in a Dubuque landfill site. The separation of CO_2 from landfill gas using proposed membrane composites will not only make landfills a more efficient source of energy but also have environmental and economic benefits.

   The team has successfully synthesized a series of nanoporous organic polymers (NPOPs) that are enriched with nitrogen functionality. These included phenazine linked polymers (PLPs), glyoxal-derived polymers (GDPs), benzoxazole-linked polymers (BOLPs), and benzothiazole-linked polymers (BTLPs). Synthesized polymers are chemically and thermally stable and possess ultra-small pores with a pore diameter distribution of around 0.5 nm. The presence of nitrogen heterogeneity in the pore apertures provides the basicity to the frames and enhances the ability to attract acidic CO_2 gas molecules. The polymers showed exceptionally high CO_2 capture ability over CH_4 and N_2 with maximum adsorption selectivity of 35 and 140, respectively, at 25°C. GDPs have been initially applied to prepare porous membranes composites. The efficiency of GDP based membranes was tested in separation

of CO_2 from CH4 using a commercially available 50/50 mixture of CO_2 and CH_4. Preliminary results showed partial separation of CO_2 from CH_4. Further experiments are underway to optimize the preparation of membranes composites.

6. Synthesis of Value-Added Aldehyde and Ketone Products from Biomass-Derived Alcohols, (PI: Robert McGaff, UW-La Crosse)
The overarching aim of the proposed project was to discover new inexpensive catalysts that will promote the efficient oxidation of alcohols that can be derived from biomass in water or under solvent-free conditions. The new catalysts were designed to have optimal solubility characteristics and fully characterized to allow for intellectual property protection. Methods for the application of these catalysts were developed and optimized for performance as defined by standard metrics. The design of new catalysts and reaction methods in which these catalysts would be utilized will be based upon very encouraging results from the team's current project. The team aimed to extend the application of the catalysts currently under investigation and those yet to be discovered into the realm of heterogeneous catalysis by anchoring these onto solid supports, thereby increasing their potential for commercial application.

   The team successfully synthesized a sulfonated catalyst that dissolves very well in water. Its identity has been conclusively proven through infrared (IR) spectroscopy and electrospray mass spectrometry. The team also demonstrated the effective solvent-free oxidation of one of the five alcohols initially proposed as reactants (5-hydroxymethylfurfural). While the team remains confident that they will eventually be able to demonstrate the oxidation of all of the proposed alcohol reactants, they have already shown effective solvent-free oxidation of several other alcohols of commercial importance. The completion of this goal will require modification of a piece of shared instrumentation at UW-La Crosse (GC-MS). In addition, the team successfully anchored its sulfonated catalyst on a solid support (Amberlite ion exchange resin). Further, they have established the identity and stability of this "heterogenized" catalyst and shown its effectiveness in catalyzing alcohol oxidation.

Center for Dairy Profitability – UW-Extension/UW-Madison

A. Background

The University of Wisconsin Center for Dairy Profitability (CDP) is a multi-campus Extension unit with faculty and staff at UW-Madison, UW-Extension, UW-Platteville, and UW-River Falls. The CDP develops and delivers effective interdisciplinary education and applied research to dairy farms and dairy industry service providers resulting in sustainable, profitable decisions, and a healthy and progressive dairy industry in Wisconsin. Mark Stephenson, Director of Dairy Policy Analysis at UW-Madison, is also the Director of the CDP.

The CDP receives funding from the Industrial and Economic Development Research Fund (IEDRF). In 2015-17, the IEDRF provided $269,746 to fund 3.18 FTEs that were allocated as follows: 2.49 at UW-Madison; 0.35 at UW-Platteville; and 0.40 at UW-River Falls.

The economic success of Wisconsin's dairy industry contributes $43.4 billion of dairy revenue annually—a rate of more than $82,500 per minute. The dairy industry is linked directly and indirectly to many businesses in Wisconsin, providing jobs and additional revenue for the state. For example, every dollar of dairy income generates an additional $1.54 for our communities and our state. In addition, the dairy business in Wisconsin directly supports 78,900 jobs. Plus, the employment multiplier for dairy is 2.23, which means that every job in dairy supports an additional 1.23 jobs elsewhere in the Wisconsin economy. This workforce depends largely on the knowledge and management skills of dairy farmers and agribusiness professionals who work with them. Their decisions determine whether the state's dairy industry is competitive and prosperous over time. From the mid-1980s through the mid-2000s, milk production in the state was in decline. Since 2004, the state's milk production has been increasing and is currently at record highs.

Informed management decisions are a key to dairy farming's economic success. The CDP's emphasis is on educational programs that enhance the management skills and decision-making abilities of dairy producers and others who assist them in making management decisions. It is the vision of the CDP to be the preeminent academic institution empowering farm managers toward profitable decisions. To this end, the CDP will: 1) enrich the quality of life for farm owners, operators, employees, animals, and industry stakeholders; 2) collaborate with universities and industry to identify, develop, and supply a diverse clientele of farm managers and service-providers with research-based information and best-management practices; 3) create a work environment that is challenging, rewarding, and fun; and 4) disseminate our products through traditional means and cutting-edge technologies. The core values of the CDP are diversity, sustainability, planning, collaboration, and quality of life.

This section describes the CDP's educational programs. It also contains examples of how the CDP facilitates the development of multi-disciplinary educational programs and partners with other agencies—such as the Department of Agriculture Trade and Consumer Protection and, previously, the Department of Commerce—that share its goal of enhancing the profitability of the dairy businesses and enhancing business development in Wisconsin and throughout the world.

The Center for Dairy Profitability leverages its limited resources by cultivating key collaborations with professionals and organizations in the agriculture industry throughout Wisconsin. CDP staff work in conjunction with UW-Extension agriculture agents to develop educational programs, materials, speakers, and financial support for programs to help dairy and agricultural producers. Equally important is the relationship between CDP and the Lakeshore and Fox Valley farm management associations. The majority of the farms in the AgFA© database (a financial benchmarking tool) are gathered through these two associations. Wisconsin Technical College System (WTCS) farm business instructors also collaborate with the CDP in providing financial record-keeping workshops and financial analysis for dairy producers in all parts of the state. Other collaborations include:

- Farm Credit Services: Badgerland & AgStar
- Farm Service Agency (FSA)
- Professional Dairy Producers of Wisconsin (PDPW)

- Dairy Business Association (DBA)
- Wisconsin Farm Bureau Federation (WFBF)
- Wisconsin Farm Center (WDATCP)
- Wisconsin Cheese Makers Association
- Wisconsin Department of Agriculture, Trade & Consumer Protection (WDATCP)
- Wisconsin Farm & Rural Appraisers Association
- Wisconsin Milk Marketing Board (WMMB)
- Wisconsin Frame Builders Association
- Wisconsin Custom Operators Association

B. Economics of Dairy

Farm Financial Management and Financial Benchmarks

The CDP works with the Lakeshore and Fox Valley Farm Management Associations, UW-Extension Agents, and Wisconsin Technical College System (WTCS) instructors and others on a farm financial management, records, and benchmark project to increase the knowledge of the economic and financial operations of dairy farm business. This program is an integral part of the mission of the CDP. The records gathered by all the entities are used to compute costs of production of dairy farms and selected financial measures such as return on assets, return on equity, debt to asset, etc. These performance measures are widely used by county agents, lenders, policy-makers, and agribusiness professionals who work with producers on economic related problems. Since 1996, the AgFA© database has served dairy producers and others to summarize and analyze the annual financial performance of farm businesses.

The Center for Dairy Profitability's AgFA Benchmarking tool is:

- A real-time, web-based agricultural financial database and program,
- For collecting and reporting farm level financial information,
- For use in providing farm financial statements and reports,
- For use in conducting farm financial analysis, and
- For benchmarking.

AgFA enables data collection, generating individual producers' financial reports, and benchmarking reports. Financial reports can be generated based on selected criteria, and provide results consistent with industry standards and the recommendations of the Farm Financial Standards Council (FFSC).

FarmBench: CDP was successful as the lead organization in securing a substantial NIFA grant to rewrite the AgFA program from the ground up on a modern web platform. This is in process at this time and sets CDP up for future partnerships in this area going forward. The new program will be known as "FarmBench"—as in benchmarks. One of our goals is to formalize a partnership between Cornell University and Michigan State University to merge their financial record systems to FarmBench.

Nate Splett, represents the CDP on the Farm Financial Standards Council (FFSC). Representation includes memberships on the FFSC, Board of Directors, Technical

Committee, and Subcommittee on Guidelines Terminology (Splett – Chair). The CDP actively participated in the annual meeting in Billings, Montana this past summer, and was recognized "for continued commitment of time, personal resources and service to the Technical Committee of the FFSC." CDP provided substantial input to updating the Guidelines of the FFSC. The result of this effort led to formation of a subcommittee to complete an edit of the Guidelines for consistency in terminology, language, style, and currency. This effort is being led by Splett. CDP is also an active participant in the FFSC's program to provide financial management education.

C. Farm Business Financial Management and Benchmarking (Collaborative Effort between Center for Dairy Profitability, University of Wisconsin, Cornell University, Michigan State University and the Farm Service Agency, U.S. Department of Agriculture)

Situation:
There is a great deal of heterogeneity across U.S. dairy farms and this is reflected in farm financial performance. In order to facilitate comparisons across farms and over time, financial ratios that account for farm size are used. For example, the dollar value of profit that is sufficient for a smaller farm might be insufficient for a larger farm. Using ratios implicitly assumes a stable relationship between the values in question.

Farm managers are responsible for controlling many factors that influence profitability. These include controlling input costs, and efficiently converting capital, feed, and labor into milk. It is useful for farm managers to know the characteristics that allow farm businesses to survive and thrive over time. Benchmarking is a process used by farm managers to compare the performance of their farm to other (similar) farm businesses or an industry standard. Performance may vary across farms due to external factors such as geography, weather, and local market conditions. However, the differences between farms due to internal factors, which are generally under the control of farm owners and managers, such as managerial ability and decision making, make benchmarking a useful tool. Farm financial benchmarking helps managers to identify areas for improvement, set targets for performance, and focus on planning and managing finances. Financial ratios provide a method for standardizing information. A ratio by itself may have little meaning, so it is compared to either that firm's performance in previous years, ratios of similar firms, or industry standards.

Data are currently collected by a variety of means including: partnerships with farm management associations, Cooperative Extension personnel, university faculty and staff, and individual farms. These associations will continue and we will actively look for partnerships to expand farm participation. Data from the three universities will provide about 1,000 annual dairy farm records in a single source. In addition, data from the U.S. Farm Service Agency will add thousands of farm financial records to the total. These data will give a detailed look at the financial status and situation for underserved, beginning, small and medium sized dairy farms across the country.

This dataset is a rich source for analysis. The universities have annually published summaries

from the data which highlight farms by regions, size, business model (pasture, organic, etc.). And, the universities have used the data for special topic research such as analysis of risk metrics for USDA, contribution of representative farms with the International Farm Comparison Network (IFCN), research for dissertations and more. We will continue to conduct applied research from the combined data set.

Response:
The CDP will establish a dairy farm financial management benchmarking system/software by combining the efforts of three long-standing programs at the University of Wisconsin (UW) (AgFA, Agriculture Financial Advisor), Cornell University (DBFS, Dairy Business Farm Survey), and Michigan State University (Telfarm) with particular emphasis on dairy farms. Further, this project will add national farm financial records from US Department of Agriculture Farm Service Agency records.

Objectives:

1. Consolidate long-standing dairy farm business management programs and data from the University of Wisconsin, Cornell University and Michigan State University. To produce a 10-year database of panel farms that can be used for benchmarking financial, cost and efficiency performance by herd size and other parameters. Efforts will be coordinated going forward to future years.
2. Add records from US Department of Agriculture Farm Service Agency.
3. Examine benchmarking standards for financial ratios, efficiency measures, and cost of production using panel data by location, farm type, herd size, etc.
4. Establish procedures for converting cash accounting records with accrual adjustments to relevant farm financial ratios to measure profitability, solvency, liquidity and financial efficiency.
5. Examine benchmarking standards and procedures for profitability, solvency, liquidity, financial efficiency, and cost of production.
6. This project will help improve the profitability and competitiveness of U.S. dairy producers; particularly small and mid-size producers by providing benchmarking opportunities for informed decision-making.
7. Analyze important questions about dairy farm financial benchmarking including: Where to set benchmarks? Are heuristics appropriate across farms and over time? How big are industry, farm size, and year effects? Examine ratio patterns across farms and over time for persistence and stability.
8. Develop a simple financial stress-test tool for dairy farms that incorporates existing farm specific risk tools including the Dairy Margin Protection Program, milk and feed futures and options, forward contracts, and available credit lines. The purpose of this project is threefold: 1) to improve producers' financial management decision-making for their farm businesses; ii) to improve and increase the use of data for decision-making; and iii) to improve the quantity and quality of financial information and data.

D. Dairy Markets and Policy

Dairy Markets and Outlook

Mark Stephenson, Director of the CDP, has given many talks and interviews, written articles, and created podcasts providing updates on milk market conditions throughout the year. These market updates prove to be very popular and help producers and processors understand the directions that prices may take in the year or month ahead. The video podcast series was developed a few years ago but continues to be very popular with 3,000 to 4,000 unique IP hits each month when it is posted.

Risk Management

Farms have several options available to mitigate price risk on their dairy farms. Many programs have been conducted to help farms understand the use of the various options available. We have developed and host a decision tool for dairy farmers that USDA's Farm Service Agency uses to help farm's evaluate the level of protection that they would choose under the Margin Protection Program for the year ahead. We have also worked with USDA and the National Milk Producers Federation to look at modifications to the current MPP for program improvements.

Threatened Markets

In the Spring of 2017, seventy-five dairy farmers in the state were threatened with the loss of market when dropped by their handler. We worked with DATCP and other organizations to help producers find new market homes for their milk. We also conducted dozens of state and national interviews regarding the evolution of the situation.

In late summer, producers faced a second problem of declining premiums and increased hauling costs. This was actually another outcome of heavy milk production throughout the Northeast and Upper Midwest that caused farms to lose their markets.

We Co-hosted a UW-Extension program to help explain Extension's role in addressing the problems. About 200 attendees participated from the state legislature, media, universities and others to better understand the nature of an evolving dairy industry.

Hosted Workshops

We also hosted invitational workshops in Buffalo and San Diego. Themes at this workshops were "Supply, Demand and Pathways to Progress" and "Dairy Markets: Shaken, not Stirred". These were attended by about 150 people at each location from across the country and also international guests.

Changing Landscape of Dairy

Shifting milk production, trade, and resulting price pressures have caused an oversupply of milk in some regions. There is a lack of processing capacity in these areas while other regions have declined in milk production and have excess capacity. Milk has been dumped at farms where a processing home can't be found. We have coordinated a team of researchers from New York, Pennsylvania, Michigan and Wisconsin looking at the implications off the changing landscape. A three hour special presentation was presented at

the 2017 World Dairy Expo in conjunction with DATCP that provided preliminary findings of this research.

E. Extension Educational Programs

The CDP is involved in a variety of management education programs that are intended to teach farm managers and agribusiness professionals about practices to improve the performance and profitability of farm businesses. The following is a brief summary of some of these programs.

Agricultural Land Values and Rental Rates
The CDP has worked with the Wisconsin Chapter of the American Society of Farm Managers and Rural Appraisers and the Wisconsin Department of Revenue to tabulate and identify trends in agricultural land values. Land values, a major factor in determining land rental rates are an important cornerstone of farm financial strength. Annual reports are published on the average price of Wisconsin farm land parcels between 35 and 1000 acres.

Beginning Farm Financial Record-Keeping Using QuickBooks and AAIMS
Dairy farming is a complex business which demands accurate records and careful financial management. Both financial and production records are required to provide the information the farm manager needs to make critical risk management decisions. Unfortunately, since farming is widely viewed as a "way of life" rather than a business, the financial management tools long available in other industries have not been universally embraced by farmers. Record-keeping has, and continues to be, a major skill-set deficiency among small farm businesses. Lacking the scale and margins necessary to access specialized skills beyond rudimentary tax preparation, many producers' accounting systems fall far short of being able to address basic business, financial, and risk management issues such as accurate measurement of profit and owners' equity, the ability to budget cash flows. Beginning workshops on QuickBooks were introduced in 2005 and have continued through the last 10+years. AAIMS, an in-house record-keeping program, was developed in the early 90s and continues to thrive with about 300 users across the state. Workshops and personal support continue to be met by the CDP. These financial accounting workshops achieve two main objectives: (1) improve the accounting/recordkeeping knowledge base of small Wisconsin dairy farm businesses and (2) train farm businesses in the use of QuickBooks® and/or AAIMS. In addition to CDP funding, these trainings are partially funded through competitive grants from the North Central Region Risk Management Education Center and USDA Risk Management Agency Education Partnerships Program.

Outcomes/Impacts: Evaluations from recordkeeping workshops show that 67% of participants would be able to set up a recordkeeping system using QB or AAIMS as a result of this workshop. 58% had a better understanding of assets and liabilities.

Dairy Modernization
According to the Wisconsin Agricultural Statistics Service (WASS), the number of Wisconsin dairy farms continues to decline. As of September 2017 the number has fallen to approximately 9,520 (WMMB) with an average herd size of 134 cows. Approximately 75

percent of these farms are less than 100 cows and are still operating with tie/stanchion stall barns and associated feeding, milking, and manure-handling procedures. These systems are labor intensive and inefficient. Updating older systems with new investments in housing, milking, feed storage, or manure-handling facilities is necessary to provide a functional labor efficient and profitable dairy production system. As these farmers struggle with the future of their dairy farm operations, they need information and education on available options and how to transition the dairy business and invest in new facility designs that will allow the farm to stay profitable. David Kammel and the CDP staff, in cooperation with the UW-Extension Dairy Team, provide information, decision aids, and educational programs that allow farmers to determine whether and/or how to adopt technology and modernize, and permit farmers to develop their businesses, enhance profitability, and improve their quality of life.

Economics of Grazing, Organic, and Confinement Dairy Farms

This summarized data helps understand the financial performance of Wisconsin dairy systems and helps WI dairy farmers determine which system offers the most advantages to them.

Farm Business Financial Management Curriculum

A curriculum for financial management consisting of six modules was developed by Vanderlin and Splett. This course follows the continuum, beginning with farm business records, through financial statements, to decision-making. Structure, analysis, and interpretation of financial statements is emphasized in accordance with the Farm Financial Standards Council. Benchmarking financial position and performance is presented, using the Agriculture Financial Advisor (AgFA) database program. Budgets and the budgeting process are taught as principle decision-making tools.

FarmCEO

The FarmCEO project is an agent training and development activity on farm business management topics between the Center for Dairy Profitability and ANRE county faculty. A county team of two representatives from each region work together with CDP staff (Bernhardt & Vanderlin) to develop farm management topics and coordinate logistics.

Long-Term Outcome: Increase the capacity of farmers to understand and use farm business management principles to help them help themselves determine their own economic destiny.

Short and Medium Term Outcomes: Increase the farm business management capacity of county agents through continuous and purposeful in-service training, development of curriculum, development of decision aids, and dissemination of applied research results.

The FarmCEO project for agent training and development has two primary efforts:

1) *Farm Management Clinics:* The purpose of clinics is to have continuous annual training activities that provide awareness of farm management topics, basic understanding, and provision of resources. The clinics are intended for all Ag agents as means to keep up and aware of farm management topics and resources. Clinics are held in each region, each year on a different topic: Farm Financial Analysis and Diagnostics (2015); Commodity Situation and Outlook (2016); Facilitating Management Decisions (2017).

2. *Farm Management Instruction and Curriculum:* Boot Camps are for in-depth coverage, understanding, and implementation of farm management topics. The Boot Camps are intended for those agents that have a desire to specialize in on a specific farm management topic (Example: Farm Business Financial Management Curriculum: Topics covered in this workshop includes understanding: the financial model, records and recordkeeping systems, the balance sheet and income statement; financial statements, position and performance; and partial budgets). In addition, there is an option training on facilitation. This particular workshop is focused on the agents own skill, confidence, and success in presenting financial management material to their producers in order that they gain (fundamental) substance, direction to pursue more info/knowledge, and become more motivated about financial management. Focus is not on the depth of content, but instead, on the presentation of content and personalizing it so that it works for each facilitator. Workshop is taught as a 20/20 approach. Each presenter will make a 20 minute presentation, followed by a 20 minute constructive, friendly critique and discussion of presentations.

Farming your Finances:
A two day workshop curriculum was developed by Vanderlin/Splett/Stuttgen) for women producers to learn the basics of financial management. This workshop is designed for farm women who are interested in improving their farm financial management skills, part of the fabric of farm life and their farm business. Curriculum includes introduction to: financial model, Record-keeping, Balance Sheet, Income statement and how it relates to the Schedule F and Financial analysis and Benchmarking. Factsheet Series on the financial statements is forthcoming.

Farm Succession Facilitator's Manual and Training
Joy Kirkpatrick co-authored a Farm Succession Facilitator's Manual in 2012 with John Baker from the International Farm Transition Network. This manual has been used in Wisconsin and other states. Using this manual, over 85 agriculture professionals in Wisconsin including Extension and Technical College educators, attorneys, tax specialists, lenders, and insurance agents have been trained. An additional 200 professionals have also been trained in other states. Evaluations from this program indicate participants are better prepared to work with farm clients as a facilitator of the planning process rather than providing expert advice in their field of service.

Farm Succession Facilitation
Individual facilitation for farm businesses and families continues to be requested. These meetings provide farm families and businesses assistance on current analysis of the farm, goal clarification and development of next steps. Approximately 40 – 50 farms per year are provided with this support from CDP staff. Participants are coached on conducting farm meetings and improving communications among farm and family members. The goal of this work is to help farms be better prepared when they work with their tax specialist, attorney and other professionals.

Farm Succession Webinar Series

Seven farm succession webinars were offered from August 2016 through March 2017. Topics included ag leases, transitioning to an LLC, communications, financial analysis, estate planning, long term care, and Medicaid recovery. One hundred seventy-five people participated in the webinars, which were offered in a dozen counties across the state. The participants increased their awareness on these topics and took action by scheduling meetings with ag professionals to begin work on their succession plans.

Human Resource Management

Wisconsin's dairy sector relies heavily on hired labor. The tightening of the farm labor market in recent years poses a challenge to the state rural economy. Yet, most farm owners and managers have little to no training in labor supervision and human resource management. Since 2015, the FARM team HRM group (J. Blazek, S. Jette-Nantel, and T. Wagner) has worked on the development of an HR education program design for farm owners/managers, entitled Becoming the Employer of Choice. The program format is based on a curriculum of seven modules. It addresses questions such as "Do you know how to deliver effective feedback?", "Do you understand what motivates your employees?", or "Do you have a vision and can you effectively share it to engage your employees?" These questions and many others are addressed in our program via hands-on interactive sessions which aim to build skills related to hiring, training, motivation, conflict management, communication, and leadership.

In the last year, the program has been delivered in different counties across the state and under different formats. Targeted audiences included larger dairy farms, consultants, and smaller operations, as they all face the challenge of managing relationships with personnel and partners. Much of the program resources/materials are available on the UW-Extension FYI website (http://fyi.uwex.edu/ag-human-resources/). Also on the website, are series of human resource management factsheets, which will help fill the need for information, providing useful human resource management information for farmers and managers, as well as agents. While continuing to build on opportunities in this topic, the team has also offered professional development opportunities to UWEX Agricultural Agents to help them better understand the HRM issues faced by their clients and improve their effectiveness in working with farms and agribusiness professionals.

Management Assessment Center

In today's changing farm environment, dairy farm managers are required to take on more of a managerial role. Specialists from the CDP and a team of UW-Extension agricultural agents designed the Management Assessment Center (MAC) for Dairy Managers. The assessment center curriculum was developed, tested, and implemented to help dairy farm managers understand their own competency levels as they relate to selected managerial attributes. Each assessment center includes a two-day program where producers participate in a series of activities which help assessors evaluate individual managerial strengths and areas needing improvement. Following the program, producers are given a detailed individualized report and a personal consultation. A resource guide is provided that assists them in developing a plan for self-improvement. In recent years, the CDP has collaborated with Professional Dairy Producers of WI (PDPW) to hold two centers with PDPW clients/board members per year. In addition to the dairy MAC, UWEX received interest from new audiences and agricultural

organizations to develop and hold a MAC specifically for them. To date, the team has developed curriculums for Agronomy Managers, Fruit Growers and UW-River Falls to host a MAC for juniors and seniors who plan on going into farming themselves or back to their family farm after graduation. To date, 176 dairy managers, agricultural professionals (current and potential), and college juniors and seniors have participated in the assessment program.

Outcomes/Impacts: Evaluations show that 83% of the participants have changed how they use their managerial strengths, while 66% have changed their day to day approach to managing their farm. Other evaluation results have been extremely encouraging and there is an increasing demand to modify the curriculum for other commodity groups as well. According to survey work, the MAC program has changed the managerial behavior of participants a "moderate amount." Participating producers indicated that the program ranked 3.1 out of 5 (a 5 indicates that their behavior very much changed) in terms of the degree to which it changed their behavior. In other words, they have observed a 62% change in their managerial behavior.

Returning to the Farm

Returning to the Farm (RTTF) is a project designed to address the human, legal, and financial risks involved in the transfer of the farm to the next generation. It attempts to reach college juniors and seniors who are planning to return to their home farming operations. The project includes two weekend sessions held in the fall and spring. Each student and the farming family members are required to attend both sessions. Communication, conflict management, financial analysis of the farm, strategic planning, business arrangements, retirement planning, and estate planning are covered in the two sessions. Consultations are offered between the two sessions to analyze the financial capacity of the farm. Evaluations from the workshops indicate participants use the tools provided to help analyze their farms and to develop farm succession plans.

Shifting Gears in Your Later Farming Years

This curriculum was originally developed by a UW-Extension educator team lead by Joy Kirkpatrick and offered in 2012. It continues to be offered in various locations throughout the state. The curriculum includes communications, financial considerations, and estate planning topics. Approximately 160 farmers have attended the two-day workshop series since 2012. Evaluations indicate the participants have estimated their income needs and nest egg needed for retirement and have considered and discussed what activities will replace their farm responsibilities as they shift gears.

Wisconsin Farm Succession Professionals Network (WIFSPN)

In 2014, CDP staff, Joy Kirkpatrick and Phil Harris, brought together agriculture service professionals who work in the area of farm succession for networking meetings. An initial meeting of 30 professionals in January of 2014 provided the impetus to offer three regional meetings in the fall of 2014 in Eau Claire, Appleton, and Madison. Two hundred forty-five professionals attended one of the regional meetings. In 2016, WIFSPN offered a one-day training on using partnerships/LLCs for transfer and the tax issues around this topic. Approximately 100 professionals attended this session. Evaluations of the regional network meetings indicate the professionals valued the time to network with other professionals and have professional development on farm succession issues. Regional meetings have been

for 2017 based on feedback from the group. Focus will be on financial analysis for farm succession.

Wisconsin Women in Agriculture

Of the 69,000 farms (2012 Census of Agriculture), 7,346 or just over one in ten, are operated by women. In 1997, women farmers accounted for only 7.3% of all Wisconsin farms and 4.3% of acreage. By 2012, the number of women farmers increased by 28.3%. During the same period, the total number of farms in Wisconsin declined by 12.3%. While the growth in the number of women farms in Wisconsin was not sufficient to entirely off-set the decrease in the total number of farms, it slowed the rate of decline. Indeed, women farmers are a source of growth for Wisconsin agriculture. Coordinated by Jenny Vanderlin, the CDP and UW-Extension county, faculty and state specialists continue to provide one-day Heart of the Farm-Women in Agriculture (HOF-WIA) conferences spinoff workshops to farm women across Wisconsin. Vanderlin works with county agents and other state staff to provide risk management education tailored to the needs identified by the county agents and/or past participant evaluations and feedback. In 2016-17 programming year, approximately 400 people attended UW-Extension programs specifically targeting farm women. Evaluations indicate participants increased their knowledge and skills in several of the topic areas that were presented. The women also indicated the need for farm women's meetings that provide them a venue to network with other farm women. Follow up evaluations indicate 75% of the respondents used information presented at the conferences. Examples of this included: farm financial and business management, farm succession, farm safety checks, herd health information, 5Ds information, improved internet security, connecting with other generations, and writing a business plan.

The place of farm women in Wisconsin over the last 5-6 decades has changed remarkably, from Alice in Dairyland, to women in management and ownership of farm businesses. Traditionally, women have been the financial record-keepers for the farm business; however, women are increasingly becoming decision-makers for the farm business, and as such, it is important that they are skilled in making farm business decisions in today's rapidly changing agriculture world. Over seventy percent of past participants in Wisconsin's HOF-WIA and Annie's Project indicate they equally share the farm investment and long term planning decisions for the farm.

The *Heart of the Farm-Women in Agriculture (HOF-WIA)* Conference Series continues to empower Wisconsin farm women in production, price, and the financial, legal and human areas of risk management education. The Heart of the Farm – Women in Conference Series bring women together in a professional setting and increase their knowledge and competence in farm business management skills and production. These conferences are a vehicle to decrease the social isolation experienced by many farm women by providing opportunities to network with their counterparts. HOF-WIA evaluations reveal farm women place priority on attending an agriculture educational program that is relevant to their business. Other factors that determine farm women's participation in agriculture education programs are the distance they must travel and knowing that other women will be attending the program. With partial funding through competitive grants from the North Central Region Risk Management Education Center and USDA Risk Management Agency Community and Outreach Assistance Partnership Grants, the CDP has been able to offer at least eight

workshops each year throughout the state each year. The funding covers speakers' costs, travel costs, materials and supplies.

Heart of the Farm Workshop Series: This series is another opportunity for women farmers to connect with risk management resources and to network with each other. Participants usually meet with instructors anywhere from two to six times in a workshop setting to learn and engage in critical risk management and decision-making processes. These workshops are of a more intimate nature than the one day Heart of the Farm workshops and build support networks with other women throughout the state. During the years 2015-17, several 2-3 day workshops were held covering topics such as Retirement Planning, Business Succession Plans and Exits, Financial Management. As with the Heart of the Farm Conference series, these workshops are partially funded by CDP, UWEX, and competitive grants from the North Central Risk Management Education Center.

Outcomes/Impacts: End of session evaluations for both the Heart of the Farm Conferences and workshops were used. Six month follow-up evaluations were also used to measure behavior changes or decisions made. The evaluations included open ended questions on how the participants would use the information provided and also a Likert scale from 1 to 5 with 1 = strongly disagree and 5 = strongly agree. Among other topics, producers improved their knowledge and increased profitability, changed/looked into various insurance options, and gained an understanding of marketing from these workshops.

F. Management Information Systems

Agriculture Financial Advisor (AgFA©)

Agriculture Financial Advisor (AgFA©) is a real time financial analysis & benchmarking tool. It is richly populated (over many years) with high quality data, developing a very comprehensive set of financial statements and reports all guided by the Farm Financial Standards Council. An integral part of the Farm Financial Management Project, the AgFA© benchmark data are used to determine how farm businesses compare to others. The financial benchmark data and publications resulting from the economic data analysis are used extensively in dairy extension programs, and permit lenders, policy makers, and agribusiness professionals to help producers become better managers and more profitable farmers. The AgFA © benchmarking site gives producers access to financial records from which they can generate and print reports immediately from the internet. (http://cdp.wisc.edu/AgFA.htm)

FarmBench:

CDP was successful as the lead organization in securing a substantial NIFA grant to rewrite the AgFA program from the ground up on a modern web platform. This is in process at this time and sets CDP up for future partnerships in this area going forward. The new program will be known as "FarmBench"—as in benchmarks. One of our goals is to formalize a partnership between Cornell University and Michigan State University to merge their financial record systems to FarmBench.

Agricultural Accounting and Information Management Systems (AAIMS©)

The Agricultural Accounting and Information Management System (AAIMS©) is a computerized agricultural accounting system maintained and updated by Jenny Vanderlin (UW-Madison). Training workshops are held across the state throughout the year through UW-Extension and the Wisconsin Technical College System. Software is sold by word of mouth and through the Heart of the Farm and financial management programs. Yearly updates are disseminated with current year tax files. In 2016 an update was created and included requests by producers including an option for online banking capability.

Appendix A

Industrial & Economic Development Research Program/SEED (IEDR/SEED) Grants 2015-2016

Investigator	Department	Amount	Researcher Company	Title
David Beebe	Biomedical Engineering	$132,154	Salus Discovery, LLC, Madison	Kit-On-A-Lid-Assays (KOALA) for the cell based assay market
Mikko Lipasti	Electrical and Computer Engineering	$122,400	Thalchemy Corp., Madison	Neural Algorithms for Ultralow Power Always-On Audio Analysis
William Murphy	Orthopedics and Rehabilitation	$142,224	Stem Pharm, Madison	Optimized biomaterials for stem cell biomanufacturing
Walter Block	Biomedical Engineering, Medical Physics and Radiology	$100,418	NeuWave Medical, Madison	Platform for Real-time Magnetic Resonance Image-Guided Therapy Using Quantitative Thermal Mapping
Mark Cook	Animal Sciences	$127,804	Isomark, LLC, Madison	Exhaled breath is an early biomarker of infection in adults with trauma

Appendix B

Industrial & Economic Development Research Program/SEED (IEDR)/(SEED) Grants 2016-17

Investigator	Department	Amount	Researcher Company	Title
Jess Reed	Animal Science	$110,931	Complete Phytochemical Solutions (CPS), LLC (Cambridge, WI)	Polyphenol Fingerprinting for Authentication of Functional Food, Dietary Supplements and Botanicals
David Beebe	Biomedical Engineering	$110,399	Stacks to the Future, LLC, Monona, WI	Feasibility Study for Quantitative Prostate Cancer Pathology Platform
Marcin Filutowicz	Bacteriology	$150,989	AmebaGone, Inc., Madison, WI	Dicty cell applications in agriculture and medicine
Daniel Ludois	Electrical and Computer Engineering	$133,291	C-Motive Technologies Inc., Madison, WI	Medium Voltage Power Electronics for Electrostatic Motor Drives
Krishnan Suresh	Mechanical Engineering	$60,469	SciArt, LLC, Madison, WI	A Computational Framework for Efficient Additive Manufacturing Simulation
Adel Talaat	Pathobiological Sciences	$150,755	Pan Genome Systems, INC, Madison, WI	Protective Vaccines Against Avian Influenza in Poultry

Appendix C
IEDR Research Projects, University of Wisconsin-Madison
2015-2016

1. Kit-On-A-Lid-Assays (KOALA) for the cell based assay market (PI: David Beebe, Biomedical Engineering Department), Industrial Partner: Salus Discovery, LLC, Madison, Wisconsin.
2. Neural Algorithms for Ultralow Power Always-On Audio Analysis (PI: Mikko Lipasti, Electrical and Computer Engineering Department), Industrial Partner: Thalchemy Corp, Madison, Wisconsin.
3. Optimized biomaterials for stem cell biomanufacturing (PI: William Murphy, Biomedical Engineering Department), Industrial Partner: Stem Pharm, Madison, Wisconsin.
4. Platform for Real-time Magnetic Resonance Imaging-Guided Therapy Using Quantitative Thermal Mapping (PI: Walter Block, Biomedical Engineering, Medical Physics and Radiology Departments), Industrial Partner: NeuWave Medical, Madison, Wisconsin.

   MR guided microwave thermal ablation therapy: Guidance and monitoring for extending the physics of thermal therapy. Simonson, Wang, Brace, Block, Proceedings of ISMRM 24th Annual Meeting, Singapore, May 7-13, 2016

5. Exhaled breath is an early biomarker of infection in adults with trauma (PI: Mark Cook, Animal Science Department), Industrial Partner: Isomark, Madison, Wisconsin.

Appendix D
SEED Research Projects, University of Wisconsin-Madison
2016-2017

1. Polyphenol Fingerprinting for Authentication of Functional Food, Dietary Supplements and Botanicals (PI: Jess Reed, Animal Science Department). Industrial Partner: Complete Phytochemical Solutions, LLC, Cambridge, Wisconsin.
2. Feasiblity Study for Quantitative Prostate Cancer Pathology Platform (PI: David Beebe, Biomedical Engineering Department). Industrial Partner: Stacks to the Future, LLC, Monona, Wisconsin.

   Reconfigurable open microfluidic models to illuminate sequence and time-dependent paracrine signaling. Jiaquan Yu, Erwin Berthier, Alexandria Craig, Theodorus E. deGroot, Patrick N. Ingram, David J. Beebe, Ashleigh B. Theberge. Nature Biomedical Engineering (Accepted and under revision).

3. Dicty Cell Applications in Agriculture and Medicine (PI: Marcin Filutowicz, Bacteriology Department). Industrial Partner: AmebaGone, Inc., Madison, Wisconsin.

   A mouse model of multi-drug resistant staphylococcus aureus induced ocular disease. Broekema, Larsen, Naruzawa, Filutowics, Kolb, Teixeira and Brandt. Journal of Ocular Biology (2016; 4(2))

   Multiple Dictyostelid Species Destroy Biofilms of Klebsiella oxytoca and other gram negative species. Sanders, Borys, Kisa, Rakowski, Lozano, Filutowicz. Protist (Formerly Archiv fur Protistenkunde) 2017 (168(3):311-325)

4. Medium Voltage Power Electronics for Electrostatic Motor Drives (PI: Daniel Ludois, Electrical and Computer Engineering Department). Industrial Partner: C-Motive Technologies, Inc., Madison, Wisconsin.
5. A Computational Framework for Efficient Additive Manufacturing Simulation (PI: Krishnan Suresh, Mechanical Engineering Department). Industrial Partner: SciArt, LLC, Madison, Wisconsin.
6. Protective Vaccines Against Avian Influenza in Poultry (PI: Adel Talaat, Pathobiological Sciences Department). Industrial Partner: Pan Genome Systems, Inc., Madison, Wisconsin.

Note: not all publication titles were made available at the time of reporting

Appendix E
Applied Research Program Awards
2016-17

Applied Research Grant (ARG)

Investigator	Campus	Amount	Title
Barry, Brian	UW-Platteville	$ 47,500	*Homogeneous Electrocatalytic Reduction of Carbon Dioxide Using Earth Abundant Metals*
DeGruson, Min Liu	UW-Stout	$ 47,500	*Development of Bio-based Antimicrobial Food Packaging by Incorporating Antimicrobial Molecule-Nanoparticle Systems in Starch*
Gutow, Jonathan	UW-Oshkosh	$ 33,250	*Experimental Testing of Computationally Designed Inhibitors of Rhinovirus Infectivity*
Rabbani, Mohammad	UW-Platteville	$ 40,258	*Preparation of Metal-Organic-Frameworks (MOFs)-based Nanoporous Membranes for Carbon Dioxide Separation Application*
Xu, Shangping	UW-Milwaukee	$ 47,500	*Development of Ceramic-Based Water Filtration Materials for the Removal of Arsenic and Virus*
Vonk, Matthew	UW-River Falls	$ 47,481	*Scientifically Authentic Video-based Experiments (SAVE)*

Applied Research-WiSys Technology Advancement Grant (AR-WiTAG)

Investigator	Campus	Amount	Title
Hamilton, Jim	UW-Platteville	$ 43,806	*Development of Optimized Economical Metal Oxide Nanowire and Chalcogenide Quantum Dots for Displays, Solar and Water Splitting: Processing, Fabrication and Purification Technologies*
Lewis, David	UW-Eau Claire	$ 47,500	*Novel Chiral Organocatalysts for Synthetic Organic Reactions*
Li, Wei	UW-Platteville	$ 43,700	*Development of a Semiconductor Quantum Dot Computer Aided Design Simulator*
McGaff, Robert	UW-La Crosse	$ 39,329	*Design and Construction of a Prototype Flow Reactor for Oxidations of Alcohols and Olefins*
Mueller-Spitz, Sabrina	UW-Oshkosh	$ 47,500	*Short Circuiting Bacterial Communication to Prevent Plant Disease*
Opdahl, Aric	UW-La Crosse	$ 30,400	*Thermostable Attachment of Capture Probes to SPR Sensors, for Use in Temperature Gradient SPR Measurements*

Prototype Development Fund (PDF)

Investigator	Campus	Amount	Title
Samaranayake, Sobitha	UW-Whitewater	$ 10,793	*Prototype Development of Requirement-Driven Interactive Degree Planner*
GRAND TOTAL		**$526,517**	

Appendix F
Applied Research Program Awards
2015-16

Applied Research Grant (ARG)

Investigator	Campus	Amount	Title
Alkasrawi, Malek	UW-Stevens Point	$ 40,600	*Upgrading Organosolv Lignin to Small Aromatics by Catalysts in Presence of Green Solvents*
Beal, Chip	UW-Superior	$ 48,504	*Preserving the Power of Plants*
Chen, Junhong	UW-Milwaukee	$ 50,000	*Scale-up of Hollow Si Lithium-ion Battery Anode Materials for High-performance Electric Vehicles*
Fischbach, Jason	UW-Extension	$ 20,000	*Scaling-Up Hazelnuts in the Upper Midwest*
Niu, Junjie	UW-Milwaukee	$ 49,898	*An Approach to Next-generation Lithium-based Batteries*
Tang, Yijun	UW-Oshkosh	$ 47,170	*Direct Methanol Fuel Cells with Ionic Liquid Replacing Polymer Electrolyte*

Applied Research-WiSys Technology Advancement Grant (AR-WiTAG)

Investigator	Campus	Amount	Title
Barry, Hamilton Brian, Jim	UW-Platteville	$ 50,000	*Isolating High-Value Aromatics from Lignin Stockpiles: A 'Bottom-Up' Approach Made Possible Via Increased Solubility and Novel Catalyst Design*
Cornett, Charles Annamalai, Wu Raja, Joseph	UW-Platteville	$ 50,000	*Developing a Viable Commercial Field Color Test Kit for Synthetic Cannabinoids*
Droske, John	UW-Stevens Point (Joint-Lead)	$ 24,940	*Further Characterization of "Green" Thermosetting Resins: Material Data Sheets and Degradation Kinetics*
Gopalakrishnan, Gokul	UW-Platteville	$ 48,585	*Silicon Nanomembranes for Piezoresistive MEMS Pressure Sensors*
McGaff, Robert	UW-La Crosse	$ 42,851	*Synthesis of Value-Added Aldehyde and Ketone Products from Biomass-Derived Alcohols*
Rabbani, Mohammad	UW-Platteville	$ 49,933	*Design and Synthesis of Nanoporous Organic Polymers to Construct Nanoporous Membrane Composites for Gas Separation Applications*
Zheng, Wei	UW-Stout (Joint)	$ 23,985	*Further Characterization of "Green" Thermosetting Resins: Material Data Sheets and Degradation Kinetics*
GRAND TOTAL		**$546,466**	

Appendix G

Center for Dairy Profitability Research and Outreach Grants Awarded from External Sources 2016-2017

Investigator	Funding Source	Amount	Title
Kevin Bernhardt	North Central Region Risk Management Education Center University of Nebraska- Lincoln	3,000	*Farm SUCCESS: A Farm Management Association*
Joy Kirkpatrick Jenny Vanderlin	North Central Region Risk Management Education Center University of Nebraska- Lincoln	49,900	*Managing Succession Planning and Profit Margins*
Joy Kirkpatrick	American Farmland Trust	4,400	*Land Access Training*
Mark Stephenson	Agriculture Food Research Initiative	19,865	*Safety Net Programs*
Brent Hueth/ Mark Stephenson/	USDA, National Institute for Food and Agriculture (NIFA)	401,775	*Spatial Competition in Agricultural Markets (with application to US Dairy)*
Mark Stephenson/Brian Gould	University of IL-Urbana	455,000	*Web-Based Decision Aids and Education Tools*
Jenny Vanderlin	USDA-RMA	39,667	*Farm Financial Management Education for WI Farmers*
Jenny Vanderlin	USDA-RMA	40,734	*Farm Business Management and Benchmarking for WI Farm Women and their Families*
Mark Stephenson Jenny Vanderlin	USDA-NIFA	161,290	*Farm Business Management and Benchmarking*
Tom Kriegl	Organic Valley	10,000	*Organic Farming and Pasture Grazing*
Total External Funding		**1,176,631**	

Appendix H

Center for Dairy Profitability Publications and Internet Sites
2016-2017

CDP Internet Sites

Center For Dairy Profitability Website
(http://cdp.wisc.edu)
Since 1995, the Center for Dairy Profitability has maintained a home page. The new homepage design was created to enhance access and retrieval of educational information. This site has a wealth of information of value to dairy producers and other professionals making economic decision in their business.

Heart of the Farm Website
(http://www.uwex.edu/ces/heartofthefarm)
Developed in 2002, this site promotes educational programs, conferences, and resources of interest primarily to farm women.

FARM Team Website
(http://www.uwex.edu/ces/farmteam)
Release in Fall 2007.

Dairy Markets and Policy
(http://dairy.wisc.edu)
Developed in 2010, this site updates a dashboard of dairy values daily, posts publications by contributing authors, and hosts monthly podcasts on outlook for prices and other occasional topics.

CDP Publications

Kammel, David W. 2016. Dairy Goat Facilities. Dairy Goat production handbook. Published by the American Institute for Goat Research, Langston University. Langston, OK 73050. www2.luresext.edu

Kammel, David W. 2016. How Much will that New Barn Cost You? Progressive Dairyman Magazine. www.Progressivedairy.com 7th most viewed article of 2016.

Kammel, David W. 2016. Building Cost Estimates-Beef Related Facilities Dairy. UWEX. Dairy Extension Resources. December 2015.

Jones, Dr. Gordon A., D.V.M., D.W. Kammel. 2017. Large Dairy Herd Design in Temperate and Cold Climate. In process. Third Edition of Large Dairy Herd Management. American Dairy Science Association. 1800 S Oak St. Ste 100. Champaign,
IL 61820-6974.

Kammel, David W., 2017. Systems Approach to Dairy Farmstead Design. In Process. Third Edition of Large Dairy Herd Management. American Dairy Science Association. 1800 S Oak St. Ste 100. Champaign, IL 61820-6974.

Kammel, D.W., Dr. G.A. Jones. 2017. Transition Cow Housing Design and Management. In Process. Third Edition of Large Dairy Herd Management. American Dairy Science Association. 1800 S Oak St. Ste 100. Champaign, IL 61820-6974.

Nicholson, C.F. and M. W. Stephenson, *Farm-Retail Margins for Fluid Milk and Cheese During the Dairy Price Cycle, 2000-2016.* Information Letter Series, 16-03. September 2016.

Nicholson, C.F. and M. W. Stephenson, *How Accurate are MPP-Dairy Margin Forecasts and What are The Implications of Forecast Inaccuracy?* Information Letter Series, 16-02. September 2016.

Nicholson, C.F. and M. W. Stephenson, *Sources of Differences in the MPP-Dairy Margin and a Similarly-Calculated Margin for Pennsylvania during 2010-2016.* Information Letter Series, 16-01. August 2016.

Nicholson, C.F. and M. W. Stephenson, *How Accurate are MPP-Dairy Participation Strategies for 2007-2013.* MPP Decision Guide, 16-02. July 2016.

Nicholson, C.F. and M. W. Stephenson, *Comparison of Optimal MPP-Dairy Participation Strategies for 2007-2013 Actual Margins and 2014-2018 Actual and Expected Margins.* MPP Decision Guide, 16-01. July 2016.

Stephenson, M.W., *International and domestic dairy market landscapes.* Large Dairy Herd Management, 3rd ed. American Dairy Science Association. *chapter pending*

Stephenson, M.W., *The U.S. and World Milk Price Outlook: An Improving Prospect?* Western Large Herd Management Conference. *chapter pending.*

Stephenson, M.W., *Changing Demand for Dairy Products and How This May Affect Dairy Production in the US.* Proceedings, Tri-State Dairy Nutrition Conference. Fort Wayne, IN. April, 2016.

Wolf, C.W., M. W. Stephenson, et al., *Where the Grass is Always Greener: Dairy Farmer Location Preferences,* Choices. May, 2015

Human Resource Management on WI Farms, Factsheet series / Ken Barnett, Jennifer Blazek and Jenny Vanderlin and Trisha Wagner. 1-*Farm Employee Characteristics, 2-Wages and Benefits for Farm Employees, 3-Human Resource Characteristics and Challenges for Wisconsin Farms, 4-Factors Which Affect Human Resources Challenges on Wisconsin Farms, 2015.*