S1075 Multistate Regional Project

The Science and Engineering for a Biobased Industry and Economy

FY 2023/2024 Annual Report

Submitted by Lin Wei, PhD

South Dakota State University

S1075 Project Committee Chair in 2023-2024

Along with Dr. Ewumbua Monono (Vice Chair) and Dr. Tyler Barzee (Secretary)

Executive Summary

This annual report was compiled from individual station reports that were submitted by the representatives of participating stations. The individual objectives and tasks were detailed in the annual report and shown in the project statement available on the NIMSS database website. Some of the significant outcomes and impacts against the S1075 objectives and target audiences in FY 2023/2024 are highlighted but not limited to:

- A total of 28 agriculture experiment stations with more than 80 investigators across the country participated in this multistate project. The target audiences of this project included farmers, industrial producers/engineers, professionals, scientists/researchers, educators and students, investors, policy makers, and public.
- Many of the investigators from different agriculture experiment stations had sigficantly collaborated each other and secured over $57 million funding to perform more than 100 new or active projects in the FY2023/2024.
- The multistate project (S1075) strongly supported not only the research communities but also the education programs, professionals, biorefinery industrial partners, local bioeconomy, and other stakeholders through publications, websites, updated textbooks/course materials, field days, workshops, social medias, etc. Thousands of farmers, producers, local representatives, industrial partners, graduate and undergraduate students, K12 schoolteachers and students, and public were involved in the S1075 project activities.
- The multistate project (S1075) resulted in more than 180 peer-reviewed papers, 150 presentations (abstracts, posters, oral presentations), 3 textbook/book chapters, 10 patents, etc. in FY 2023/2024.

Project Objectives & Tasks

The objectives and tasks of this S1075 multistate project are:

- **Obective A**. Develop deployable biobased feedstock and supply knowledge, processes, tools and logistics systems that sustainably, timely, and sufficiently deliver feedstock to meet efficient handling, storage, and conversion process specifications.

  Task 1: Biomass feedstocks in selected geographic regions.

  Task 2: Characterize and use feedstocks.

  Task 3: Transport and store biomass feedstocks.

- **Obective B**. Research and develop sustainable technologies to convert biobased resources into bioenergy, biological materials, and bioproducts, including co-products, to enable circular bioeconomy.

  Task 1: Develop and assess biological technologies including synthetic biology.

  Task 2: Develop and assess thermochemical conversion technologies.

  Task 3: Develop and assess chemical, catalytic, electrocatalytic, and other conversion technologies.

  Task 4: Develop and assess hybrid conversion technologies.

- **Obective C**. Use advanced models to provide system level analytics to enable sustainable feedstock supply and conversion technologies.

  Task 1: Develop system models and data to assess sustainability.

  Task 2: Use system models to configure, analyze and optimize bioenergy, biological materials, and bioproduct systems.

Participating Stations and Investigators:

S1075 State	Submitted by:	Email:	Listed investigators
Alabama	Hassan Khodaei	hkj0008@auburn.edu	Hassan Khodaei, Oladiran Fasina, Sushil Adhikari, Hossein Jahromi, Brendan Higgins.
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Kansas	Donghai Wang	dwang@ksu.edu	Xiuzhi (Susan) Sun, Donghai Wang, Mark Wilkins, Yi Zheng
Kentucky	Tyler Barzee	j.shi@uky.edu	Tyler Barzee, Jian Shi, Mike Montross, Czar Crofcheck.
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Tennessee	Alvin Womac	awomac@utk.edu	Alvin Womac, Mi Li, Nourredine (Nour) Abdoulmoumine, Nicole Labbé
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*Not included in this annual report.

Outcomes and impacts related to Objective A: Develop deployable biobased feedstock and supply knowledge, processes, tools and logistics systems that sustainably, timely, and sufficiently deliver feedstock to meet efficient handling, storage, and conversion process specifications.

Alabama

The agriculture experiment station (AES) team at Auburn University explored biochar application in agricultural systems. They securied $3 million research funding to support 5 active or new research projects in FY2023/2024. Dr. Oladiran Fasina focused on identifications and characterizations of different streams of wood, agricultural waste, and plastic feedstocks, helping other team members to develop biofuels, biochar, and/or other bioproducts in the biomass thermalchemical coversion processes (e.g., pyrolysis). Dr.Higgins developed an algal-bacterial process for pretreatment of anaerobic digestates and poultry processing wastewater for algae growth to feed fish feed. The team included 15 PhD students and postdoctoral fellows in the S1075 project. They published 17 peer-review papers in FY 2023/2024.

California

The AES team at University of California Davis (UCDavis) conducted research on biomass conversion and biorefining with cost effectiveness and eco friendliness. They collaborated with other AES teams at University of Maryland, Volcani Institute, University of Arizona, American University, etc. with more than $ 24 million research funding to support 14 new or active projects in FY 2023/2024. The main research activities related to the Objective A included: promoting translation and addressing hurdles to adoption for biosolarization as an alternative to soil fumigation to decrease worker exposure to toxicants; demonstrating the potential for on-site electricity generation from food waste using containerized anaerobic digestion units; develop a digital dtlas of food and agricultural byproducts in California; Prevention and management of fusarium wilt of lettuce; transforming the community, climate, and soil health of urban agriculture through applying food waste derived fertilizers in community learning gardens; establishing multiscale resilient, equitable, and circular innovations with partnership and education synergies) for sustainable food fystems; adapting soil biosolarization to local by-products and low water inputs by harnessing the indigenous microbiome in lettuce crops; recycled olive waste as a new tool to control nematodes and weeds in perennial crops using biosolarization, cover cropping and strip tillage to improve pest suppression; create a comprehensive database of major food processing byproduct flows in California, prioritizing almonds, pistachios, and pomegranates, informed by an intitial pilot project on processing tomatoes. The team included 12 graduate students in the research activities and published 8 peer-reviewed papers and 6 presentations. Moreover, 2 PhD and 1 M.S. of the students finished their dissertations or thesis and earned the degrees in FY 2023/2024.

Hawaii

The AES team at University of Hawaii secure more than $6.7 million funding to conduct 2 new or active projects on education of novel CRISPR technologies for Hawaii undergraduate and graduate students in biological sciences. They focused on developing affordable and efficient photobioreactor and biofiltration systems with fungal filters to grow and harvest microalgae. They designed bioreactors to develop algae strain and plants and then harvest the microalgae with fungi for biofuels and bioproucts. They hosted the 2023 and 2024 USDA-UHM CRISPR summer workshops on the campus. The team lunched a website www.dulab.bio, published 18

peer-reviewed papers in professional journals and presented 21 presentations in conferences to disseminate new knowledge and technologies to the target audience and public. The included 3 PhD, 3 M.S. graduate students and 13 undergraduate students to participate in the projects. Two of M.S. students completed their thesis and graduated from the team in FY 2023/2024.

Illinois

The AES team at University of Illinois Urbana-Champaign provided workshops to train bioprocessor employees and allied industries regarding the corn wet milling, a commercial scale biorefining process to produce a variety of biobased products. They continuely offered 2 workshops on corn wet milling to industry representatives to satisfy the market demands. They have reached more than 650 representatives from 12 countries and invited speakers from academia, industry and USDA research labs in FY 2023-2024.

Kentucky

The AES team at University of Kentucky collaborated with 5 AES teams from Iowa State University, Louisiana State University, Purdue University, North Carolina State University, and Kansas State University to secure a total of $4.3 million funding to perform 6 new or active projects in FY2023/2024. They focused on developing surface enhanced preprocessing of municipal solid waste (MSW) for year-round supply of conversion-ready feedstocks. They developed deep eutectic solvent (DES) technology to reduce carbon emission in pulp and paper industry and commercialized the DES technology for critical metal recovery from expired batteries. They included 10 grdaute and undergraduate students to participate in the research activities. They were granted 2 patents on the methods of recycling the critical metals from spent lithium-ion batteries and hydrophobic deep eutectic solvent based lignocellulosic biomass processing. They published 11 peer-reviewed papers and 24 presentations in FY2023/2024.

Michigan

The AES team at Michigan State University is continually developing models for stationary and portable biochar production systems to maximize access to feedstock and minimize transportation costs. This research is being led by Dr. Raju Pokharel in the Department of Forestry and supported by Dr. Chris Saffron and Dr. Jessica Miesel. In these models, forest biomass serves as the feedstock for slow pyrolysis to make biochar for cropland agriculture. Both Michigan's upper peninsula and lower peninsula are included in the study's geographic scope. Most of the biochar will be land applied in the southern portion of Michigan's lower peninsula, which is the region with the greatest cropland area. Transportation costs of biomass to stationary facilities followed by biochar hauling to agricultural sites are significant. Contrastingly, portable system economics are affected by lower biochar yields after slow pyrolysis.

Minnesota

The AES team at Univeristy of Mineasota collaborated with other AES teams from University of Missouri, Washington State University, Mississippi State University, and Stanford University to secured more than $1.5 million to support 6 new or active projects in FY2023/2024. They also worked with national labs (Lawrence Berkeley National Laboratory, NREL), funding agencies, and industrial companies, including Resynergi, Quasar Energy Group, Maas Energy, Minnesota Metropolitan Council Environment Services, Holistic Health Farms, Forsman Farms, and Minesga), to utilize livestock waste (e.g., liquid swine manure) and various biomass

feedstocks to prevent water contamination and convert wastes into valuable bioproducts like fertilizers, energy, fuels, and feed, contributing to a circular economy. They have made significant progress in developing deployable biomass feedstock and supply systems, particularly by utilizing landfill leachate in their processes. This closed-loop system integrates anaerobic digestion, algae cultivation, and hydroponic farming to produce biomass efficiently and sustainably. We've successfully scaled up our algae cultivation efforts, focusing on PFAS remediation, which tackles a critical environmental issue while generating valuable biomass. They developed a catalytic microwave system to disinfect prions that contains animal tissues in soil. They demonstrated the feasibility of using catalytic microwave technology and plasma to disinfect aerosols containing the avian influenza virus to enabling clean air circulation in animal barns, enhancing biosecurity and protecting animal health. They created a non-thermal microwave system to disinfect the outer surface of whole wheat kernels, reducing the risks associated with handling and processing them in later stages to improves food safety. Overall goal is to improve the feedstock supply systems to deliver high-quality, reliable biomass that meets the demands of modern handling, storage, and conversion processes, all while contributing to environmental sustainability and public health.

Missouri

The AES team at University of Missouri collaborated with Purdue University and University of Wisconsin to suecure $314,245 to perform 2 new/active projects. They developed effective technologies and education platforms for next generation aquaculture in Missouri and the midwestern region. They quantified the resource utilization in autotrophic vs hetertrophic aquaculture production and optimized co-production from freshwater and marine aquaculture and algal culture. Dr. David Brune published an aquaculture extension website and 3 presentations to dissiminate the new knowledge and technologies of aquaculture intensification and embodied resource utilization, photosynthesis in enhanced catfish production systems, and the resource utilization in heterotrophic vs autotrophic marine shrimp production to the target audiences and public in FY2023/2024.

Montana

The AES team led by Dr. Chengci Chen at Montana State University continually evaluated camelina and other oilseed crops as potential feedstock for developing biodiesel and sustainable aviation fuels. They collaborated with other AES teams to enhance Camelina oilseed production with minimum nitrogen fertilization in sustainable cropping systems with $10 million funding supppored by NSF. The research includes: 1) camelina and canola cultivar evaluation for higher oil yield with less nitrogen fertilizer input; 2) genetic modification to improve camelina nitrogen-use-efficiency (NUE). Dr. Chen’s team investigated the relationship between camelina germplasm and selecting genotypes to identify if they can contribute to high NUE. They also worked on evaluating sugar beet for bioenergy production. They conducted research to improve camelina oil yield and NUE using genetic engineering approaches. The team included multiple undergraduate/graduate students and postdoc in their projects and published 1 peer-reviewed paper and 3 presentations in FY2023/2024.

North Dakota

The AES team at North Dakota State University performed 8 new/active project with about $ 943,692 research funding in 2023/2024. They collaborated with other AES teams and USDA-ARS Northern Great Plains Research Laboratory to develop remote sensing and image

processing tools for applications in North Dakota agricultural and range-land. The team also studied on the digestibility and toxicity of corn-based bale net wrap, bioconversion, and bioaugmentation of soybean, meal for sustainable biofertilizer production, biobased polymer degradation and impact on human health, and optimization of the drying and storage conditions of cannabidiol hemp grown in North Dakota. They included 6 graduate students in the projects and published 11 peer-reviewed papers and 13 presentations in FY2023/2024.

Ohio

The AES team at Ohio State University led by Dr. Ajay Shan focused on exploreing different approaches and tools to estimate the availability of different feedstocks and potential for their utilization in biorefineries and power plants. They tested alternative methods for improving the logistics of feedstock (lignocellulosic, fiber and oilseeds), and investigated whole-plant based feedstock supply system as well as alternative whole-plant cotton logistics and pre-cleaning system for process improvement with residue utilization for biobased industries. They partinered with other AES teams to work on alternative whole-plant cotton logistics and pre-cleaning system for process improvement with residue utilization, the feasibility of whole-plant cotton harvest and processing, sustainable hydrothermal manure management practice to improve nutrient use efficiency for enhanced agroecosystem services, climate smart camelina, nature inspired bio-manufactured terminal hydroxylated fatty acid copolyesters, and a separation system for efficient fermentation of mixed substrates and in situ recovery of hydrophobic bulk chemicals. They included 2 Master's students, 1 Ph.D. student, 1 research technician and 2 research scientists participated in the project activities in FY2023/2024.

Pennsylvania

The AES team at Pennsylvania State University (PSU) secured multi million funding to work on the objective A. Dr. Ali Demirci at PSU performed research on single-cell protein production from date wastes to provide nutritional supplements for animals by using microbial fermentation. His group also produced hyaluronic from distillers dried grains with solubles (DDGS) for cellulosic biomass hydrolysis for biofuels and other uses by microbial fermentation in biofilm reactors. This yaluronic is a valuable product for pharmaceutical applications. The AES team included 12 graduate and under graduate students and 4 of the graduate students completed their theses/dissertations and got their degrees. They filed 5 patent applications, published 10 peer-reviewed paper in professional journals and over 30 presentations in conferences.

Tennessee

The AES team at University of Tennessee continually worked on several projects related to the Objective A in FY 2023-2024. Professor Womac's group focused on charterized biomass feedstocks physical properties and their relationships, including moisture content, density, terminal verlocity, paricle size, etc. They developed a vertical wind tunnel to investigate the terminal velocities of various biomass feedstocks under different conditions (e.g., MC, particles size, etc.), such as the stem internodes and nodes of switchgrass, wheat straw, corn stover, and so on. This offered a limited difference and may indicate that separations may need to be confined within groups of moisture category and/or particle length. The observations indicated that there is potential of using terminal velocity to separate node from internode for similar-sized particles of biomass feedstocks at a given moisture content. Dr. Abdoulmoumine established long-term miscanthus and biomass sorghum experiments in Tennessee and

Mississippi with biochar and poultry litter amendments for enhanced carbon sequestration and reduced fertilizer input. They collected agronomic and soil data for these crop systems to support model development for decision-making. The team included multiple graduate and under graduate students and published 16 peer-reviewed paper in professional journals and over 9 presentations in conferences. Two of the graduate students completed their theses/dissertations and received their degrees in FY2023/2024.

Texas

The AES team at Texas A&M University collaborated with other stations, national labs (e.g., INL, Beta Lab), and industrial partners (e.g., Shell International Explorations Group) to secure $1.77 million to proferm 3 new or active projects in FY2023/2024. They designed an in-motion pyrolizer attached to a commercial sorghum and corn combine for bio-oil production while directly applying biochar into the soil for production of crops and other biomass feedstocks. The new machinery attachment can kill weed seeds, insects, and pathogens and then immediately fertilize the soil. The team also initiated research on graphene production for generating graphene sheets and nanotubes from numerous biomasses wastes and residues, including commercial coal through pyrolysis using the Beta Labs Chemical Vapor Deposition (CVD) facility. These graphene sheets and nanotubes can be used in the products including batteries, semiconductors, high energy capacitors and numerous high value materials. They have converted Municipal Solids Wastes, Plastics and rubber tires into Siemens certified fuels for gas turbines to generate electrical power. They included 2 undergraduate and 7 graduate students in the projects and published 2 Books/Chapters, 11 refeered journal papers, and 3 presentations in conferences in FY2023/2024.

Virginia

The AES team at Virginia Tech collaborated with the AES team at Kansas State University to secure $2.7 million funding to perform 2 new or active projects. They develop an enzyme-assisted wet fractionation technology to convert brewer's spent grain into high-value animal feed and food ingredients. Another project was to produce high-protein ingredient from brewer's spent grain to replace fishmeal in aquaculture feed. They included 3 undergraduate, 6 graduate students, and 4 postdocs to converting agricultural and food wastes into high-value products. They published 1 peer-reviewed papers and 3 presentation in FY2023/2024

Washington

The AES team at Washington State University collaborated with other AES teams to secure $8 millon funding to perform 3 new or active projects. They triled to efficiently utilize waste resource as a feedstock for promoting bioeonomy. They investigated the variability and potential waste resources for developing relationships between waste generation levels and community level socioeconomic factors representing culture, knowledge, microeconomics, infrastructure, social provisions, technology, policy, institutions, and macroeconomics. They evaluated the potential of entire U.S. and developed models to predict MSW generation patterns at a state/multi-state levels. They identified the factors that impact MSW fraction generation and develop relationships between the MSW fraction profiles and spatial variability factors to guide future prediction model development using county-level MSW fraction generation data from two states and associated socioeconomic data. They included 4 undergraduate and 4 PhD graduate students in the research activities and hired 2 high school students for summer internships in their labs. The team published 13 refeered papers in jounals and 11 presentations

in conferences in FY2023/2024.

Wisconsin

The AES team at the Univeristy of Wisconsin-Madison collaborated with the AES team at Washington State University to secure $210,000 funding to perform 2 new or active project on pretreatment and fractionation of biomass feedstocks, enzymatic and chemical saccharification of lignocellulose to produce sugars, biomass composition and separation technologie for bioenergy and bio-based materials. Dr. Xuejun Pan developed a strong and stretchable cellulose film (CelloFilm) as a plastic alternative for packaging, which was supported by Wisconsin Agricultural Experiment Station. He shared the new knowledge and discovering with the classes of BSE 460 Biorefining: Energy and Products from Renewable Resouces to graduate and undergraduate students. Dr. Troy Runge performed research on developing handheld near-infrared spectroscopy for undried forage quality estimation, biomass-derived p-hydroxybenzamide, and economic and environmental analysis of producing soy protein-cellulose-based bionanocomposite fruit coating, and techno-economic and life cycle analyses of bio-adhesives production from isolated soy protein and kraft lignin. The team published 12 peer-reviewed papers and 2 presentations in FY2023/2024.

Outcomes and impacts related to Objective B: Research and develop sustainable technologies to convert biobased resources into bioenergy, biological materials, and bioproducts, including co-products, to enable circular bioeconomy.

Alabama

Drs. Adhikari & Khodaei at Aurbun University led a group to convert various biomass feedstocks into chemicals, bioenergy, and biomaterials. They designed different pyrolysis and gasification systems for production of hydrogen from biomass resources such as municipal soild wastes) using higher efficient combustion mechanisms and computational modeling approaches. They also utilized various biobased plastics and biochar to produce horticulture plant containers. They collaborated with the AES teams from University of Delaware and New Mexico State University to develop sulfur (S)-doped biochar to lower nitrogen oxide emission from soil and agricultural practices. They are working with an international research group (U.Vigo, Spain) to design indirect rotary kiln pyrolysis plants for efficiently producing biofuels and other chemicals. Dr. Hossein Jahromi collaborated with Drs. Sushil Adhikari, Brendan Higgins, and Robert Jackson) to develop biolubricants from waste cooking oil. They filed a patent application for this technology.

California

Dr. Yi Wang at UCDavis used engineering approaches to isolate *Clostridium* strains for chirally pure (R)-1,3-butanediol (R-1,3-BD) production from lignocellulosic biomass. This bacteria is a valuable building block for the production of fragrances, pheromones, insecticides, and particularly as a key chiral intermediate for the synthesis of β-lactam antibiotics, which is the most used antibacterial agents in clinical practice worldwide. He also worked on producing *Clostridium* strains for chirally pure (R)-3-hydroxybutyrate (R-3HB) production from lignocellulosic biomass. R-3HB is the monomer of poly[(R)-(3-hydroxybutyric acid], or PHB, a high-demand biodegradable plastic. In addition, R-3HB, as a chiral chemical, is a valuable intermediate for pharmaceutical and fine chemical industries. Particularly, R-3HB has been used as a precursor for manufacturing vitamins, antibiotics, pheromones, and aromatics.

Dr. Zhiliang Fan's lab at UCDavis aims to produce ologosccharides and gluocnic acid from walnut and almnd hulls. Their research focused on producing high-value prebiotic products, cellobiose, oligosaccharides, and gluconic acid from almond and walnut shells to increase the economic return to farmers and processors while ensuring sustainable management of these byproducts. Dr. Simmons' group at UCDavis explored effective methods to bioconvert organic matter residues (e.g., food processing byproduct streams) into biopesticides (e.g., organic acids) for application in agricultural soils.

Hawaii

Dr. Du's lab at University of Hawaii worked on the lipid metabolism in photosynthetic organisms including plants and microalgae, as well as lipid biosynthesis and turnover in soil fungi and bacteria. They explored the dynamic of the membrane and storage lipids and the role of lipid metabolism in development and stress response. Theyt use engineering and synthetic approaches to produce valuable bio-products in microalgae and establish co-production systems with synthetic consortia of algae, bacteria, and fungi. Another project is to develop research instruments such as environmental photobioreactors for algae incubation.

Dr. Khanal at University of Hawaii worked on converting organic wastes, including food wastes and agri-residues into black soldier flies (BSF) (*Hermetia illucens*) larvae for both animal feed and biodiesel production. They target on developing zero waste insect-based biorefinery for valorization of waste and biofuel production. They also worked on innovative anaerobic digestion (AD) biorefinery for highly complex feedstocks. They utilized lignocellulosic feedstock to convert hemicellulose into biogas while converting cellulose and lignin into multiple products via thermochemical conversion. They employed ORP-based microaeration for anaerobic digestion/co-digestion of agri-residues, sewage sludge and food wastes. This novel operational strategy can be applied as an effective process control approach for full-scale AD system at high organic loading rates, and offers significant economic and logistical merits. Another research of this group is to work on nitrogen transformations in aquaponics with nanobubble technology. They examined nitrogen use efficiency (NUE) under different hydraulic loading conditions and the pathways of nitrogen transformations via nitrogen-stable isotope and microbial community analyses. This research also investigated nitrous oxide (N_2O) emission for contribution to global climate change by incorporating with nanobubbles technology to improve the productivity of fish and organic produce, and bioponics. Additionally, they explored the potential of algal biomass for various biomaterials production in collaboration with different research groups.

Dr. Su at University of Hawaii led a group to work on three research areas: (1) engineering a yeast-based microbial cell factory for producing high-value terpene products from sugar and lipid feedstocks; (2) development of a microbial fermentation process to defat and add proteins to insect (Black Soldier Fly larvae, BSFL) meals as unique aquatic feeds; and (3) deveop ground papaya seeds as a natural biofumigant for sustainable management of soil-borne plant pathogens.

Kansas

The AES team developed effective technologies to convert starch into anticancer drugs. They used food wastes, such as valorize black liquor, and hydrothermal liquefaction wastewater (HTLWW) into value-added products and antioxidant-rich feed additives. They explored lignin-based 3D printed wearable triboelectric nanogenerators for personal health. They used lignin to

produce wearable triboelectric biosensor for personal health monitoring and targeted anticancer drug delivery carriers. They conducted research on development of affordable, biodegradable, durable, disposable containers for food services by utilizing biomass and biorefinery by-products. They evaluated the potential of hempseeds protein for plant protein-based adhesives. The team published 10 peer-reviewed journal articles and 13 meeting presentations and 1 patent in FY2023/2024.

Kentucky

The AES team at University of Kentucky developed novel and sustainable cell-cultivated foods through additive biomanufacturing and transformed distillers' spent grains into novel food ingredients with prebiotic and antioxidant characteristics. They designed a bottom-up approach for sustainable cultivated meat production. They synthesized a lignin-based hydrogel and investigated its impact on soil water retention in silt loam and loamy fine sand soils, which was found significantly increasing water retention at -3 cm to -15,000 cm soil water pressure head by 0.01 - 0.03 cm^{-3}. They also developed and implemented a process-intensified approach for fermentative volatile fatty acids (VFAs) production from Brewer's spent grain (BSG), along with methods to enhance VFA yield and recovery through novel VFA extraction and esterification techniques enabled by green solvents and enzyme immobilization. These findings provide a potential solution to the sustainable utilization of BSG waste from the brewing industry. Another project is to immobilize microalgae cells of *Haematococcus pluvialis* using the edible fungal strain *Aspergillus awamori* for potential food applications. This study investigated the impact of fungal loading, pellet geometry, and initial microalgae cell concentration on the immobilization performance and product characteristics. They found that higher fungal loading and larger fungal pellets contributed to increased immobilization performance while increased initial microalgae concentration inhibited the process. Larger fungal pellets had decreased biomass density, which led to decreased surface concentration of immobilized microalgae but deeper penetration within the pellets. Kinetic and equilibrium models were applied to allow for process prediction and manipulation of key operational parameters allowed the product composition to be tuned to desired criteria. This study provides new insights to the fungal-assisted microalgae immobilization process and demonstrates a novel application in bioproduct customization.

Minnesota

The AES team at UMN developing advanced technologies to enhance the commercialization potential of biomass conversion. The efforts include the production of clean syngas through innovative preprocessing and gasification of lignocellulosic feedstocks, as well as the use of ZSM-5 zeolites to optimize plastic cracking and improve catalyst performance. These initiatives aim to create high-quality, energy-dense syngas while maximizing the efficiency and sustainability of the conversion process. They conducted a promising hydrodeoxygenation test using waste vegetable oil to produce an aviation fuel product with high alkane content and minimal oxygenates. This process utilizes polyolefinic plastics as hydrogen donors to produce sustainable aviation fuel (SAF) without the need for external hydrogen to enhance economic viability and reducing the carbon footprint. Moreover, they develop concentrated high-intensity electric field (CHIEF) reactor to simulate natural lightning for nitrogen oxide synthesis for cost-effective nitrogen fixation. This innovation opens new avenues for sustainable chemical production, further strengthening the economic and environmental impact of our biomass conversion technologies.

The team included 10 undergraduate and/or graduate students in their research activities and published 36 peer-reviewed papers, 21 presentations in FY2023/2024. Moreover, they hosted IFT-EFFoST 2023 International Nonthermal Processing Workshop & Short Courses. They provided consulting on development of advanced oil treatment processes for Cargill company and offered their facilities for stakeholder demonstrations.

Missouri

Dr. David Brune at Univeristy of Missouri developed photosynthetic techniques such as partitioned aquaculture systems (PAS) and split-onds (SP) allow high feed loading in excess of 200 lb/ac-d, supporting fish production in excess of 10,000–14,000 lb/ac at algal fixation rates of 6–12 g C/m^2-d. In spite of intense energy usage and elevated feeding rates, this super-intensive aquaculture offers the potential to provide sustainable seafood production in terms of energy and water requirements per unit of aquatic biomass produced. They integrated super-intensive aquaculture production with harvest and convertion of microbial biomass to maintain water quality, provides valuable by-products, while simultaneously reducing or eliminating water and waste discharge to the environment, which can reduce/eliminate the threats to local streams and groundwater, while providing a healthy and environmentally friendly alternative to imported seafood products via locally grown seafood and co-production.

Mississippi

The AES team at Mississippi developed effective processes to convert woody wastes, forestry residues and municipal solid wastes to liquid biofuels to achieve the goal of 10 gallons of renewable aviation fuels per dry ton of biomass feedstocks.

North Dakota

The team focused on bioconversion and bioaugmentation of soybean meal for sustainable biofertilizer production. They developed remote sensing and image processing tools for North Dakota agricultural and range- land applications. They conduced research on upscaling, formulation and technoeconomic assessment of biofertilizer from soybean meal. They explored innovative technologies to gelatinize corn starch as a binder alternative to cement in concrete to enhance the strength of the corn starch-based material known as CoRncrete by optimizing the processing conditions. They conducted experiments to optimize the ratio of sand, starch, water, curing temperatures and time. They found that the optimum processing conditions having a sand grain size of 0.250-0.425 mm, a mixture ratio of starch, water, and sand 1:1:5, and curing temperature and time of 110 °C and 24 h can yield a maximum compressive strength up to 18.9 MPa.

Ohio

The team focused on waste valorization, primarily through hydrothermal carbonization of the high moisture waste to produce hydrochar for different applications.

Oklahoma

The team collabored with the AES team at Ohio State University to perform research to enhance butanol production by developing a novel clostridia platform for co-fermentation of non-detoxified switchgrass hydrolysate and CO_2. They used *Clostridium carboxidivorans* as a platform for butanol production via co-fermentation of lignocellulosic biomass. They have made progress in advancing gas fermentation for converting syngas and CO_2 into biofuels and

biobased products while reducing greenhouse gas (GHG) emissions. The team has developed a method to convert CO_2 into various products, including alcohols, contributing to GHG reduction and waste stream utilization. They evaluated five gas fermentation strains, including *Clostridium Carboxidivorans* P7, *C. ragsdalei* P11, *C. muellerianum* P21, and strains A and B isolated in Oklahoma.

The team also worked on produce jet fuel intermediates from biomass and CO_2 using a novel co-fermentation process, which involves converting biomass-derived sugars and gas into butanol. They worked on the design, fabrication, and placement of a downdraft gasifier for use in processing yard waste for the city of stillwater carbonJet technologies. They utilized CRISPR-based gene editing to engineer Clostridium carboxidivorans for metabolic optimization. They successfully developed lignocellulose-derived microbial inhibitory compounds (LDMIC)-tolerant strains of *Clostridium beijerinckii* and *C. carboxidivorans* in the presence of inhibitory compounds. Their work resulted in 2 applications of U.S. Patents. They also investigated the potential of eastern red cedar biochar as potting media for greenhouse production of ornamental and vegetable crops. These projects provided training opportunities for 1 Post-Doc, 2PhD students, and 1 MS student, and publication of 4 peer-reviewed papers in FY2023/2024.

Pennsylvania

Dr. Jeffrey Catchmark at Pennsylvania State University developed, patented, and transitioned to manufacturing a new polysaccharide-based (starch & cellulose) oil and water barrier coating to replace PFAS and plastic laminates on paperboard for packaging applications. Their technology was licensed by Big Idea Ventures and a new company Terrasafe Materials for commercialization. The group also developed, patented and established volume manufacturing for a new starch-based hemostatic foam for wound care and a new hydrocarbon surfactant-based for PFAS replacement for cotton and synthetic textiles. A new start-up company is being established to commercialize the technologies. Another technology they are working on is to developed a new starch-based soilless medium that can replace peat and other commercial materials for plant production.

Dr. Catchmark developed and submitted a patent on a new hydrocarbon surfactant based PFAS replacement for cotton and synthetic textiles including clothing, fabrics and carpets and a new soilless medium based on starch that can replace peat and other commercial materials for plant production.

Dr. Ali Demirci focused on hydrolytic enzymes production from distillers dried grains with solubles (DDGS) for cellulosic biomass hydrolysis for biofuels and other uses. He collaborated with Universiti Putra Malaysia to evaluated biogas production from lignocellulosic biomass was evaluated in terms of opportunities and challenges. They produced single-cell proteins from date wastes by using microbial fermentation. These single cell proteins are important in providing nutritional supplements for animals. They also worked on hyaluronic production via microbial fermentation in biofilm reactors. The hyaluronic is a valuable product for pharmaceutical applications.

Dr. Juliana Vasco-Correa Designed and tested a lab-scale solid-state bioreactor to mitigate dilute methane emissions, envisioning a biobased system that can benefit economically from carbon markets. She led a group to perform anaerobic digestion of grasses (prairie, winter rye, corn stover → Grass-to-Gas) to test soil application of digestate. They started a new project on

anaerobic co-digestion of ice cream waste.

Dr. Stephen Chmely led another group to develop mixed-metal oxide catalysts for lignin upgrading after cosolvent-enhanced lignocellulosic fractionation (CELF). They continued to work on biomass fractionation and 3D printing with lignin. They developed a new catalytic system based on mixed-metal oxides that catalyze the transfer hydrogenation of lignin using biomass-derived ethanol. This catalytic system has the potential to substantially enhance the carbon footprint of the fractionation process by using earth-abundant catalysts and biomass-derivable reagents. The 3D printed objects containing lignin with varying degrees of mechanical performance compared to non-renewable controls, but they are working on modification reactions to enhance their performance properties.

South Dakota

The AES team at South Dakota State University. They collaborated with multiple universitied to develop various effective technologies to utilize different biomass feedstocks for syntheiszing biomaterials, nanocomposites, and other bioproducts. They secured more $15 million to perform 13 new or active projects. Dr. Lin Wei focused on developing effective and affordable biochar-based control release fertilizers (BCRNFs) to improve the sustainability of agricultural production by utilizing agriculture and forest residues/wastes, energy crops, and other renewable resources. He has established a pilot sale BCRNF production line for commercialization the technologies to promote local economy and increase farmer incomes. The new technologies reduced environmental impacts while improving precision agriculture sustainability by applying BCRNFs in different crop productions (e.g., corn, wheat, etc.) The new technologies produced healthy and safe foods and functional bio-products by using co-products or wastes from bio-refinery industries. He worked with other investigators to develop nanobubble technology for dairy processing effluent management and extraction and delivery of bioactive compounds from fruit waste pomace using milk proteins.

Dr. Kasiviswanathan Muthukumarappan worked on development of bioresins from soybean oil and renewable composites from thermoset resins, and feed pellet processing of Camelina and Carinata meal using an extrusion process.

Dr. Zhengrong Gu developed various biomass conversion technologies for applications in bioenergy, food safety, and agricultural productions. The project included: Activated carbon pad to deliver glucosinolates and myrosinase enzymes to extend the shelf-life of strawberries; Separate Glucosinolates from non-food oil-seeds as value added co-products and improve nutrition value of oil-seeds as animal feed; Biorenewable graphene from new thermochemical biorefinery process, development of an edible bio composite for a replacement to petroleum-based plastics used in agricultural net wrapping, etc.

Three of new investigators: Dr. Srinivas Janaswamy, Dr. Bishnu Karki, and Dr. Ananda Nanjundaswamy) joined in the team in 2023. Dr. Janaswamy worked on developing biopolymers for applications in food processing and agricultural production via the Center for Climate-conscious Agricultural Technologies. Dr. Karki untilized bioconversion of agricultural resources for food and feed applications. She developed fermentation technologies (solid and liquid state fermentation) for bio-based products and chemicals. Dr. Nanjundaswamy developed bioprocess technologies for producing bio-colorants for food and feed applications.

The team included 36 undergraduate and graduate students in their research activities and published 20 peer-reviewed papers and 23 presentations in FY2023/2024.

Tennessee

To valorize glycerol, which is an excessive co-product of biodiesel production, Dr. Ye conducted catalytic glycerol dehydration to acrolein using supported silicotungstic acid as solid acid catalysts, focusing on the effects of mesoporous catalyst supports on the catalytic performance. Acrolein, industrially produced from the partial oxidation of petroleum propylene, is an important intermediate for many common industrial chemicals, leading to an array of useful end-products, such as acrylic acid and ester, glutaraldehyde, methionine, polyurethane, and polyester resin. The results showed that the characteristics and catalytic performance of the supported silicotungstic acid were greatly influenced by the physicochemical properties of the support materials, including the mesopore size, surface area, and chemical structure of the catalyst supports. It is informative to conduct this study on the new use of commercially available catalyst-support products for potential industrial applications.

Collaborating with Dr. Toni Wang, Dr. Ye also conducted two projects: 1) Plasma-induced oil-based polymer to enhance the dyeing of recalcitrant para-aramids, and 2) Oil-based antimicrobial waxes to be used as both physical and biological protection to perishable fruits and vegetables. In the first project, they addressed industrial need to durably dye or print para-aramids, a high-performance polymer that finds increasing commercial uses as protective clothing (e.g., flame-resistant apparel), body armor (e.g., bullet-proof vests, helmets, and puncture-resistant correctional wear), and sportswear, but is very difficult to dye. It's demonstrated that increasing the functionalities of soybean oil applied to the surface of para-aramids followed by a nonthermal plasma (NTP) treatment significantly improved the dyeing color strength. In the second project, six distinct structures having three different quaternary ammonium compound (QAC) groups were synthesized and evaluated, showing potent inhibition toward the growth of both bacteria and fungi. Both the projects promoted the new uses of renewable materials for commercial applications.

Dr. Hayes formed bicontinuous microemulsion-based delivery systems composed of biobased oils (e.g., isopropyl myristate and limonene) for delivery of antimicrobial peptides to chronic wounds that possess activity against several bacteria that are prominent in skin.

Dr. Abdoulmoumine developed and is improving a solvent fractionation process to extract and convert lignin into sustainable aviation intermediates. He developed processes to convert CO_2, along with biomass-derived chemicals, into chemical and fuel precursors.

Texas

The AES team at Texas A&M University designed an in-motion pyrolyzer that was attached to a commercial corn, sorghum and silage combine for immediate conversion of crop residues into biooil and biochar with the syngas to be used as fuel for the pyrolyzer. The team also designed a unique pyrolyzer to convert MSW, plastics and rubber tires into fuels that can be used to run a gas turbine to generate electrical power. The biochar can be used as carbon capture and sequestration (CCS) material. Moreover, they designed a high-rate anaerobic digestion (AD) system with solids separation system to convert dairy manure into biogas with the sludge being used as composted materials. Likewise, the composted feedlot manure can be gasified to generate electrical power and biochar for CCS studies as well. The team the Beta Labs

Chemical Vapor Deposition (CVD) facility to pyrolyze numerous biomasses wastes and residues, including commercial coal to generate graphene sheets and nanotubes, which can be used in applications of batteries, semiconductors, high energy capacitors and numerous high value materials. The fuels produced from advanced pyrolysis of MSW, plastics and rubber tires are certified by Siemens gas turbine facilities. These certified fuels will used in a power plants (170 MW each) that are being designed for construction in Puerto Rico and Dominican Republic.

Virginia

The AES team at Viginia Tech developed a thermochemical process to convert switchgrass into high-value sodium-ion battery anodes. They also designed a fermentation process to convert food waste into renewable 2,3-butanediol. Another project they worked on is to completed preliminary experiments for the encapsulation of enzymes in alginate beads for the biocatalytic conversion of biomolecules using a flow mode, as opposed to batch mode. A Pilot demonstration of a modular bioprocess system for manufacturing consumer bioplastic products from food wastes is under developed.

Washington

The AES team at Washington State Univeristy secured over $5M to perform 4 new or active projects in FY2023/2024. They focused on economical production of lignin-based jet fuel (LJF) to improve the sustainability of sustainable aviation fuels (SAFs) as well as reducing the overall greenhouse gas emissions. They demonstrated a simultaneous depolymerization and hydrodeoxygenation (SDHDO) process to produce lignin-based jet fuel from the alkali corn stover lignin (ACSL) using engineered Ru-HY-60-MI catalyst in a continuous flow reactor. The maximum carbon yield of LJF of 17.9 wt% was obtained, and it comprised of 60.2 wt% monocycloalkanes, and 21.6 wt% polycycloalkanes. Catalyst characterization of Ru-HY-60-MI suggested there was no significant change in HY zeolite structure and its crystallinity after catalyst engineering. Catalyst characterizations performed post the SDHDO experiments indicate presence of carbon and K content in the catalyst. K content presence in the spent catalyst was due to K+ ion was exchanged between lignin solution and HY-60 while carbon presence validated the SDHDO chemistry on the catalyst surface. Tier α fuel property testing indicates that LJF production using SDHDO chemistry can offer SAF with high compatibility, good sealing properties, low emissions, and high energy density for aircraft.

The team also studied on production of cellulosic sugars emerges as a pivotal strategy in advancing biomass bioconversion. They developed a chemical-recovery-free sulfite-based pretreatment technology, which potentially addresses current challenges and decreases the minimum sugar selling price. They evaluated ammonium and/or potassium alkali and salts pretreatment of corn stover and poplar wood to develop comparative data on sugar, lignin, chemicals, and overall mass recovery profiles in batch reactors at various temperature, pH, chemical loading, and solid loading levels. The pretreatments' performance was characterized and the effects of the reaction conditions on overall sugar recovery were determined. New mechanisms and models, particularly in tracking sugars and chemicals, that can explain the different results under different reaction conditions, were investigated in order to optimize the process. The pretreated spent residues, containing ammonium or/and potassium sulfite, biomass-derived organics, and inorganics, showed great potential to be used as a fertilizer replacement while avoiding chemical recovery to aid in applications and advances in

pretreatment technology.

Outcomes and impacts related to Objective C. Use advanced models to provide system level analytics to enable sustainable feedstock supply and conversion technologies.

Alabama

Drs. Adhikari and Khodaei at Aurbun University used modelling approaches to simulate pyrolysis and gasifier in multi-step heterogenous reactions and tar break up. They developed advanced CFD simulations to model hetro/homogenous reactions in the Ansys-Fluent software to model full thermal conversion in different pyrolysis plants.

Dr.Jahromi conducted techno-economic analysis (TEA) and lifecycle assessment (LCA) for the bio-lubricant and methane decomposition processes that he worked on.

Dr, Higgins developed a process model (mass balance and nutrient transformation) and LCA of the algal-bacterial-zooplankton process to upcycle anaerobic digestate nutrients into fish feed. The outcome of this effort is to identify "hot spots" within the system that could benefit the environmental carbon footprint of the facility. The efforts have also identified unit operations that contribute most to losses of nutrients and water.

California

The AES team at UCDavis developed a decision support system (DSS) model for lifecycle techno-economic and environmental assessments to quantify the potential impacts of electricity generation from renewable resources. Biomass resources associated with the extreme tree mortality in California and elsewhere throughout the U.S. and the world currently constitute a primary ecological concern and represent opportunities to increase renewable energy supplies as part of improved management approaches.

They lunched a web-based Forest Resource and Renewable Energy Decision Support System (FRREDSS) to provide site-specific project development guidance on potential feedstock availability as well as estimated economic and environmental performance. This model enables users to assess short- and longer-term feedstock availability and potential economic feasibility and environmental impacts for biopower facilities. The current resource database derived from the USFS national data collection is used for the Sierra Nevada region of California.

The spatial analysis integral to the model yields proximity of feedstock, landings, and road networks, along with estimated delivered costs of feedstock at the facility and overall levelized cost of energy (LCOE) as electricity transmitted to the nearest substation. The spatial analysis includes related attributes, including defined fire hazard zones where wildfire mitigation, particularly within wildland-urban interface areas, may have relevance to project siting. The model provides preliminary information to help inform more detailed engineering, environmental, and other studies critical to the final determination of overall project feasibility and decisions to proceed. The model is flexible toward future enhancements to expand the types of facilities considered, the available resource data and resource uncertainties, and many other factors influencing decision outcomes.

The FRREDSS model is currently being imbedded as part of a larger integrated digital marketplace implementation to add additional and improved local resource quantification and spatial data. This marketplace tool can also extend the lifecycle environmental analysis. Other model enhancements are being developed, including more detailed uncertainty and financial

risk assessment estimates, supply competition analyses, other conversion systems and product types, user-contributed feedstock opportunities, automated (AI) interpreted image processing, and recognition for improved feedstock quantity and property estimation, among others.

Iowa

The AES team at Iowa State University developed technically feasible, economically viable and environmentally sustainable technologies to convert biomass resources into chemicals, energy, and materials. They secured $216,000 funding to perform 2 new or active projects in. One is to assesse CO_2 supply chain Issues for the meat industry in Iowa. Another project is to bridge the gap for more informed and accurate sustainability commitments and progress tracking. The team partnered with industrial partner: miniPCR bio, to have workshops for training Waukee APEX high school students (April) and Iowa high school teachers. They built a corn wet milling LCA model (cradle to plant gate) for the Corn Refiners Association (CRA), which was used by the corn wet milling industry to impove process operations and lower environmental footprints. The team included 6 undergraduate students and 8 graduate students (2 Ph.D., 6 M.S.) in the projects and published 5 peer-reviewed papers in professional journals in FY2023/2024.

Michigan

Dr. Chris Saffron at Michigan State University investigated a decentralized biofuel system consisting of pyrolysis depots to make partially upgraded bio-oil for subsequent hydroprocessing in centralized refineries for hydrocarbon production. It was found that fast pyrolysis bio-oils could be partially upgraded in the depots using electrocatalytic hydrogenation and deoxygenation if powered by renewable electricity. Life cycle assessment indicated how this system could become “carbon negative” when using corn stover as a feedstock.

Missouri

The AES team at University of Missouri aims to doublily increase sustainably aquaculture in Missouri and Midwestern by 2030. They launched an aquaculture extension website. They posted videos and slide-sets of cost-effective seafood production technologies and practices to highlight the opportunities for aquaculture in Missouri and the Midwestern region. These technologies include the development, testing and demonstration of zero-discharge, super-intensive, controlled temperature (indoor) recirculating aquaculture systems, which integrate water quality control and waste treatment. The website can provide useful information to support aquaculture market and business models, etc. They collaborated with the Missouri Soybean Merchandising Council and North Central Regional Aquaculture center to optimize water, land, and energy usage, as well, as cost and resource quantification/reduction. They also evaluated the profitability and environmental sustainability of potential aquaculture industry expansion in Missouri and Midwestern through techno-economic analysis (TEA) and life cycle assessment (LCA).

Nebraska

The AES team at University of Nebraska Lincoln conducted simulation modeling combined with applied statistics facilitates evidence-based decision-making to guide policy analysis. They aim to develop an integrated modeling framework of the Corn-Water-Ethanol-Beef (CWEB) nexus as a tool for decision-making that can also be an educational resource to foster systems thinking. The CWEB also provided an interesting case to study circular bioeconomy. This project centers on a specific case study around a corn-based ethanol biorefinery in Nebraska to analyze the

transition to a more circular system. The simulation can provide insights to discuss what happens if we move one step closer to or away from circularity.

North Dakota

The AES team at North Dakota State University used advanced models to provide system level analytics to enable sustainable feedstock supply and conversion technologies.

Ohio

The AES team conducted TEA and LCA of different agricultural and biobased systems including hydrogen production from lignocellulosic feedstocks, biobased coating obtained from spent coffee ground, alternative feedstock logistics system of emerging crops such as hemp grain and fiber and oilseeds such as camelina, and production of different biofuels and bioproducts.

Pennsylvania

Dr. Juliana Vasco-Correa led another group to design and test a lab-scale solid-state bioreactor to mitigate dilute methane emissions, envisioning a biobased system that can benefit economically from carbon markets. They performed anaerobic digestion of grasses (e.g., prairie, winter rye, corn stover) to gas and tested soil application of the digestates. They started a new project to work on anaerobic co-digestion of ice cream waste. The group published an open-source superstructure-based optimization model to assess emerging routes for lignin valorization with biological upgrading, and a spreadsheet techno-economic analysis of small-scale pelleting to compare centralized pelleting, versus on-farm pelleting in PA, and a preliminary process and techno-economic model for anaerobic co-digestion of grasses in dairy farms.

South Dakota

The AES team developed sensor/biosensors to improve food safety by utilizing biochar and nanocelloses and other biopolymer composites. They established a real-time monitoring crop growth system by integrated AI, image processing, internet of thing (IoT) to improve decision making and production management practices.

Tennessee

Dr. Abdoulmoumine at University of Tennessee integrated decision support modeling tools for identifying suitable areas for miscanthus production and for biorefinery location to co-optimize economic, environmental, and social benefits. He conducted TEA and LCA for the hardwood forest residue depot systems in Tennessee. His research can advance science and engineering knowledge to reduce the commercialization risk of biomass thermochemical conversion technologies and train the next-generation workforce for the coming bioeconomy.

The team also developed nano-particles from lignin to change the surface charge characteristics to allow for preferential binding of targeted molecules, such as CO_2 by combining computational models with analytical tools. They designed several nanoparticles, carbon quantum dots and magnetic nanoparticles, which allow for preferential binding of materials to carbon surfaces. The analytical and computational experiments confirmed that bthe new nanoparticles can improve surface sorption of carbon dioxide, proteins, electrolytes, and pollutants for a host of new applications in medicine, energy, and environmental remediation.

Texas

The TAMU Group incorporated LCA and TEA in all of the projects implemented. They included numerous circular economy concepts in they research projects, such as carbon footprint (CF), carbon capture and sequestration (CCS), and carbon intensity (CI). They followed the ASABE circular bioeconomy principles in their projects implemented. They completed LCA and TEA for the design and development of in-motion pyrolizer attached to a commercial 3-row Zurn corn and sorghum combine.

Virginia

The AES team conducted TEA to evaluate the economic feasibility of converting dried distiller's grain with soluble (DDGS) into antioxidant peptides. The resulting information can guide researchers and producers for technology commercialization.

Washington

The AES team investigated the economic feasibility of individual products for biorefineries using TEA tools. They conducted TEA of cellulosic ethanol biorefinery with coproduction of both PAN/lignin blend-based CFs and PHA using lignin from cellulosic ethanol processes. Cascading of potential products from highest to lowest economic value is required to allocate limited global biomass potentials to preferred products with higher economic feasibility. Therefore, carry out TEAs of individual products for biorefineries have to be compared to each other. Reported economic feasibilities for individual products from a wide range of TEA studies were reviewed, in the context of 1st and 2nd generation biorefineries, to prioritise the allocation of biomass resources to preferred products. Substantial variabilities exist in methodologies and input assumptions to reported TEA results, which affects the comparativeness of individual products. Key factors affecting the economic feasibility of products include feedstock type, composition and cost, plant location, operational time, production scale and process integration strategies. Despite such variability, current reviewed TEAs indicate that chemical, bioplastic and food products such as adipic acid, 1,4-butanediol, citric acid, ethanol, 2,5-furandicarboxylic acid, fructooligosaccharides, glutamic acid, 5-hydroxymethylfurfural, (poly)lactic acid, levulinic acid, polybutylene succinate and succinic acid are preferred options for allocation of limited global biomass resources, considering current technology performances and market prices. Improvements to the prioritisation of bioproducts on a global scale will require a standardised approach for biorefinery TEAs, similar to the requirements for comparison of environmental impacts between different products and associated life cycles. Developments in global agreements, policies, and market-related regulations are likely to continue to alter the economic feasibility of different products, in lieu of their perceived environmental benefits.

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Presentations, abstracts, and/or posters

1) AB Gillmore (presenter), SM Schaeffer**, AF Astner*, SA Sistla, DG. Hayes, Quantitative 1H-NMR spectroscopy to measure PBAT microplastics in soil, American Geophysical Union, San Francisco, 11-15 December 2023

2) Abdulkarim Aldekhail, Lin Wei*, Robiul Islam Rubel, Kasiviswanathan Muthukumarappan. Development Biochar-based Control Release Nitrogen Fertilizers Coated by Polypropylene. Paper #: 230000. ASABE annual meeting, July 9 – 12, 2023. Omaha, Nebraska.

3) Abdulkarim Aldekhail, Lin Wei*, Robiul Islam Rubel, Kasiviswanathan Muthukumarappan. Biochar Based Controlled-Release Nitrogen Fertilizer as An Enhancer. USDA NIFA S1075 multi-state research project annual meeting on July 13 – 14, 2023. Omaha, Nebraska.

4) AF Astner*,**(oral presenter), DG Hayes, TM Young, J Bozell, Predictive Chemometric Analysis for Thermal Properties of Biorefinery Lignins and Characterization Techniques for Lignin-Based Nanoplastics in Environmental Studies, Processing Technologies for the Forest & Biobased Products Industries conference, St. Simons Island, GA, October 30 - November 1, 2023

5) Anne Carolyne Mendonca Cidreira, Lin Wei*, Robiul Islam Rubel. Control nitrogen eutrophication in water from the sources: development and application of biochar-based control release nitrogen fertilizers. South Dakota Water Resource and Water Quality Annual Conference. October 10 – 11, 2023. Brookings, SD 57007.

6) Anne Carolyne Mendonca Cidreira, Lin Wei*, Robiul Islam Rubel. Develop an ethyl cellulose coating material for fabrication of biochar-based controlled release nitrogen fertilizers. USDA NIFA S1075 multi-state research project annual meeting on July 13 – 14, 2023. Omaha, Nebraska.

7) Anne Carolyne Mendonca Cidreira, Lin Wei*, Robiul Islam Rubel. Modeling of N release from coated urea fertilizers in soil environments. Paper #: 230000. ASABE annual meeting, July 9 – 12, 2023. Omaha, Nebraska.

8) Anne Cidreira, Lin Wei*. Enhancing Nitrogen Release Control in Biochar-Based Controlled Release Nitrogen Fertilizers, ASABE annual meeting, July 27 – 31, 2024, Anaheim, California.

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10) Arvelli, S., Liu, M., Chen, G., Weiss, T., Li, Y., Wang, D., Zheng, Y., 2024. Solid state fermentation of corn to make Chinese liquor: effect of corn variety and dynamic microbial community variation. ASABE Annual Meeting, Anaheim, CA, USA.

11) Austin Gluth, Yunqiao (Joseph) Pu, Dehong Hu, Xiaowen Chen, Xiaolu Li, Arthur J. Ragauskas, Tong Zhang, Wei-Jun Qian, and Bin Yang, “A Multipronged Investigation of the Oleaginous Yeast Cutaneotrichosporon oleaginosum Cultivated on Alkali-purified

Lignin" 46th Symposium on Biomaterials, Fuels and Chemicals (SBFC), Washington DC, April 29th, 2024.

12) Barretto, G. Qi, C. Jones, X.S. Sun, Y. Li, J. Griffin, D. Wang. 2023. Hempseed protein is a feasible source for plant protein-based adhesives. American Society of Agricultural and Biological Engineers Annual International Meeting, July 9-12, 2023, Omaha, United State. Paper No. 2300585.

13) Barzee, T. 2023. Anaerobic Digestion of Food and Agriculture Byproducts for Renewable Natural Gas: Trends and Opportunities. Keynote Presentation at the 2023 UK Food Energy Water Nexus Symposium on 12/7/23.

14) Barzee, T. 2023. Assessing Sustainability in Food Systems. Oral, Institute of Food Technologists (IFT) FIRST Annual Event and Expo. Chicago, IL. 5/11/2023

15) Barzee, T. 2023. Bioprocessing of Kentucky Bourbon Stillage to Culinary Mushrooms and Renewable Natural Gas. Presented to the ASABE Annual International Meeting Invited Session on Engineering Perspectives of Circular Bioeconomy in Food and Bioenergy Systems on 7/12/23.

16) Barzee, T. 2023. Food Waste, Upcycling, and Life Cycle Assessment of Food Systems. Presented to University of Tennessee Knoxville Food Systems: Farm to Table Lecture Series on 11/15/23.

17) Barzee, T. 2023. Life Cycle Assessment of Food Systems: Anaerobic Digestion, Food Waste, Methane, and Upcycling. Presented to the Korea University 2023 Sustainable Living Systems Lecture Series on 9/27/23.

18) Barzee, T. 2023. Utilization of Filamentous Fungi for Sustainable Bioproducts and Bioprocesses. Presented to Auburn University Biosystems Engineering Department Seminar Series on 11/30/23.

19) Barzee, T. 2024. Sustainable Bioprocess Engineering: Microbes for the Circular Bioeconomy. Presented to Clemson University Environmental Engineering and Earth Sciences Seminar Series on 2/8/24.

20) Barzee, T. 2024. Sustainable Bourbon Shrooms: Valorization of Distillers Spent Grains Through the Cultivation of Edible Gourmet Mushrooms. Oral, Annual James B. Beam Institute Industry Conference. Lexington, KY 3/13/2024.

21) Barzee, T., Adedeji, A., Schendel, R., Talukdar, S., Oloyede, A. 2024. Development of Novel and Sustainable Cell-Cultivated Foods Through Additive Biomanufacturing. Oral and poster presentations presented to the USDA NIFA A1364 Program Director's Meeting in Amherst, MA on 6/17-18/24.

22) Barzee, T., Annamalai, R. 2024. A Bottom-up Approach for Sustainable Cultivated Meat Production. Presented to the UK IRC Seminar Series on 2/16/24.

23) Barzee, T., Shi, J. 2023. Finding Common Ground in Upgrading Ag Process Byproducts: From Renewable Battery Materials to Stillage Mushrooms. Presented to the 45th Annual Symposium on Biomaterials, Fuels, and Chemicals on 5/1/23.

24) Bradbury, A., Chwatko, M., Ingram, E., Barzee, T. 2023. Purification of Lactic Acid with Ultrafiltration Membranes. Poster, AIChE Annual Meeting, Orlando, FL. 11/6/2023.

25) Brian O'Callahan, Bin Yang, "Cellulose hydrolysis studied by infrared nanospectroscopy" EMSL User Meeting: Visualizing Chemical Processes Across the Environment, Richland, WA, October 5, 2023.

26) Brune, D. E., Aquaculture Intensification and Embodied Resource Utilization, Presentation at American Society of Agricultural and Biological Engineers, Omaha NE. July 2023.

27) Brune, D., E., Advancing Aquaculture in the Midwestern Region, Presentation

28) Brune, D., E., and C. M. Drapcho, Photosynthesis in Enhanced Catfish Production Systems, Presentation at Aquaculture American Symposium, San Antonio Texas, Jan 2024.

29) Brune, D., E., Resource Utilization in Heterotrophic vs Autotrophic Marine Shrimp Production, Presentation to the Florida Shrimp Growers Association, May 2024.

30) C Liu, J Shi, 2024. 46th Symposium on Biotechnology for Fuels & Chemicals, "Exploring ionic liquid tolerant laccases for biological lignin deconstruction", Alexandria, VA (April 29, 2024)

31) Capareda, Sergio C. 2023. Biomass and Energy Development for the Food Manufacturing and Processing Industries. Plenary Speaker for the 2023 Annual Meeting of the Philippine Society of Agricultural and Biosystems Engineers, 34th

32) Capareda, Sergio C. 2023. Science and Engineering for Sustainable Agricultural Development and Transformation. Paper presented at the International Conference on Strategies for Global Food and Nutritional Security, Sustainability and Wellness (NUTRI-2023) held on December 4-6, 2023 at Chaudhary Charan Singh Haryana Agricultural University Hisar (Haryana), India.

33) Capareda, Sergio C. 2024. Waste to Energy (WTE) Conversion Technologies via Fluidized Bed Pyrolysis/Gasification for a Circular Economy. Keynote Speaker at 2024 Annual National Meeting of Korea Institute of Chemical Engineers held on April 24-26, 2024 at Jeju Island, South Korea.

34) Castner, E., & Spang, E. Cow Power: Dairy methane as socioecological fix. American Assocaition of Geographers (AAG), March 23-27, 2023, Denver, CO.

35) Ccorahua, R., Zheng, Y., Wu, W., 2023. Lignin-based bio-triboelectric films for self-powered wearable devices. Materials Research Society, San Francisco, CA, USA.

36) Chen, C., S. Gautam, M. Etesami S. Franck, W. Franck, and C. Lu. 2024. Variations of camelina genotypes in canopy area, biomass, seed yield, and oil concentration under low and high nitrogen environments. First International Camelina Conference. July 19-21, 2024. Lincoln, Nebraska.

37) Chuenchart, W.*, Surendra, K.C., and Khanal, S.K. Application of artificial intelligence in anaerobic co-digestion with microaeration. Poster Presentation. College of Tropical

Agriculture and Human Resources Showcase and Research Symposium (CTAHR SRS 2023), March 27, 2023, University of Hawai'i at Mānoa, Honolulu, Hawai'i , USA.

38) Chuenchart, W.*, Surendra, K.C., Khan, M., and Khanal, S.K. Time series machine learning application in anaerobic co-digestion of food waste and sewage sludge with microaeration. International Conference on Solid Waste 2023: Waste Management in Circular Economy and Climate Resilience (ICSWHK 2023), May 31-June 3, 2023, Wan Chai, Hong Kong, China.

39) Chung, S., Han, Z., and Su, W.W. Bioengineering of Intein-ubiquitin Polyprotein Expression. Summer Undergraduate Research Experience Symposium (SURE 2024), August 2, 2024, University of Hawaii at Manoa, Honolulu, Hawaii, USA (Oral presentation).

40) Conner Pope, Nourredine Abdoulmoumine, and Nicole Labbé. Carbon capture with sustainable adsorbent materials. 2023 AIChE Spring Annual meeting, March 12th - March 16th, 2023, Houston, Texas.

41) Conner Pope, Tawsif Rahman, Gabriel Goenaga Jimenez, Sushil Adhikari, Thomas Zawodzinkski, Nicole Labbé, and Nourredine Abdoulmoumine. Improving Biochar Surface Area for CO2 Adsorption through Potassium Hydroxide Chemical Activation. 2023 AIChE Spring Annual meeting, March 12th - March 16th, 2023, Houston, Texas.

42) D. Wang, XS. Sun. 2023. Lignin-protein interaction and adhesion performance of lignin-protein adhesives. 3rd International Conference on Carbon Chemistry and Materials, October 23-27, 2023, Paris, France

43) D.G. Hayes** (invited), Tracing the Environmental Fate: Microplastics and Nanoplastics from Mulch Films to Agricultural Soil Ecosystems, Department of Bioproducts and Biosystems Engineering, University of Minnesota, Minneapolis, MN, 1 November 2023

44) D.G. Hayes** (invited), Tracing the Environmental Fate: Microplastics and Nanoplastics from Mulch Films to Agricultural Soil Ecosystems, Tennessee Environmental Network, Chattanooga, TN, 15-17 May 2024

45) Doyle, L., Barzee, T. 2023. Production of Mycoprotein Hydrogels for 3D Bioprinting and Cellular Agriculture. Oral (Lightning Talk), American Society of Agricultural and Biological Engineers (ASABE) Annual International Meeting (AIM). Omaha, NE. 7/12/2023.

46) Duduyemi, AS, Okezie, E, Udegbe, F, and Ezeji TC (2023) Improving Product Yield and Reducing Carbon Footprints in Biomanufacturing. The Ohio State University Biomanufacturing Opportunities Workshop, Columbus, Ohio, USA, April 4 – 5, 2023.

47) E. Shrestha, A. Manandhar, A. Shah. 2024. Adsorption of phosphorus from agricultural runoff using hydrochar produced from agricultural wastes. The CFAES Research Forum Poster Competition, April 9, Columbus, OH. [Poster]

48) E. Shrestha, A. Manandhar, A. Shah. 2024. Adsorption of phosphorus from agricultural runoff using hydrochar produced from agricultural wastes. The CFAES Research Forum Poster Competition, April 9, Columbus, OH. [Poster]

49) Edalati, A., Chio, A., Nielsen, I., El-Mashad, H., Chen, Y., Nia, K. S., Barzee, T., Khalsa, S. D. S., Zhang, R. 2023. Production and Application of Compost Products from Dairy Manure and Almond Waste as Soil Amendment on California Almond Orchards. Oral (Lightning Talk), ASABE AIM. Omaha, NE. 7/11/2023.

50) Edalati, A., Chio, A., Nielsen, I., El-Mashad, H., Chen, Y., Nia, K. S., Barzee, T., Zhang, R. 2023. The Impact of an Advanced, Multistage Solid-Liquid Separator System with Centrifuge on Manure Management and Methane Emissions on a California Dairy. Oral (Lightning Talk), ASABE AIM. Omaha, NE. 7/11/2023.

51) Ezeji, TC, Keynote Speaker on "Green chemistry: A case for sustainable production of biofuels from non-food substrates". 2023 International Joint Conference on Environmental Engineering and Biotechnology (CoEEB 2023), Malmo, Sweden, May 19-21, 2023.

52) Fitria, Ad, Adarsh Kumar, Jian Liu, Bin Yang, "Development of sulfonated carbon-based solid acid catalysts derived from biorefinery residues and biomass ash for xylan hydrolysis" ICESTech2023, Bangkok, Thailand, September 5th, 2023.

53) G Lopez, J Shi. 2023 AIChE Annual Meeting, "Variability of sulfur content in loblolly pine residues across age, soil type, and harvest method", Orlando, FL (Nov 7, 2023)

54) Gan, A., Roell, G.W., and Su, W.W. Optimization and Verification of the Genome Scale Model IYLI647. Summer Undergraduate Research Experience Symposium (SURE 2024), August 2, 2024, University of Hawaii at Manoa, Honolulu, Hawaii, USA (Oral presentation).

55) Gyawali, M. and H. K. Atiyeh, " Enhancing Biological Butanol Production with In-Situ Gas Stripping", 3-minute presentation, ASABE Oklahoma Section Annual State Meeting, Oklahoma State University, Stillwater, OK, March 8, 2024.

56) Gyawali, M., Thunuguntla, R. and H. K. Atiyeh, "Effect of Temperature on C4 and C6 alcohol Production by Clostridium muellerianum P21", Robert M. Kerr Food & Agricultural Products Center 2024 Food Science Research Symposium, Stillwater, OK, USA, April 11, 2024.

57) Gyawali, M., Thunuguntla, R., R. S. Tanner, H. K. Atiyeh, "Temperature-Dependent Synthesis of Butanol and Hexanol from C1 Gases by Clostridium muellerianum P21 for Use in Sustainable Aviation Fuel Production", 2nd Annual CEAT Graduate Research Symposium, Stillwater, OK, USA, April 20, 2024.

58) J. Allen*, Y. Yin, Y. Feng, H. Chu, H. Wang, H. Huang. Production of protein concentrates from brewer's spent grain via wet fractionation and enzymatic purification. IFT23 Annual Meeting & Food Expo. Chicago, IL, 2023.

59) Jiansong Chen, Haishun Du, Yi-Cheng Wang, and Xuejun Pan. Chemical functionalized cellulose films for high-performance triboelectric nanogenerators in energy harvesting and self-powered sensing. The 7th International Conference on Nanogenerators and Piezotronics (NGPT 2024), May 19 – 23, 2024, Madison, WI.

60) Jiansong Chen, Zhiqiang Pang, Haishun Du, Xuejun Pan. Cellulose dissolution and regeneration in calcium bromide solution. The 2023 AIChE Annual Meeting, November 5–10, 2023, Orlando, FL.

61) Jinghao Li, Jorge Arrelo, ChengCheng Fei, Xianzhi Meng, Bruce McCarl, Bin Yang, Susie Dai, Arthur J. Ragauskas and Joshua Yuan, "Multi-stream Integrated Biorefinery for Sustainability and Economics" 45th Symposium on Biomaterials, Fuels and Chemicals (SBFC), Portland, OR May 3rd, 2023. "

62) Jinghao Li, Jorge Arreola Vargas, Cheng Hu, Zhihua Liu, Phatchaya Piriyathanasak, Rongchun Shan, Yunyan Wang, Xianzhi Meng, Chengcheng Fei, Bruce McCarl, Bin Yang, Arthur Ragauskas, Susie Dai and Joshua Yuan. "Multi-Stream Integrated Biorefinery for Sustainability and Economics" San Deigo, CA. Oct. 31th, 2024.

63) Kakadellis, S., Muranko, Ż., Harris, Z.M., Spang, E., & Aurisicchio, M. Enabling a circular biodegradable plastic flow through a systems thinking framework. 30th International Symposium on Sustainable Systems and Technology – ISSST, June 13-15, 2023, Fort Collins, CO.

64) Kakadellis, S., Simmons, C.W., & Spang, E.S. Transformative urban agriculture: applying food waste-derived fertilizers in Community Learning Gardens. 31st International Symposium on Sustainable Systems and Technology – ISSST, June 17 - 20, Baltimore, MD.

65) Kawasaki, M., Han, Z., and Su, W.W. Development of a Multiplexed Low-Cost Microfluidic Bioreactor to Study Cell Physiology. Spring Undergraduate Research Experience Symposium (SURE 2024), May 2, 2024, University of Hawaii at Manoa, Honolulu, Hawaii, USA (Oral presentation).

66) Keynote Speaker 2023 & 2024

67) Khan, M.*, Chuenchart, W., Surendra, K.C., and Khanal, S.K. Artificial intelligence-based modeling and optimization of anaerobic co-digestion with micro-aeration. Poster Presentation. S-1075: Science and Engineering for a Biobased Industry and Economy, Research Meeting, July 13-14, 2023, Omaha, NB, USA.

68) Khan, M.*, Chuenchart, W., Surendra, K.C., and Khanal, S.K. Artificial intelligence-based modeling and optimization of anaerobic co-digestion process. Poster Presentation. College of Tropical Agriculture and Human Resources Showcase and Research Symposium (CTAHR SRS 2023), March 27, 2023, University of Hawai'i at Mānoa, Honolulu, Hawai‘i , USA.

69) Khanal, A. Shah. 2024. Techno-economic analysis of camelina production and logistics for hydroprocessed renewable diesel production in the U.S. 2024 ASABE Annual International Meeting, July 28-31, Anaheim, CA. [Oral]

70) Khanal, A. Shah. 2024. Techno-economic analysis of camelina production and logistics for hydroprocessed renewable diesel production in the U.S. 2024 ASABE Annual International Meeting, July 28-31, Anaheim, CA. [Oral]

71) Khanal, A. Shah. 2024. Techno-economic analysis of hemp production, logistics and processing in the U.S. 2024 ASABE Annual International Meeting, July 28-31, Anaheim, CA. [Oral]

72) Khanal, A. Shah. 2024. Techno-economic analysis of hemp production, logistics and processing in the U.S. 2024 ASABE Annual International Meeting, July 28-31, Anaheim, CA. [Oral]

73) Khanal, B.B. Rana, S. Dhakal, J. Wanjura, E. Barnes, A. Shah. 2024. Evaluating feasibility of cotton stalks as solid fuel. The CFAES Annual Research Conference, April 9, Columbus, OH. [Poster]

74) Khanal, B.B. Rana, S. Dhakal, J. Wanjura, E. Barnes, A. Shah. 2024. Evaluating feasibility of cotton stalks as solid fuel. The CFAES Annual Research Conference, April 9, Columbus, OH. [Poster]

75) Kwon, J.S.*, and Khanal, S.K. Optimization of cultivation parameters for R. oligosporus in local agroindustrial wastes for aquafeed application. Poster Presentation. S-1075: Science and Engineering for a Biobased Industry and Economy, Research Meeting, July 13-14, 2023, Omaha, NB, USA.

76) Larrañaga Tapia, M., Ni, K., Kakadellis, S., Simmons, C.W., Tagkopoulos, I., Spang, E.S. Digital Atlas of Food and Agricultural Byproducts in California. 30th International Symposium on Sustainable Systems and Technology – ISSST, June 17-20, Baltimore, MD.

77) Lin Wei*. Development and Application of Smart Fertilizers for Shifting Crop Management from 3D to 4D Model in Precision Agriculture. Paper #: 2301101. ASABE annual meeting, July 9 – 12, 2023. Omaha, Nebraska.

78) Lin Wei*. Systematical Modeling of Crop Growth. Paper #: 2301100. ASABE annual meeting, July 9 – 12, 2023. Omaha, Nebraska.

79) Liu, M., Umeda, I., Wang, J., Kumar, S., Wang, Z.W., Zheng, Y., 2024. Harnessing filamentous fungi and fungal-bacterial co-culture for biological treatment and valorization of hydrothermal liquefaction wastewater. ASABE Annual Meeting, Anaheim, CA, USA.

80) Liu, M., Umeda, I., Wang, J., Kumar, S., Wang, Z.W., Zheng, Y., 2024. A comparative study on the biodegradability of wastewater from hydrothermal liquefaction of corn stover under varied temperature, residence time, and feedstock loading conditions. ASABE Annual Meeting, Anaheim, CA, USA.

81) Lopchan Lama, S.*, Marcelino, K.R., Surendra, K.C., and Khanal, S.K. Biochar and Ultrafine Bubble-Integrated Aquaponic System. 19th International Symposium of Fine Bubble Technology, February 20 – 23, 2024, University of Hawai'i at Mānoa, Honolulu, Hawai‘i , USA.

82) Lopchan Lama, S.*, Marcelino, K.R., Surendra, K.C., and Khanal, S.K. Application of biochar and nanobubble technology in aquaponic system. Poster Presentation. S-1075: Science and Engineering for a Biobased Industry and Economy, Research Meeting, July 13-14, 2023, Omaha, NB, USA.

83) Lopchan Lama, S.*, Marcelino, K.R., Surendra, K.C., and Khanal, S.K. Application of biochar and nanobubble technology in aquaponic system. Poster Presentation. College of Tropical Agriculture and Human Resources Showcase and Research Symposium (CTAHR SRS 2023), March 27, 2023, University of Hawai'i at Mānoa, Honolulu, Hawai‘i , USA.

84) Manandhar, A. Shah. 2024. Life cycle assessment of biobased coating material derived from spent coffee grounds. 2024 ASABE Annual International Meeting, July 28-31, Anaheim, CA. [Oral].

85) Manandhar, A. Shah. 2024. Life cycle assessment of biobased coating material derived from spent coffee grounds. 2024 ASABE Annual International Meeting, July 28-31, Anaheim, CA. [Oral].

86) Manandhar, A. Shah. 2024. Technoeconomic analysis of renewable hydrogen and ethylene production via biological pathway using corn stover. 2024 ASABE Annual International Meeting, July 28-31, Anaheim, CA. [Oral].

87) Manandhar, A. Shah. 2024. Technoeconomic analysis of renewable hydrogen and ethylene production via biological pathway using corn stover. 2024 ASABE Annual International Meeting, July 28-31, Anaheim, CA. [Oral].

88) Manish M. Shreshta, Lin Wei*. Advancing Water Quality Management through Integration of Real-time Nitrogen Sensing and Internet of Thing (IoT) Technologies. South Dakota Water Resource and Water Quality Annual Conference. October 10 – 11, 2023. Brookings, SD 57007.

89) Manish Man Shrestha, Lin Wei*. Develop an activated biochar-based biosensor for detection and monitoring of nitrogen nutrients in water and soil. Paper #: 230000. ASABE annual meeting, July 9 – 12, 2023. Omaha, Nebraska.

90) Manish Man Shrestha, Lin Wei*. Real-Time Monitoring and Management of Soil Moisture in Agriculture using an Azure IoT platform. USDA NIFA S1075 multi-state research project annual meeting on July 13 – 14, 2023. Omaha, Nebraska.

91) Manish Shrestha and Lin Wei*. Advanced Security in IoT Greenhouse Monitoring: Soil and Environmental Analytics with AES and TLS. 2024 ASABE North Central Regional Section Meeting, April 11th, 2024, South Dakota State University, Brookings, SD - 57007.

92) Manish Shrestha and Lin Wei*. Integrate IoT and renewable energy in a crop monitoring system for sustainable smart precision agriculture. ASABE annual meeting, July 27 – 31, 2024, Anaheim, California.

93) Marcelino, K.R.*, Wongkiew, S., Surendra, K.C., and Khanal, S.K. Application of Ultrafine Bubbles in Aquaponic System. 19th International Symposium of Fine Bubble Technology, February 20 – 23, 2024, University of Hawai'i at Mānoa, Honolulu, Hawai‘i , USA.

94) Marcelino, K.R*., Wongkiew, S., Surendra, K.C., and Khanal, S.K. Application of nanobubble technology in floating-raft aquaponics—Updated findings. Poster Presentation. S-1075: Science and Engineering for a Biobased Industry and Economy, Research Meeting, July 13-14, 2023, Omaha, NB, USA.

95) Marcelino, K.R*., Wongkiew, S., Surendra, K.C., and Khanal, S.K. Application of nanobubble technology in floating-raft aquaponics. Poster Presentation. College of Tropical Agriculture and Human Resources Showcase and Research Symposium (CTAHR SRS 2023), March 27, 2023, University of Hawai'i at Mānoa, Honolulu, Hawai‘i , USA.

96) Maruwan, J., Han, Z., and Su, W.W. Rewiring Regulation of Terpenoid Biosynthesis in Yarrowia lipolytica Utilizing Renewable Lipid Feedstocks. College of Tropical Agriculture and Human Resources Showcase and Research Symposium (CTAHR SRS 2024), April 11, 2024, University of Hawaii at Manoa, Honolulu, Hawaii, USA (Oral presentation).

97) Mithlesh and Lin Wei*. Overview the response of soil properties and microbial communities to Biochar based control release fertilizers. USDA NIFA S1075 multi-state research project annual meeting on July 13 – 14, 2023. Omaha, Nebraska.

98) Mithlesh and Lin Wei*. Synergistic effects of integrating biochar-based control release nitrogen fertilizers and deficit irrigation approaches on maize's nitrogen use efficiency and water productivity. South Dakota Water Resource and Water Quality Annual Conference. October 10 – 11, 2023. Brookings, SD 57007.

99) Murphy L., Wang, Y. & Wang J. Systematic evaluation of two genome-scale models for Clostridium tyrobutyricum through knowledge matching, AIChE annual meeting, Nov. 5- 10, Orlando, FL

100) Philippine Agricultural Engineering Week and 9th ASEAN Regional Convention held on April 24-28, 2023, at SMX Mall of Asia, Manila, Philippines

101) R. Barretto, G. Qi, C. Jones, X.S. Sun, D. Wang. 2023. Mechanical and Water Soaking Properties of Switchgrass Composites with Soy Flour Adhesives. American Society of Agricultural and Biological Engineers Annual International Meeting, July 9-12, 2023, Omaha, United State. Paper No. 2300581.

102) Rachel Emerson, Vicki Thompson, and Bin Yang, "Modeling geospatial municipal solid waste generation" 46th Symposium on Biomaterials, Fuels and Chemicals (SBFC), Washington DC, April 29th, 2024.

103) Robiul Islam Rubel, 1Lin Wei*, 1Mithlesh, 2Nidhi Priya, 2Yajun Wu. Effects of varied biochar application rates with organic sources on soil microbial dynamics, nutrient availability, and yield potential of maize. ASABE annual meeting, July 27 – 31, 2024, Anaheim, California.

104) Robiul Islam Rubel, Lin Wei*, Anne C. M. Cidreira, Abdulkarim Aldekhail, Gary Anderson. Production Interference on Microorganism Conservation in Biofertilizer Production from Biowastes. ASABE annual meeting, July 27 – 31, 2024, Anaheim, California.

105) Robiul Islam Rubel, Lin Wei*, Anne Carollyne, Gary Anderson. Process interferences on preserving microorganisms in biofertilizer production from biowastes, STAR Symposium, Monmouth University, 2023

106) Robiul Islam Rubel, Lin Wei*, Anne Carolyne Mendonca Cidreira, Abdulkarim Aldekhail. Experimental study of nitrogen leaching from biochar-based control release nitrogen fertilizer application for improving water quality. South Dakota Water Resource and Water Quality Annual Conference. October 10 – 11, 2023. Brookings, SD 57007.

107) Robiul Islam Rubel, Lin Wei*, Anne Cidreira, Abdulkarim Aldekhail, Process interferences on preserving microorganisms of biofertilizer usable in organic food production, MNIFT poster competition, SDSU, 2023

108) Robiul Islam Rubel, Lin Wei*, Salman Alanazi, Abdulkarim Aldekhail. Effects of coating contents on nitrogen lost through leaching from biochar based controlled release fertilizer particles. Paper #: 230000. ASABE annual meeting, July 9 – 12, 2023. Omaha, Nebraska.

109) Robiul Islam Rubel, Lin Wei*, Yajun Wu*, Abdulkarim Aldekhail, Anne C. M. Cidreira. Effect of biochar based controlled-release nitrogen fertilizer on wheat growth. USDA NIFA S1075 multi-state research project annual meeting on July 13 – 14, 2023. Omaha, Nebraska.

110) Roger Ruan, Jianfei Guo, Yuchuan Wang, Kirk Cobb, Juer Liu, Yanling Cheng, Yuancai Lyu, Peng Peng, Xiangyang Lin. 2024. Catalytic Nitrogen Fixation using Concentrated High Intensity Electric Field (CHIEF) Generated Non-thermal Plasma (NTP). IHI Americas Visit. Minneapolis, Minnesota. February 8, 2024.

111) Roger Ruan, Leilei Dai, Junhui Chen, Juer Liu, Dongjie Chen, Yuchuan Wang, Suman Lata, Jianfei Guo, Frank Liu, Kirk Cobb, Mark Gino Galang, Lu Wang, Ana Beatriz, Cassiano Oliveira, Yanling Cheng, Min Addy, Paul Chen, Hanwu Lei. 2023. Nonthermal Technologies for Gas, Liquid and Solid Wastes Utilization for Sustainable Animal and Food Production and Circular Economy Development. Session 1: Nonthermal Food and Bioprocessing for Circular Economy, 2023 IFT-EFFoST Nonthermal Processing Workshop and Short Course. Minneapolis, MN. October 16, 2023.

112) Roger Ruan, Leilei Dai, Suman Lata, Haotian Fei, Yuchuan Wang, Yuxi Chen, Cassiano Oliveira, Ana Lobo-Moreira, Junhui Chen, Yanling Cheng, Xiangyang Lin, Yunpu Wang, Yuhuan Liu, Kirk Cobb, Fei Yu, Hanwu Lei. 2024. Thermochemical Conversion – Pyrolysis and Gasification - Catalytic microwave-assisted pyrolysis of solid wastes for circular economy development. Guest lecture to BBE 4713/5713. March 15, 2025.

113) Roger Ruan, Leilei Dai, Suman Lata, Haotian Fei, Yuchuan Wang, Yuxi Chen, Cassiano Oliveira, Ana Lobo-Moreira, Junhui Chen, Yanling Cheng, Xiangyang Lin, Yunpu Wang, Yuhuan Liu, Kirk Cobb, Hanwu Lei. 2024. Catalytic microwave-assisted pyrolysis of solid waste for circular economy development. Pennsylvania State University Chemical Engineering Department seminar. State College, PA, February 22, 2024.

114) Roger Ruan, Leilei Dai, Suman Lata, Haotian Fei, Yuxi Chen, Cassiano Oliveira, Yanling Cheng, Xiangyang Lin, Yunpu Wang, Yuhuan Liu, Kirk Cobb, Hanwu Lei. 2024. Catalytic microwave-assisted pyrolysis for sustainable PFAS remediation and waste plastics utilization. Invited speaker of the Division of Catalysis Science and Technology's session on Catalyst Development and Process Integration for Biomass and Waste Derived Fuels and Chemicals at the ACS Spring, New Orleans, LA. March 19, 2024.

115) Roger Ruan, Leilei Dai, Yuchuan Wang, Suman Lata, Juer Liu, Yanling Cheng, Xiangyang Lin, and Hanwu Lei. 2024. Microwave Technology for Solid Waste

Treatment and Aerosol Disinfection. IMPI's 58th Annual Microwave Power Symposium (IMPI 58), invited Plenary Session speaker. Washington, DC. May 30, 2024.

116) Roger Ruan. 2024. Advancing Technologies for A Sustainable Circular Economy. 3M Tech Form Climate Chapter feature speaker. Maplewood, MN. April 22, 2024.

117) Roger Ruan. 2024. Catalytic Microwave-assisted Pyrolysis Technology for Recycling/Upcycling Waste Plastic Packaging Materials and Mixed Packaging Wastes. Circular Processing, Packaging, and Food Loss & Waste Workshop organized by the American Society of Agricultural and Biological Engineers (ASABE) Circular Bioeconomy Systems Institute (CBSI). Chicago, IL. April 24, 2024.

118) Roger Ruan. 2024. Innovative Technologies for Sustainable Circular Economy Development. Putian College seminar. Fujian. January 8, 2024.

119) Roger Ruan. 2024. Nonthermal processing technologies development and applications in food pasteurization. Nanchang University College of Food Science and Engineering seminar. Jiangxi. January 11, 2024.

120) Roger Ruan. 2024. Systematic Intervention for Sustainable Circular Animal and Food Production. Yuexiu Swine Production Company seminar. Guangzhou. January 12, 2024

121) Roger Ruan. Sustainable Dairy and Food Production Technologies and Systems. Yili and Cargill visit. St. Paul, Minnesota. March 8, 2024.

122) S. Alanazi, L. Wei*, R. I. Rubel, K. Muthukumarappan, A. Aldekhail. Effects of water uniformity of a drip irrigation system on crop productivity. Paper #: 230000. ASABE annual meeting, July 9 – 12, 2023. Omaha, Nebraska.

123) Selecting camelina genotypes for higher yield and nitrogen use efficiency. American Society of Agronomy Annual Meeting. Oct. 29-Nov. 1, St. Louis, MO.

124) Shah., A. Khanal. 2023. Alternative harvest and post-harvest logistics for agricultural crops. NABEC 2023, Aug 1, Guelph, ON, Canada. [Oral]

125) Shah., A. Khanal. 2023. Alternative harvest and post-harvest logistics for agricultural crops. NABEC 2023, Aug 1, Guelph, ON, Canada. [Oral]

126) Shitanaka T., Higa, L., Bryson, A., Bertucci, C., VandePol, N., Lucker B., Khanal, S.K., Bonito, G., Du, Z-Y. Flocculation of oleaginous green algae with Mortierella fungi. Poster Presentation. C-Māiki Symposium, December 14, 2023, University of Hawai‘i at Mānoa, Hawai‘i, USA.

127) Shitanaka T.*, Higa, L., Bryson, A., Bertucci, C., VandePol, N., Lucker B., Khanal, S.K., Bonito, G., and Du, Z-Y. Flocculation of oleaginous green algae with Mortierella fungi. Poster Presentation. The International Conference on Algal Biomass, Biofuels, and Bioproducts, June 14, 2023, Waikoloa, Hawai‘i , USA.

128) Shitanaka, T.*, Lowe, L., Marcelino, K.R., Kaur, M., Surendra, K.C., and Khanal, S.K. Harnessing nanobubble technology to alleviate oxygen deficiencies in Schizochytrium culture. Poster Presentation. College of Tropical Agriculture and Human Resources Showcase and Research Symposium (CTAHR SRS 2023), March 27, 2023, University of Hawai'i at Mānoa, Honolulu, Hawai‘i , USA.

129) Shitanaka, T.*, Marcelino, K.R., Kaur, M., Surendra, K.C., and Khanal, S.K. CO2-Ultrafine Bubbles: Mass Transfer and Carbonate Chemistry. 19th International Symposium of Fine Bubble Technology, February 20 – 23, 2024, University of Hawai'i at Mānoa, Honolulu, Hawai‘i , USA.

130) Shiva, Shuaishuai Ma, Austin Gluth, Fitria, Qianwen Lu, Tao Haiying, Xiaowen Chen, J.Y Zhu, and Bin Yang", "A Chemical-Recovery-Free Sulfite-Based Pretreatment of Biomass for Low-Cost Sugar Production" 46th Symposium on Biomaterials, Fuels and Chemicals (SBFC), Washington DC, April 29th, 2024.

131) Stehanie Thibert, Bin Yang, "Demystifying the molecular mechanisms of glycoside hydrolases by glycoproteomics" EMSL User Meeting: Visualizing Chemical Processes Across the Environment, Richland, WA, October 3, 2023.

132) Su, W.W. Biomanufacturing using plant and microbial cell factories – synthetic biology, bioprocessing, and protein engineering. Department of Molecular Biosciences & Bioengineering faculty seminar, March 5, 2024, University of Hawaii at Manoa, Honolulu, Hawaii, USA (Oral presentation).

133) T. Weiss, J. Zhao, R. Hu, M. L. Y. Li, Y. Zheng, G. Smith, D. Wang. 2023. Production of Distilled Spirits using Grain Sorghum through Liquid Fermentation. American Society of Agricultural and Biological Engineers Annual International Meeting, July 9-12, 2023, Omaha, United State. Paper No. 2300337

134) T. Weiss, R. Barretto, G. Chen, S. Hong, Y. Li, Y. Zheng, X.S. Sun, D. Wang. 2023. Effect of Maize Varieties and Yeast Strains on Production of Distilled Spirits using Simultaneous Saccharification and Fermentation. American Society of Agricultural and Biological Engineers Annual International Meeting, July 9-12, 2023, Omaha, United State. Paper No. 2300338

135) Talukdar, S., Barzee, T. 2023. Mathematical Modeling of the Fungal Assisted Immobilization of Microalgae Cells: Impact of Fungal Activity State and Bioreactor Operational Parameters. Oral, ASABE AIM. Omaha, NE. 7/10/2023.

136) Talukdar, S., Barzee, T. 2024. Co-Immobilization of Microalgae and Bacteria with Filamentous Fungi: Mechanistic Insights and New Applications. Oral, ASABE AIM. Anaheim, CA 7/31/24.

137) Talukdar, S., Barzee, T. 2024. Fungal-Assisted Immobilization of Microalgae for Customizable Bioproducts: A Modeling Approach. Oral, International Conference on Algal Biomass, Biofuels, and Bioproducts. Clearwater Beach, FL 6/10/24.

138) Talukdar, S., Islas, Y. C., Roy, K. R., Sarhan, R., Barzee, T. 2024. MyceColors. Oral and Written Pitch Competition for Bioprocess Startups at 2024 ASABE AIM. Anaheim, CA 7/30/24. 3rd Place Winner. Barzee: Faculty Project Mentor.

139) Thunuguntla, R., H.K. Atiyeh, M. S. Chinn and R. S. Tanner, "Unlocking the Potential of Biological CO2 Conversion to Ethanol by Clostridium ragsdalei P11 in Batch and Continuous Operations", ASABE 2024 Annual International Meeting; Anaheim, CA, July 28-31, 2024.

140) Thunuguntla, R., H.K. Atiyeh, R. L. Huhnke and R. S. Tanner, "Biochar-Assisted Acetogenic Conversion of Carbon Dioxide to C2-C6 Alcohols: A Sustainable Solution

for Renewable Fuel Production", 2023 AIChE Annual Meeting, Orlando, FL, November 5-10, 2023.

141) to the NCRAC executive committee, Jan 2024.

142) Tofani, S., Maruwan, J., Han, Z., and Su, W.W. An Improved Degron System for Conditional Protein Degradation. College of Tropical Agriculture and Human Resources Showcase and Research Symposium (CTAHR SRS 2024), April 11, 2024, University of Hawaii at Manoa, Honolulu, Hawaii, USA (Oral presentation).

143) U Abbas, Y Zhang, J Tapia, J Shi, J Chen, Q Shao. 2023 AIChE Annual Meeting, "Machine learning-assisted design of deep eutectic solvents based on uncovered hydrogen bond patterns", Orlando, FL (Nov 7, 2023)

144) Wang, J., Wang, Z., Zheng, Y., Liu, M., Umeda, I., 2024. Biological treatment of hydrothermal liquefaction wastewater from sewage sludge with municipal wastewater activated sludge. Water Environment Federation/International Water Association, Oklahoma City, OK, USA.

145) X. Su*, Q. Jin*, Y. Xu, H. Wang, H. Huang. Subcritical water treatment to modify insoluble dietary fibers from brewer's spent grain for improved functionalities and intestinal fermentability. IFT23 Annual Meeting & Food Expo. Chicago, IL, 2023.

146) Xiaowen Chen, Junyong Zhu, Bin Yang, Shuhua Yuan, Eric Tan, Ryan Davis, Nancy Dowe, Zhihua Jiang, Yudong Li, Jorge Arreola Vargas, Fernando Roberto Paz Cedeno, Carlos Driemeier, and Michael E. Himme, "Production of Low-Cost and Highly Fermentable Sugar from Corn Stover Via Chemical-Recovery-Free Deacetylation and Mechanical Refining (CRF-DMR) Process", 2023 AIChE Annual meeting, Orlando, FL. Nov. 8th, 2023

147) Xiaowen Chen, Junyong Zhu, Bin Yang, Shuhua Yuan, Eric Tan, Ryan Davis, Nancy Dowe, Zhihua Jiang, Yudong Li, Jorge Arreola Vargas, Fernando Roberto Paz Cedeno, Carlos Driemeier, and Michael E. Himme, "Production of Low-Cost and Highly Fermentable Sugar from Corn Stover Via Chemical-Recovery-Free Deacetylation and Mechanical Refining (CRF-DMR) Process", 2023 AIChE Annual meeting, Orlando, FL. Nov. 8th, 2023.

148) Y Yu (presenter), AF Astner*, DG Hayes, M Flury**, Transport of Biodegradable Nanoplastics Affected by Weathering and Proteins in Unsaturated Porous Media, American Geophysical Union, San Francisco, 11-15 December 2023

149) Y Yu (presenter), AF Astner*, TM Zahid, I Chowdhury, DG Hayes, M Flury**, Aggregation Kinetics and Stability of Biodegradable Nanoplastics: Effects of Weathering and Proteins, European Geosciences Union Conference, Vienna, 23–28 April 2023

150) Y Zhang, A Ullah, J Shi. Lignin-based hydrophobic deep eutectic solvents as sustainable extractants, Invited talk at 2023 ACS Midwest and Great Lakes Regional Meeting, St. Charles, MO, (10/29/2023)

151) Y Zhang, U Abbas, Q Shao, R Katahira, X Chen, J Shi. Fractionation of Lignocellulosic Biomass Using Lignin Derived Hydrophobic Deep Eutectic Solvents, Invited talk at the

46th Symposium on Biotechnology for Fuels and Chemicals, Alexandria, VA, (04/30/2024)

152) Y. Wang. Systematic metabolic engineering of Clostridium for fatty acid ester biomanufacturing. The 2nd International Conference on Advanced Biomanufacturing, April 12-15, 2023. Nanjing, China.

153) Ye, X. 2023. Development and engineering of technologies for new oil products. American Oil Chemists" Society, Presentation with abstract at 2023 AOCS Annual Meeting & Expo May 1, 2023, Denver, CO, USA (invited presentation).

154) Zach Johnson, Natalie Sadler, William Chrisler, Hugh D. Mitchell, Bin Yang, Shulin Chen and Pavlo Bohutskyi, "Enrichment and Functional Characterization of A Hyper-thermophilic Lignocellulose Degrading Consortium" 46th Symposium on Biomaterials, Fuels and Chemicals (SBFC), Washington DC, April 29th, 2024.

155) Zhang, Y., Zheng, Y., 2024. Optimizing distilled spirit production from U.S. waxy sorghum: influence of traditional jiuqu types on fermentation and flavor profiles. ASABE Annual Meeting, Anaheim, CA, USA.

156) Zheng, Y., 2023. Biotransformation of crop starches to anticancer compounds and efficacy analysis. The 3rd ICC Asia-Pacific Grain Conference (APGC), Zhengzhou, Henan, China.

157) Zheng, Y., 2023. Lignin bioconversion, materials, and fuels. 2023 Advances in Bioenergy Workshop, Elsevier, online.

Textbook, Book/Chapters

1) Bataller, Butch and Sergio C. Capareda. 2023 Multi-feedstock biorefineries for converting agricultural wastes and microalgae into co-products (Chapter 19, pp. 1-71). In: Developing Circular Agricultural Production Systems (Edited by Prof. Barbara Amon). Scholar One Manuscript, Burleigh Dodds Series in Agricultural Science, BD Publishing, Germany. ISBN-13: 978-1-80-146256-3.

2) Capareda, S. C. 2023. Introduction to Biomass Energy Conversions. 2nd Edition. CRC Press Taylor and Francis Group, Boca Raton, FL. USA. ISBN-978-1-032-27833-9 (hbk); ISBN-978-1-032-27837-7 (pbk); ISBN-978-1-003-29430-6 (ebk); ISBN-978-1-032-27855-1 (eBook+).

Dissertation/Thesis

1) Na Guo. 2023. Biochemical production from engineered Bacillus species. PhD dissertation. University of California Davis

2) Shangjun Wang. 07/2024. Developing Genome Engineering Tools for Engineering Non-model Microorganisms for Biochemical Production and Sustainable Agriculture Applications. PhD dissertation, University of California Davis.

3) Vu Quach, 2024. Dilute gluconic acid pretreatment and fermentation of wheat straw to ethanol. University of California Davis, MS Thesis

4) Sang Li, 2024. “Bioconversion of starch and almond hulls into value-added antioxidant compounds”, PhD Dissertation, Kansas State University.

5) Caleb Metzcar. 2023. Development of Domestic Oleochemicals for Coating Applications. M.S. Thesis University of Kentucky

Collaborations and synergistic activities

1) The investigators at University of California Davis collaborated with the AES teams from University of Arizona, University of Maryland, University of California Berkeley, etc. to advance biological conversion methods for food system residues in agricultural soils to produce biopesticides and improve soil health. They included the development of a new module on formulating recovered food streams to meet compositional targets in the graduate food systems and sustainability course at University of California Davis.

2) The researchers at university of Kentucky collaborated with the AES teams from Iowa State University, Louisiana State University, Purdue University, North Carolina State University, Kansas State University, etc.

3) The researchers at Univeristy of Minnesota collaborated with the investigators at the University of Missouri, Washington State University, Mississippi State University, Stanford University, Berkeley Lab — Lawrence Berkeley National Laboratory, NREL, Resynergi, Quasar Energy Group, Maas Energy. in research and grant writing activities. They continue to work with agencies and companies including Minnesota Metropolitan Council Environment Services, Holistic Health Farms, Forsman Farms, and Minesga.

4) Dr. Xuejun Pan at University of Wisconsin collaborated with Dr. Lisa DeVetter at Washington State University on cellulosic films for mulch application in agriculture.

5) The researchers at Oklahoma State University collaborated with Ohio State University on a project entitled: Development of Clostridium carboxidivorans as a Platform for Butanol Production via Co-Fermentation of Lignocellulosic Biomass.

6) The researchers at Texas A&M University collaborated with Beta Lab assisted, Analytical Chemistry Group, Idaho National Laboratory| Sambandh Bhusan Dhal in developing AI-based characterization of biomasses.

7) The researchers at South Dakota State University collaborated with the AES teams from Mississippi State University, University of Montana, North Dakota State Univeristy, etc. to submit proposals for the RFPs of DOE, USDA, NSF, etc.

8) Collaborating with researchers at Kansas State University to conduct system-level techno-economic analysis for the conversion of DDGS to peptides

9) The researchers at Washington State University collaboration with the AES teams from PNNL, Texas A&M University, University of Tennessee, University of North Dakota, NREL, ORNL, etc.

10) Dr. Simmons at UCDavis joined the UC Agricultural and Natural Resources Fumigant Alternatives Workgroup, which is developing best practices for growers to implement bio-based approaches to pest control in agricultural soils.

11) Dr. Spang at UCDavis was invited to the workshop: After Dark: Growing Green – Open Question: Bioeconomy, Exploratorium, San Francisco, California, 250 Attendees.

https://www.exploratorium.edu/visit/calendar/open-question-bioeconomy

12) The AES team at University of Hawaii hosted the 2023 and 2024 USDA-UHM CRISPR summer workshops and lauched the website: www.dulab.bio.

13) The AES team at Iowa State Uniuversity partnered with miniPCR bio Biotechnology training kits. They offered two workshops for Waukee APEX high school students, Iowa high school teachers, and Corn Refiners Association (CRA) on corn wet milling LCA model (cradle to plant gate) for being used by the corn wet milling industry to impove process operations and lower environmental footprints.

14) The AES team at Unvieristy of Kentucky offered workshops on Life Cycle Assessment for Bioresource Engineering course materials and developed biodiesel production and purification demos in June 2023 and 2024 to annual 4-H Teen Conferences. They also offered of BE-A-STAR and E-Day materials, which engaged with local communities (K-12 students and adult community members). The research on microplastics highlighted by USDA-NIFA's Weekly Digest Bulletin on 2/21/2024 "University Of Kentucky Scientists Develop Eco-Friendly Magnet to Battle Microplastics"

15) The AES team at University of Minnesota hosted the IFT-EFFoST 2023 International Nonthermal Processing Workshop & Short Courses.

16) The AES team Montana State University hosted the Eastern Agricultural Research Center Field Days: July 20, 2023, and June 27, 2024.

17) The researchers at Oklahoma State Unviersity dissiminated the knowledge of co-fermentation process making significant strides in biofuel research, on OSU Headlines News and Media, July 1, 2024.

18) The AES team at University of Illinois offered two workshops were held on corn wet milling to industry representatives. They reached more than 650 representatives from 12 countries. They invited speakers from academia, industry and USDA research labs. More than 100 industry representatives participated in the workshops.

19) The researchers at Virginia Tech had a TV interview that was conducted by CNN International. Dr. Haibo Huang talked about how to convert agricultural and food wastes into high-value products

20) Dr. Xuejun Pan at University of Wisconsin included the ideas, methods, and outcomes of the biomass conversion research in the class BSE 460: Biorefining: Energy and Products from Renewable Resouces for graduate and undergraduate students.