S-1075 Multistate Regional Project

The Science and Engineering for a Biobased Industry and Economy

2021 – 2022 Annual Report

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S1075 Chair for 2021-2022

Executive Summary

The annual report was compiled from individual station reports submitted by station representatives including outcomes and impacts against the S1075 objectives, outputs, impacts, and target audiences. For a detailed description of each individual objective and task, see the project statement available on the NIMSS database website.

Project Objectives & Tasks

The objectives and tasks of the S1075 project are:

OBJECTIVE A. Develop deployable biomass feedstock and supply knowledge, processes and logistics systems that economically deliver timely and sufficient quantities of biomass with predictable specifications to meet efficient handling, storage and conversion process requirements

Task 1: Identify and evaluate biomass type and availability for selected geographic regions based on economic, agronomic, and climate conditions

Task 2: Characterize feedstock physical and chemical properties throughout the supply chain

Task 3: Develop harvest, pre-processing, handling, densification, storage, and transportation methods for specific biomass feedstock end-users

OBJECTIVE B. Research and develop technically feasible, economically viable and environmentally sustainable technologies to convert biomass resources into chemicals, energy, materials in a biorefinery methodology including developing co-products to enable greater commercialization potential

Task 1: Develop and assess technologies to produce valuable products from lipids and residuals from lipid processing

Task 2: Develop and assess technologies to produce valuable products from cereal grains, other starchy crops and food waste

Task 3: Develop and assess biological conversion technologies to produce valuable products from carbohydrates in cellulosic biomass

Task 4: Develop and assess technologies to produce valuable products from lignin

Task 5: Develop and assess thermochemical conversion technologies to produce valuable products from cellulosic biomass

Task 6: Integrate thermochemical and biological conversion processes to produce valuable products from lignocellulosic biomass

OBJECTIVE C. Perform system analysis to support and inform development of sustainable multiple product streams (chemicals, energy, and materials) and use the insights from the systems analysis to guide research and policy decisions

Task 1: Develop system models and data to assess sustainability of integrated conversion platforms

Task 2: Develop integrated system models to configure, analyze and optimize bioenergy and

biofuel production systems

Individual Stations Submitting Reports:

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Outcomes related to Objective A. [Develop deployable biomass feedstock and supply knowledge, processes and logistics systems that economically deliver timely and sufficient quantities of biomass with predictable specifications to meet efficient handling, storage and conversion process requirements]

Minnesota

We continued to develop methods to utilize animal wastewater for production of biomass that can be used as biofuel feedstock and food products. We are taking a closed loop system approach consisting of AD, algae cultivation, and hydroponic cultivation. An ongoing project is to demonstrate a complete system that streamlines all the processes for a continuous operation. We are tackling some technical issues such as high ammonia that can inhibit methane production, high salinity that can potentially hinder algae and vegetable growth. We have gathered data on volatile solid reduction, COD reduction, and biogas production of liquid swine manure after mesophilic AD and worked to optimize further nutrient removal using microalgae. We have also recorded the biomass growth and nutrient removal rates of the hydroponic plants and compared growth rates in treated wastewater to stock nutrients.

Massachusetts

For the thermophilic waste-to-hydrogen conversion project, the student on the project conducted 26 customer discovery interviews to better understand consumer needs to help tailor the direction of our process development.

Montana

During this report period, Chen's program at Montana State University has been working on: 1) industrial hemp variety evaluation for seed oil, protein, and biomass (fiber) production; 2) fertility trial to optimize industrial hemp production with minimal fertilizer input; 3) screening camelina germplasm and select camelina genotypes that have higher nitrogen use efficiency. For hemp variety evaluation, Montana State University participated in the multi-state hemp variety testing project led by University of Kentucky. We have identified a few cultivars that adapted well to Montana's environment, and the identified varieties have been recommended to hemp growers in Montana. The biomass and seed yield, oil and protein concentrations were evaluated. The results will be published in a scientific journal. The protein functionality was studied by collaboration with Dr. Haibo Huang's lab in Virginia Tech, and the results were published in Journal of Food Science. Since nitrogen fertilizer is the biggest energy input for bio-based feedstock production, Chen's group at Montana State University is conducting fertility study to optimize the fertilizer inputs for industrial hemp and camelina production. At the meantime, we are selecting camelina genotypes that can grow well and produce high yield and high oil concentration under low nitrogen environment. The results are very promising. We have identified a few camelina genotypes that performed superior in low nitrogen regime. The results have been presented at the DOE biomass research conference and American Society of Agronomy meeting in 2021.

North Dakota

"Forage economics calculator web tool: Economic analysis of forage production and logistics is critical for sustaining the agricultural enterprise and evaluating the associated risks. The economic analysis aids in making an educated decision related to growing or buying forage, setting forage prices, and purchasing additional equipment. Manual calculation of economics is highly complex, tedious, and time-consuming. Therefore, a multi-device web-based tool called the ""forage economics calculator web tool"" (FECWT) was developed using HTML, CSS, and JavaScript. The tool's interface was designed for a user-friendly experience with easy access to commands set in an easy-to-follow layout. The FECWT uses 29 input variables to generate results ""dynamically"" for 37 output variables, based either on the supplied default data or with user-provided inputs (imperial or metric units). Bale collection logistics is performed using either a tractor; or a tractor pulling an “automatic bale picker” (ABP), which collects and transports multiple bales in a trip. The economic analysis outputs include net return, break-even ratio, payback

period, and return on investment. Features of FECWT include the sensitivity of profit to changes in input values and downloadable reports and charts for record-keeping. Potential users of this web tool include farmers, hay producers, custom hay operators, educators, agricultural extension and financial personnel, and others interested in the economics of handling bales.

Systematic literature review on forage growth models, predictions, economics, and tools: Even though numerous individual studies on forage growth, models, predictions, economics, tools were available, a comprehensive review of forage growth prediction and economic analysis tools was not available. Therefore, a systematic literature review (SLR) was performed to establish comprehensive knowledge and identify research gaps in this knowledge domain to serve better the stakeholders. The input features (vegetation index (VI), climate, and soil), various models (regression and ML), and relevant tools for grass and forage prediction and tools developed for forage economic analysis were analyzed. Based on the search criteria and from the three publication databases, we retrieved 147 relevant peer-reviewed manuscripts of the current period (2010 - 2021), of which only 85 were screened after applying exclusion criteria for further analysis and reporting. The most frequently used remote sensing satellite platform was MODIS based on the review. The most commonly used input features were normalized difference vegetation index (NDVI), precipitation, and soil moisture. Among the ML models for forage yield was the "random forest." Four existing tools use inputs such as precipitation, evapotranspiration, and NDVI available for larger-scale grass and forage prediction and monitoring. Most tools available for forage economic analysis were spreadsheet-based and focused on alfalfa. Suggestions for future research in this knowledge domain include the use of high-resolution satellites, combined VI and climate features, advanced ML models, development of field-specific prediction, and development of interactive, user-friendly, web-based tools and smartphone applications in this knowledge domain.

Ohio

We are currently analyzing the alternative methods for improving the logistics of feedstock (lignocellulosic and oilseeds) for biobased industries.

Pennsylvania

Co-PI, Tom Richard: In support of Objective A, continued research modeling feedstock production and harvesting strategies that spatially identify and efficiently manage economically marginal subfield areas. We posted on the web results for our high resolution biophysical and economic model to identify unprofitable areas and identified market pathways to profitably convert this land to perennial biomass production. We continue characterize risks associated with feedstock and supply chain uncertainties along the value chain.

Co-PI, Jude Liu: Continued working on the Mid-Atlantic Sustainable Biomass Consortium for Value-Added Products (MASbio, USDA-NIFA) project. Worked on biomass harvesting mechanical and field efficiency.

Co-PI, Hojae Yi: Started a project to develop a test device (Forest Concepts Cubical Triaxial Tester; fcCTT) and protocols to quantify the flow behavior of milled biomass as a bulk solid. This study focuses on the gravity hopper flow and gained quantitative knowledge on the flow characteristics of milled corn stover and fuel-grade clean pine chips. Using the developed instrument and protocols, we successfully predicted the mass and core flow behavior of respective milled biomass. In another project, we also developed a device (Interparticle Mechanical Tester) and protocols to quantify the friction and adhesion between biomass particles to elucidate the origin of bulk flow behavior at the particle level. Using the developed device and protocols, we have been determining friction coefficients and adhesion forces between corn stover and southern pine residue particles of different anatomical origins. These two biomass feedstocks are of the largest agricultural and forest residual materials that have a great potential to be a sustainable bio-based renewable resources. We are investigating the magnitude and origin of variability in flow behavior of those milled biomass feedstocks.

Tennessee

Dr. Abdoulmoumine developed a machine learning model that, after sufficient training, can predict when clogging will start in biomass screw conveyors using the motor current and the conveyor vibration signatures coupled with the biomass characteristics.

Dr. Womac oversaw the development of scaled models of switchgrass (SG) modules constructed in a cotton module builder and loaded using module loader technology. Use of a 122-cm long model, compared to 978-cm long prototype, reduced the required mass of module contents from 6188 to 44 kg. Seed cotton [8% moisture wet basis (w.b.)] bulk densities for prototype and model were 166 and 107 kg m-3, respectively. Bulk densities for switchgrass (8% w.b.) prototype and model were 115 and 81 kg m-3, respectively. Reduced bulk density of models was attributed to the reduced scale of confinement stresses due to reduced module content over-burden. Mean dry bulk density slightly increased with reduced SG particle size spectra, and surprisingly increased with increased narrowness of the SG spectrum from a forage harvester. Results suggested that modules should be constructed using increased numbers of fill layers with uniform tamping of each layer with at least no skips in progressive tamper action. Overall, 33 of the 48 test modules exhibited integrity failures at a rate of 69% failures. Results suggested that SG modules should be made with coarse particle sizes, even coarser than those tested.

Dr. Hayes showed that the performance of a plastic mulch film prepared from a blend of the biopolymers polylactic acid and polyhydroxyalkanoate is equally as effective as commercially available biodegradable mulch films to produce vegetables and specialty crops. The mulch film serves as an effective barrier to weeds and is biodegradable when tested according to standardized testing methods."

Texas

The TAMU Group embarked on developing logistics for biobased landfill wastes for conversion via pyrolysis. TAMU developed specific recipe for landfill wastes to ensure sustainability of conversion. This recipe comprised yard wastes, paper and wood wastes and other agricultural biomass waste and processing into high density pellets with consistent properties. They have developed a quick method of assessing feedstock properties using the spectral response coupled with principal component analyses (PCA). Hence, conversion facilities can vary process control system in real time as feedstock enters conversion facility.

Washington

Our team, including researchers from national labs with substantial experience and expertise in renewable energy and AI, will execute this project. Various identification technologies have been proven to work individually and previous research exists for their use with MSW. These technologies have not been combined in an effort to characterize the highly variable MSW streams. Although blending these technologies to work as a combined unit will take significant time and effort, it is not a matter of if this can be accomplished; it is a matter of when. The goal of the project is to demonstrate that MSW residues can be cost effectively characterized and selectively separated as feedstocks for biofuels production via an artificial intelligence-assisted approach.

Wisconsin

A research project has continued to develop a single-pass, weather independent fractionation technology for corn stover was completed to demonstrate the ability to fractionate stover and grain after harvest from silage. This research if successful will enable corn grain/biomass biorefineries. Machine Learning and AI research has been completed on biomass logistics (yield and field path planning). These techniques lower logistical costs for biomass harvesting.

Outcomes related to Objective B. [Research and develop technically feasible, economically viable and environmentally sustainable technologies to convert biomass resources into

chemicals, energy, materials in a biorefinery methodology including developing co-products to enable greater commercialization potential.]

Alabama

We have several projects for the investigation and development of sustainable technologies for the conversion of biomass to bioenergy and biochemicals.

1) In one project supported by DOE, Dr. Yi Wang's lab is engineering Clostridium strains for fatty acid ester production. Then the fatty acid esters produced using the engineered strain from corn stover hydrolysates will be evaluated as a bioblendstock for diesel fuel. In the past year, Dr. Wang's lab engineered a train that could produce butyl acetate up to 32 g/L, which is highest that has ever been report for microbial production fatty acid ester, and >3,000 times higher than the previously reported.

2) Brendan Higgins has developed an algal-bacterial process for the treatment of anaerobic digestate and conversion of the nutrients into algae. These algae are then fed to zooplankton to create a natural, protein-rich fish feed. This system directly recycles nutrients from agricultural wastes back into the food production system. This project was funded in May of 2020 by NIFA. In the past year, one paper was published on this topic related to adapting a native consortium of algae to pretreated full strength anaerobic digestate. A second meta-analysis of algal growth on anaerobic digestate is under review.

3) B. Higgins is developing (in collaboration with others) an algal-bacterial process to treat poultry processing wastewater so that it is safe to use in hydroponic irrigation. Nutrients in this wastewater are partially sequestered by algae, generated a small biomass stream for potential valorization. However, most nutrients are used by plant crops. This project was funded in January of 2021 by NIFA. We have constructed a pilot scale system and used water from this system to grow a batch of hydroponic lettuce.

4) B. Higgins is the PI (with Sushil Adhikari as the Co-PI) of a recently-funded NSF REU site focused on converting biological waste materials into products of value. We successfully recruited our first cohort of students and all 10 of them are nearing completion of their summer program.

5) B. Higgins is the PI on a recently-funded NSF grant (Environmental Sustainability Program) to study algal integration into coupled and decoupled aquaponics systems. This project also involves operation of research aquaponics in regional high schools as well as systems operated at Auburn University. We will study the impacts of algae on nitrification, pathogen levels, and product quantity and quality. The grant is 3 years and the budget is $575,728.

6) Dr. Sushil Adhikari is developing a process for production advanced liquid transportation fuels from co-liquefaction of forest biomass and waste plastics. This project is funded by Alabama Department of Economic and Community Affairs (ADECA). The goal is to advance economic development in the state and nationally through reinvigoration of natural resource-based industries and to establish new industries based on advanced liquid fuels from woody biomass grown in the state and the waste plastics collected from cities. Woody biomass prevalent in Alabama will be co-liquefied with waste plastics using a pyrolysis technology, which will then be subjected to hydrogen treatment to produce jet and diesel fuels.

California

Research was conducted to produce polyhydroxyalkanoates (PHA) from cheese processing byproduct by using Haloferax mediterranei. The results of techno-economic analysis study indicate that utilizing dairy derived feedstocks has the potential to make PHA competitive in the bioplastic market, which could be beneficial to both dairy and bioplastic industries. The experimental research was carried out to test continuous reactor for cell cultivation and membrane filtration of fermentation broth for cell separation and harvesting. The results showed promise of achieving competitive yields, high PHA content, and high cell mass density. The results help answer key biotechnical and process engineering questions that can help commercialize the PHA process and add an additional revenue stream to the dairy industry.

Additionally, initial LCA analysis demonstrated that the proposed PHA production process can result in decreasing CO2 emissions and can even result in negative carbon emissions if the dairy byproduct is being disposed of by landfill.

Research was conducted on the conversion of almond hulls to protein-enriched fermentation residue by supplementing nutrients and fungal spores. Fungi will consume most of the free sugars and the carbohydrate fibers (cellulose, hemicellulose, and pectin) contained in the hulls to produce more fungal biomass, which contains 40-50% crude protein. After screening various fungi, M. thermophila was identified as the optimal fungi for protein production capable of producing fermentation residues with a maximum crude protein content of 18.10%. The fermentation residue had a good in vitro digestibility, composition, and complete amino acid profile. Therefore, the M. thermophila fermentation residue could potentially serve as a protein-rich supplement for poultry feed supplements.

Hawaii

Khanal's Lab has been working on the use of black soldier flies (BSF) to convert organic wastes including food wastes and agri-residues into BSF larvae for both animal feed and biodiesel production. We have been successful in maintaining native colony of BSF, developing effective mating chamber and producing larvae on diverse organic wastes/residues. We are currently working on process automation and scale-up, with a goal of developing zero waste insect-based biorefinery for valorization of waste and biofuel production.

Khanal's Lab has also been working on innovative anaerobic digestion (AD) biorefinery for highly complex feedstocks. The AD biorefinery concept have been developed using lignocellulosic feedstock to convert hemicellulose into biogas and cellulose and lignin into multiple products via thermochemical conversion. In another AD research, Khanal's Lab has employed ORP-based microaeration for anaerobic digestion/co-digestion of agri-residues, sewage sludge and food wastes. By combining reactor performance results, mass balance analyses, microbial community characterization data, and bioenergetics evaluation, an alternative pathway of volatile fatty acids conversion through synergistic association of anaerobic and facultative microorganisms, bypassing syntrophic reactions typically found in anaerobic digestion processes, has been demonstrated. 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.

Khanal's Lab continues to work on nitrogen transformations in aquaponics with nanobubble technology. Our study examines nitrogen utilization efficiency (NUE) under different hydraulic loading conditions, and pathways of nitrogen transformations via nitrogen-stable isotope and microbial community analyses. This study also looks at nitrous oxide (N2O), a highly potent greenhouse gas emission, and its subsequent contribution to global climate change. We have further expanded this research to incorporate nanobubbles technology to improve the productivity of fish and organic produce, and bioponics to include organic wastes as a nutrient source for food production.

Su Lab investigated conversion of lipid-based feedstock to terpene-based specialty chemicals using bioengineered oleaginous yeast Yarrowia lipolytica. Synthetic biology and systems biology approaches are used to investigate and improve production of acetyl-coA derived oleochemicals, using astaxanthin as a model. The investigation resulted in development of novel temporal control of metabolic pathways, leading to improved astaxanthin production. This research will greatly advance our ability to use yeast biorefinery to produce high-value oleochemicals from abundant and underutilized lipid feedstocks. Su lab also investigated the use of genome editing to improve yeast nutritional values. In an effort to achieve cost-effective microbial conversion of locally sourced carbon feedstocks in decentralized smaller-scale biorefineries, Su lab developed a novel low-cost bioreactor. The microprocessor-controlled bioreactor is made using only inexpensive off-the-shelf components. The reactor was characterized for oxygen transfer and mixing using kla and mixing-time measurements, respectively. Batch cultivation of an engineered astaxanthin-producing Yarrowia lipolytica yeast in a culled-papaya juice-based medium was successfully

achieved in the novel bioreactor under dissolved oxygen control. An important advantage of the novel bioreactor design stems from its simplicity, so it is amenable to operation even by low-skilled workers, and requires very low cost to set up and operate.

Du lab works on the lipid metabolism in photosynthetic organisms including plants and microalgae, as well as lipid biosynthesis and turnover in soil fungi and bacteria. A particular interest of the Du lab is to under the dynamic of the membrane and storage lipids and the role of lipid metabolism in development and stress response. Du lab is also interested in using 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 in Du lab is to develop research instruments such as environmental photobioreactors for algae incubation.

Illinois

Glucose and xylose are the major sugars present in cellulosic hydrolysates. The cellulosic sugars can be used for the production of platform chemicals. In this study, productions of lipid and ethanol by yeasts were compared for concentrated bioenergy sorghum syrup. Bioenergy sorghum was hydrothermally pretreated at 50% w/w solids in a continuous industrial reactor and sequentially mechanically refined using a burr mill to improve biomass accessibility for hydrolysis. Fed-batch enzymatic hydrolysis was conducted with 50% w/v solids loading and cellulase cocktail (50 FPU/g biomass) to achieve 230 g/L sugar concentration. Various strains of Rhodosporidium toruloides were evaluated for converting sugars into lipids, and strain Y-6987 had the highest lipid titer (9.2 g/L). The lipid titer was improved to 19.0 g/L by implementing a two-stage culture scheme, where the first stage was optimized for yeast growth and the second for lipid production. For ethanol production, the engineered Saccharomyces cerevisiae SR8ADH6 was utilized to coferment glucose and xylose. Ethanol fermentation was optimized for media nutrients (YP, YNB/urea, and urea), cellulosic sugar concentration, and sulfite conditioning to maximize the ethanol concentration from sorghum syrups. Fermentation of 70% v/v concentrated hydrolysate conditioned with sulfite produces 50.1 g/L ethanol from 141 g/L of sugars.

Iowa

"The effects of grain moisture content and roller mill gap size on various

physical properties of yellow dent corn flour were investigated. The particle sizes obtained were between 0.54 mm and 0.75 mm, and increased with an increase in both moisture and gap size. The white/black and yellow/blue color scores of the resulting flours were not affected by the different levels of moisture or gap, but they did impact red/green scores.

High power sonication (HPS) was investigated as a means to improve the production of soy protein isolates. The protein isolate yield increased by ~14% and ~ 20% after HPS of 720 J/mL to flakes and 180 J/mL to flour, respectively. HPS also increased the protein isolate yield significantly during room temperature extraction.

Kansas

We improved wet adhesion of plant protein-based adhesives through protein modification using depolymerized lignin and polyamide-epichlorohydrin (PAE). We conducted research on development of affordable, biodegradable, durable, disposable containers for food service utilizing biomass and biorefinary by-products. We also developed the technologies to convert cellulosic biomass and waste materials into biofuels and chemicals with improved yield and efficiency, technologies to treat and valorize the black liquor and hydrothermal liquefaction wastewater for value-added products, and technology for lignin-based 3D printed wearable triboelectric nanogenerators for personal health monitoring. 18 peer-reviewed journal articles were published. 9 meeting presentation and invited presentation were delivered. 1 patent issued. Three invited presentations were delivered in the international conferences.

Kentucky

1) Developing lignin-based super absorbent polymers (hydrogels) for soil water management and as a carrier for Rhizobium: This study focused on the development and application of lignin-based hydrogels as sustainable soil amendments. We also explored the development of pedotransfer transfer functions (PTFs) for predicting saturated hydraulic conductivity using statistical and machine learning methods with a publicly available large data set. Hydrogel treatment significantly increased water retention, decreased saturated hydraulic conductivity, while increased unsaturated hydraulic conductivity. New PTFs developed using random forest regression and gradient boosted regression of a large public database gave the best performances on the validation data set. The concentration of lignin-alginate hydrogel added to Rhizobial cell culture did not affect cell survival while the presence of starch in the lignin-alginate beads increased the survival of Rhizobium cells.

2) Storage and valorization of hemp hulls and floral material for long term stability and feed supplement applications: The current hemp industry is based on the production of essential oil that is extracted from the floral material of the crop. Essential Oil processors often deal with low density non-uniform feedstocks. By pelleting the hemp floral material, the increased bulk density and uniform shape would increase the operational range of extraction facilities and lead to automated handling. The goal of this project is to determine the ideal moisture content for the pelleting process by examining pellet features: PDI (pellet durability index), compressibility, uniformity, energy consumption, bulk density, equilibrium moisture content, angle of repose, and retention of chemical compounds during long term storage.

3) Valorization of spent grain from Kentucky bourbon industry: We have worked on multiple projects to valorize the spent grain from Kentucky bourbon industry. Such efforts include physiochemical characteristics and distillation parameters on the biomethane potential of bourbon Stillage, volatile fatty acids (VFAs) production from dark fermentation, and in-situ conversion of VFAs to extractable esters in aqueous solutions.

4) Extraction of micro- and nano-plastic particles from water using hydrophobic natural deep eutectic solvents (NADES): Hydrophobic NADES derived from natural compounds show promise as extractants in liquid-liquid extractions. This study investigated the extraction efficiency of micro- and nano-plastics including polyethylene terephthalate (PET), polystyrene (PS), and a bioplastic polylactic acid (PLA) from fresh water and saltwater using three hydrophobic NADES. Molecular simulations showed a relation between the extraction efficiency and the association between the plastics and NADES molecules. This study demonstrates the potential of hydrophobic NADES as extractants for removal of different micro- and nano-plastic particles from aqueous solutions. In additional, a class of novel lignin derived hydrophobic NADESs were synthesized, characterized, and successfully applied them to extract biofuel molecules including acetone, ethanol, n-butanol, and isopentanol from aqueous solution.

Massachusetts

Three topic areas are covered under Objective B:

1) For the thermophilic waste-to-hydrogen conversion project, experiments were conducted to determine how best to optimize the process and avoid hydrogen-to-formate conversion during the process. Analytical techniques such as bioreactor parameters and HPLC and enzyme activity analyses were optimized.

2) Research on marine invertebrate (shipworm) digestion of wood is leading to new findings on previously unknown mechanisms these organisms use to deconstruct lignocellulose. These findings help explain how shipworms circumvent the lignin barrier in the digestion of wood.

3) In fungal biodegradation research, exploration of mechanisms used by wood decay fungi to deconstruct lignocellulose suggests that these fungi have a means to maintain an effective extracellular matrix for both regulation of pH and the passage of extracellular enzymes. Since considerable biorefinery

research has focused on the use of microbial enzymes, the mechanism by which the diffusion of those enzymes is controlled once secreted from microorganisms should be of critical interest to those in the field. These discoveries in marine organisms and in fungi may lead to novel tools that can aid the sustainable conversion of biomass to useful platform chemicals.

In related research related to 2 and 3 above, discovery of a chelator-mediated Fenton (CMF) mechanism, activated by fungi that cause "grapevine trunk disease" has allowed the development of two systems that have shown promise in the laboratory for controlling this multi-Billion-dollar disease complex.

Additionally, as related to 2 and 3 above, research on the CMF mechanism for the deconstruction of wood by decay fungi has led to the discovery of a new mechanism that explains how low levels of carcinogenic formaldehyde can be released from wood, via simple contamination of wood with iron residues from the environment.

Michigan

Engineering Tools for Modeling of Polar Fluids (Lira). Work focused on application of spectroscopy for characterizing association of ethanol and alcohols in fuels and hydrocarbons. Association is present in almost all bio-derived liquids. Collaboration continued with Pacific Northwest National Laboratory and the National Renewable Energy Laboratory on enhanced understanding of the role of association of alcohol in fuels. Electrocatalytic hydrogenation (ECH) (Saffron). Continued work on biomass pyrolysis oil and lignin-derived bio-oils revealed that diaryl ethers undergo electrocatalytic hydrogenolysis (ECH) over skeletal Ni cathodes. ECH is a mild, aqueous process that achieves direct C-O cleavage without initial benzene ring saturation. This technique is useful towards upgrading the products of biomass pyrolysis, as it can saturate carbon-carbon, carbon-oxygen, and aromatic pi bonds. The product mixture is more stable during storage and less likely to corrode metal container surfaces.

Minnesota

We continue to improve microwave assisted gasification and pyrolysis. We developed a series of ZSM-5 zeolites with differential surface acid density and pore structure to illustrate the relationship between catalyst structure and catalytic performance for waste plastic cracking. The relationship between Brønsted acid site density and catalyst lifetime displays a tendency that catalyst lifetime declines with acid site density at the beginning, then rises up later, instead of a linear correlation. Also, the increase of mesoporosity extends the catalyst lifetime to some extent. Based on this, a hierarchically micro-meso-macropore high silica ZSM-5 was designed and synthesized. The lifetime improvement by using the well-developed hierarchical ZSM-5 can be rationalized based on the more open channels that promote the diffusion of reaction intermediates and the increase of Brønsted acid sites that catalyze the cracking reactions. The economic and life cycle assessments showed that the waste plastic-to-naphtha route can improve the environmental benefits of plastic recycling, with a great economic potential. These outcomes highlight the potential of creating a plastic circular economy and will move the technology closer to commercial implementation.

Missouri

1) Enhanced photosynthetic techniques such as Partitioned Aquaculture Systems (PAS) and Split-Ponds allow 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/m2-d. Productivity exceeding sustainable algal growth capacity requires culture systems utilizing nitrifying and/or heterotrophic microbial growth to keep pace with nitrogen loading at feeding rates exceeding 600–800 lb/ac-d. In spite of intense energy usage and elevated feeding rates, super-intensive aquaculture offers the potential to provide sustainable seafood production in terms of energy and water requirements per unit of aquatic biomass produced. Integrated super-intensive systems, harvesting and converting microbial biomass used to maintain water quality can provide valuable by-products, while simultaneously reducing, or eliminating, water or waste discharge to the environment.

2) Conducted research on biomass conversion and biorefining with cost effectiveness and eco friendliness. The main research activities included production of biodegradable polyester polymers (i.e., polyhydroxyalkonates) from dairy processing wastes and lignocellulosic biomass, designed green deep eutectic solvent systems for improving digestibility of cellulose pulp and lignin valorization, and developed direct laser writing process for transforming lignin into graphene-based materials for energy storage and ultrasensitive sensing applications.

North Dakota

Canola meal has limited utilization in feed and food applications because of the presence of antinutritional factors and a high fiber content. Thus, the present study used 3-day canola seed sprouting followed by hull removal to improve the nutritional quality of canola as a feed and food ingredient to further enhance and diversify the canola market. Seed sprouting and the hull removal process resulted in 63.2% sprouts, 29.3% mix fractions (MF) (hulls, ungerminated seed, and delayed sprouts) and 8.1% mass loss during sprouting. Fresh sprouts and MF were dried, ground and defatted to compare the obtained meals and oils with their counterparts of raw seed. Defatted sprouts (DFSP) resulted in a 46.2% reduction in crude fiber, a 34.3% reduction in acid detergent fiber and a 43.4% reduction in neutral detergent fiber compared to defatted raw seed (DFSE). DFSP provided a 10.1% higher protein content and a 5.9% increase in total amino acid content with higher essential amino acids compared to DFSE. Total carbohydrate was lowered by 5.5%, phytic acid content was lowered by 25.9%, and ash content was lowered by 5.5% in DFSP, whereas total glucosinolate content was higher in DFSP (13.1 μmol g−1) than in DFSE (8.8 μmol g−1). Sprouts and MF showed an oil content of 38.4% and 9.6%, respectively, compared to raw seed (34.5%).Sprouting and hull removal of canola seed can potentially provide nutritive meal for food and feed applications.

Increasing food production to meet the growing population depends on availability of health soil and organic fertilizer. This has spur efforts to develop organic fertilizer and biofertilizers most especial to reduce the 2% global carbon foot print resulting from current fertilizer production plants. This research is a paradigm shift to produce organic ammonia – an essential composition of fertilizer - via bioprocessing that require less energy and making use of renewable resources. We have successfully mimicked and improved the natural process to produce ammonia on a laboratory scale. Our findings reveal the need for bioresource pre-processing (isolation and hydrolysis) to enhance green ammonia production. The success informs conducting upscaling research in this proposal. Green ammonia upscaling will require to objectives including substrate and process optimization. The breakthrough in this research will provide the needed push towards the production of organic ammonia at industrial level.

Conventional plastic bale net wraps are dangerous for animals. While eating bale grass, farm animals usually consume the plastic wrap which clog their stomach and become severely ill and mostly lead to their death. The loss of farm animal amount to about $150 million annual loss to farmers. The toxicity of bale-net wrap has called for the development of edible alternative. We have developed edible corn-based films as an alternative bale-net wrap. Different plasticizers of varying molecular weight (xylitol, sorbitol, and glycerol) have been added to native and debranched starch polymers. Debranching cornstarch increased their elongation at the breaking point. Corn starch is the main composition of the corn-based films. However, starch easily drying out in hot-low humidity condition or absorb in cool-high humidity condition. This water challenge makes starch corn-based films prone to damage challenging their suitability for outside use. In order for ND corn producer to benefit from $250 million biomaterial annual value, the corn-based film should be water resistance.

Magnetic nanobiocatalysts (MNBCs) are a promising immobilization approach to ease enzyme recovery during bioprocessing. However, industrial adoption of MNBCs is unfeasible because MNBC-synthesis involves complex and potentially expensive processing steps including synthesis of silica-coated superparamagnetic iron oxide nanoparticles (Si-SPIONs). We developed a single-step process for Si-SPION synthesis using a tubular electrochemical system (TES) and investigated the effect of

concentration of the Na2SiO3 coating agent on Si-SPION properties. The Si-SPIONs were used as a support for attachment of polymer-cellulase conjugate to make MNBCs. The spherical Si-SPIONs were 8–12 nm in diameter including a 2-nm silica coating. Na2SiO3 concentration in the reactor did not affect Si-SPION morphology, but increasing Na2SiO3 concentration reduced SPION productivity in the reactor. Protective properties of the SPION silica coatings were demonstrated by showing that they prevented dissolution of SPIONs in an acid solution for 48 h. Enzyme attachment was quantified as protein adsorption on Si-SPIONs which reached 55 μg/mg Si-SPION. The MNBCs were recovered and reused four times. The use of TES for Si-SPION synthesis is promising to reduce MNBC production complexity.

Ohio

Our focus was on waste valorization, primarily through hydrothermal carbonization (HTC) of the high moisture waste to produce hydrochar, as well as evaluating different pretreatment/preprocessing methods of the lignocellulosic biomass.

Oklahoma

Biological conversion of syngas and CO2 to alcohols and fatty acids: Dr. Atiyeh's team continued the development of gas fermentation for the conversion of syngas and CO2 into biofuels and biobased products. We have characterized three new syngas fermentation strains (Strain A, Strain B and Strain C) and compared them with Clostridium carboxidivorans P7 and C. ragsdalei P11 for production of C2-C6 products from CO2. All strains converted CO2 into alcohols and fatty acids. New strains A, B and C produced more butanol and hexanol from CO2 than strains P7 and P11. More acids were produced from CO2 by strains P7 and P11. New strains A, B, C have the potential to produce C4-C6 compounds from CO2. The team also examined the effects of biochar feedstock type and processing temperature on microbial conversion of C1 gases to ethanol and butanol. Results showed that poultry litter biochar produced at 700°C (PLB700) outperformed PLB made at 350°C (PLB350) or switchgrass biochar (SGB350 and SGB700), which resulted in higher ethanol and butanol titers produced by C. carboxidivorans P7. The high cation exchange capacity, specific surface area, and less toxic aromatics in PLB700 enhanced the fermentation. These results provide guidance towards low-cost medium formulation with biochar for enhanced fermentation. One paper was published in a peer-reviewed journal.

Novel biocatalytic conversion of biomass to butanol: Dr. Atiyeh's team from Oklahoma State university and Ohio state University has been developing a novel co-fermentation of sugar and gas to produce butanol with high yield and carbon conversion using novel biocatalysts. In one project, the team has developed genetically modified strains that are tolerant to lignocellulose derived microbial inhibitory compounds (LDMICs) such as hydroxymethylfurfural, furfural and phenolic. We used an LDMICs tolerant Clostridium beijerinckii (Cb) by overexpressing aldo/keto reductase (AKR) to produce butanol from non-detoxified switchgrass hydrolysate. The Cb_AKR strain produced about 22% more solvents than wild Cb. In addition, 19-42% more solvents were produced with wild type Cb and Cb_AKR strains with intermittent feeding. The intermittent feeding enhanced fermentation of nondetoxified switchgrass hydrolysate. We also used C. carboxidivorans to convert the CO2 generated by Cb into additional alcohols. The new co-fermentation method is described in an awarded U.S. Patent (US 11,180,779). Two papers were also published in peer-reviewed journals.

Dr. Kumar's group continues their research in utilization of biomass and wastes for energy and fuel production. Waste disposal remains a challenge due to land availability, and environmental and health issues related to the main disposal method, landfilling. Combining computer vision (convolutional neural network) and robotics to sort wastes is a cost-effective solution for landfilling activities limitation. The objective of one of studies was to combine transfer and ensemble learning to classify landfill waste into nine classes. Pretrained CNN models (Inception-resnet-v2, EfficientNetb3 and DenseNet201) performances were compared to the ensemble model. Waste dataset, initially grouped in two classes, was obtained from Kaggle, and reorganized into 9 classes. Classes with low number of data were increased by downloading additional images from Google. The ensemble model showed the highest prediction

precision (90%) compared to 86%, 87% and 88% precisions of the original InceptionResNet, EfficientNet and DenseNet models, respectively. All models had difficulties predicting resembling classes such as glass and plastics, and wood and paper/cardboard.

Pennsylvania

Co-PI: Tom Richard: Continued to investigate microbial conversion of biomass into methane and carboxylic acids through various modes of anaerobic mixed culture fermentation, identifying a high conversion condition. This discovery has been used to develop a new two-stage digester design, and both innovations have now been formalized as patent disclosures. We are in the process of characterizing the microbiomes and their biochemical activity under that and many other conditions with a combination of proteomics, transcriptomics, and metagenomics.

Co-PI: Ali Demirci: The project to produce hydrolytic enzymes production from distillers dried grains with solubles (DDGS) for cellulosic biomass hydrolysis for biofuels and other uses have been continued. In this phase the study, the effect of dilution factor, agitation, and aeration in 2 L bench-top bioreactors was evaluated with A. niger and dilute acid-treated DDGS slurries. Furthermore, the fermentation parameters have been optimized in 2 L benchtop bioreactors. In a different study, vitamin K production via microbial fermentation have been scaled-up to 30-L pilot-scale by determining the most efficient scale up strategies. With a collaboration with Utah State University, Development of bioactive solid supports for immobilized Lactobacillus casei biofilms and Lactococcus lactis biofilms in bioreactors for the production of lactic acid and nisin, respectively.

Co-PI: Howard Salis: Engineering organisms to convert biomass resources into bioproducts requires fine control over its gene expression levels, for example, to add new metabolic pathways and maximize carbon & energy flows through existing metabolic pathways. Promoters are often engineered to exert gene expression control and yet the field does not yet have the ability to predict how different promoter DNA sequences affect gene expression levels. We applied the model to design promoters with desired gene expression levels and to optimize the expression levels of a multi-protein system. We developed a web interface to the model, which has already been used over 40,000 times in the past year.

Co-PI: Jeffrey Catchmark: The research in our laboratory has produced two commercially relevant sustainable products based on agricultural feedstocks. One is a barrier coating based on cellulose and starch that can replace plastics in coating applications such as low-density polyethylene laminates on paperboard for food and other packaging applications, and the other is a foam also based on starch that has been developed as a hemostatic wound care material but also as a more stable foam insulation product. Similarly for the wound care foam, volume manufacturing process development was pursued with Reiser and AmTek Microwaves. The potential for economical volume manufacturing was shown for both of these products.

Co-PI: Stephen Chmely: We have continued testing 3D printed composite materials. Most recently, we have shown that lauric arginate ethyl ester (LAE), a commercial grade antimicrobial surfactant, is capable of coating TOCNFs to provide enhanced performance properties to 3D printed composites. In addition, we continued extracting CELF lignin from biomass and have begun using new nanomaterial catalysts. We monitor the reaction progress and mechanism to design new catalysts. Also, we have continued our project pertaining to biocompatible hydrogels. Finally, we are continuing our project related to 3D printing lignin-containing resins. We are finishing up our work using Kraft lignin and will begin studying CELF and other biorefinery lignins.

Co-PI: Juliana Vasco-Correa: We have designed a lab-scale solid-state bioreactor to mitigate dilute methane emissions, envisioning a biobased system that can be commercialized as a product and that benefits economically from carbon markets. We have developed a preliminary process model for the bioreactor and have produced some hydrochar materials to be used as packing for the system.

Co-PI: Sibel Irmak: We have worked on utilization of low-grade woody biomass for developing

biodegradable polymers that can be used in agriculture as mulch and organic herbicides. We are also working on a project for developing innovative, economically feasible, highly active, and stable catalysts for hydrothermal conversion of biomass to hydrogen in higher yield and richer composition. In this project, bacterial cellulose is used to prepare promising carbon materials that can be used supportive material for deposition of metal catalyst particles.

Co-PI: Hojae Yi: We are developing a research program on intensifying the lignin-first fractionation process using a continuous reductive catalytic reactor in which the solvent and milled biomass are fed continuously at the same time. We aim to develop an engineered biomass fractionation reactor design that can be scaled up with minimal issues.

South Carolina

Pretreatments are required for lignocellulosic biomass for use as energy feedstocks before either thermochemical or biochemical conversion processes. Our previous research has demonstrated the potential of bioleaching with its superior capability of removing certain inorganic compounds compared to water leaching to improve biomass quality for thermochemical conversion for biofuel production. In this study, the bioleaching process was scaled up to be carried out in self designed 2.5-L bioreactors. The fungus Aspergillus niger was used in leaching sorghum straw biomass (SO) in the bioreactors. The effects of three operating parameters on leaching efficiency (i.e., residual ash content) were extensively studied, which included the fungal mass added to each reactor, leaching time, and glucose concentration in the starting liquid phase. Response surface methodology (RSM) was used for the experiment design. The results showed that the average residual ash content of the SO after bioleaching was significantly lower (3.63%±0.19%) than that of the ash content (4.72%±0.13%) after water leaching (p<0.00001). The lowest residual ash content achieved was 3.32%±0.17%. Among the three parameters, glucose concentration in the starting liquid phase was shown by the model with the most significant effect on leaching efficiency (p=0.0079). The RSM model provided useful directions for improving our bioleaching process, such as increasing the glucose concentration in the starting liquid phase. Based on these directions, following bioleaching experiments showed further reduction of residual ash content to as low as 2.73%.

South Dakota

1. Secured more than $1.6 million of research funding to conduct 10 projects on developing different innovative technologies to produce various bio-products. These projects are listed as follows:

Develop Biochar Composite Control Release Nitrogen Fertilizer for Sustainable Corn Production, $580,500 USDA/NIFA 11/2022 – 04/2026 PI: Lin Wei

Application of biosolid-based nitrogen control release fertilizers to improve nitrogen use efficiency of corn production and soil health in South Dakota $95,405 SD/NREC, 01/2022 – 12/2022 Lin Wei

Develop Biochar Composite Control Release Nitrogen Fertilizer for Sustainable Corn Production, $58,500 USDA/Sun Grant 11/2020 – 04/2022 PI: Wei

Develop biosolid-based control release fertilizer to improve yield of corn production, $25,000 SD/EDA 04/2020 – 2/2022 PI: Lin Wei

Development of Bioresins from Soybean Oil $78,032 SD Soybean oil 07/2020- 09/2022 Kas. Muthukumarappan

Feed pellet processing of Camelina and Carinata meal, $450,000 USDA/NIFA 09/2018 - 08/2023, PI: Kas. Muthukumarappan

Texture, Rheology and Tribology Characteristics of Food Materials: Recent Advance, $10,000 GIAN 07/2021- 09/2022, PI:Kas. Muthukumarappan

Biorenewable graphene from new thermochemical biorefinery process, $449,242 USDA/SunGrant 07/2021-06/2024, PI: Zhengrong Gu

Glucosinolates from Canola meal as fresh produce preservative, $29,000 SD Oilseeds Council

07/2020-06/2021.PI: Zhengrong Gu
Separate Glucosinolates from non-food oil-seeds as value added co-products and improve nutrition value of oil-seeds as animal feed, $306,000 SD Oilseeds Council 07/2015-06/2022.PI: Zhengrong Gu

2. Trained 6 graduate (3 PhD 3 MS) and 3 undergraduate students in the project

3. Published 6 conference papers/posters/presentation and 3 peer-reviewed journal papers

4. Disseminated the knowledge and technologies resulting from the research projects to public and all stakeholders through research website to reflect the research results and newest knowledge of biomass conversion and bioproduct development at: https://lw9898.wixsite.com/linweiwebsite.

Tennessee

Dr. Abdoulmoumine's (TENNESSEE) group developed a comprehensive reactor model for biomass fast pyrolysis which can be used to evaluate (i) the performance of new pyrolysis reactor designs and (ii) the scalability of pyrolysis reactors. They investigated a small part of the larger lignin thermal deconstruction reaction mechanism during fast pyrolysis and identified the order of bond cleavages on a lignin molecule which contains important linkages found in native lignin in biomass. They also developed biochar-based CO2 adsorption materials with similar performance compared to commercial activated carbon adsorption materials.

Dr. Li's (TENNESSEE) group has discovered a particularly high level of tricin-lignin in vanilla plant, which has important impacts including: (1) the presence of the high amount of tricin as part of lignin from aerial roots could play a vital role for the valorization of lignin, even tricin itself, as a feedstock for value-added chemicals and commodities; and (2) it could open new ways to scientists to design and engineer the structure of tricin-lignin, or lignin in general, to confer plants with new or improved properties due to the plasticity of lignification.

Dr. Li's (TENNESSEE) group also discovered that wood flour-included composite that has improvement of 18% in mechanical strength and 1.9-fold in Young's modulus in comparison to non-wood flour counter-part; lignin-derived lipids and carotenoids using marine protist strain and lignin-based biocomposite filaments for 3D printing; and catalytic conversion of waste into aromatic hydrocarbons.

Dr. Hayes (TENNESSEE) formed bicontinuous microemulsion-based delivery systems composed of biobased oils (e.g., isopropyl myristate and limonene) for delivery of antimicrobial peptides to chronic wounds.

Texas

TAMU received a new patent for its gasification and pyrolysis technology (Patent No. 11,186,779 B2, November 30, 2021). The gasification system sustainably produces electrical power and biochar while the pyrolysis system generates refinery-grade biooil, synthesis gas and biochar with excellent market potential. Additional research on converting the biochar into graphene sheets and nanotubes are underway. Numerous stary-up companies have licensed this TAMU technology and has been commissioned in several applications.

Virginia

Outcome 1. Fermentation processes to convert food waste into lactic acid and 2,3-butanediol.

Outcome 2: A research plan for investigating the use of flow biocatalysis for the conversion of glucose to gluconic acid.

Washington

Our team have generated a lignin-based jet fuel (LJF) blend component, composed of mostly C6–C18 mono-, di-, and tri-cycloalkanes. The product could complement five existing sustainable aviation fuel (SAF) pathways (ASTM D7566 annexes) to enable a 100% SAF drop-in solution. In addition,

collaborating with national labs, we are working on develop a scalable biomass deconstruction and fractionation processes to reduce minimum sugar selling price (MSSP) of the DMR process. The goal of the project is to develop a chemical-recovery-free DMR pretreatment technology to produce highly fermentable cellulosic sugars at a MSSP ≤ $0.20/lb.

Wisconsin

Three projects were continued including: 1) Researched the synthesis of prebiotic oligosaccharides from hemicellulose sugars from forest biomass biorefineries; 2)

Investigated the fabrication and functionalization of whole biomass aerogels from forest residue as biosorbents for heavy metals; and 3) Assessed a variety of system to obtain nanocellulose products from waste streams (dairy manure, fermentation waste).

Outcomes related to Objective C. [Perform system analysis to support and inform development of sustainable multiple product streams (chemicals, energy, and materials) and use the insights from the systems analysis to guide research and policy decisions]

Alabama

B. Higgins is engaged in process model development (mass balance and nutrient transformation) and life cycle assessment of the aquaponics facility at Auburn University. The outcome of this effort is to identify "hot spots" within the system that could benefit from improvements that reduce the environmental footprint of the facility. The efforts have also identified unit operations that contribute most to losses of nutrients and water. Several manuscripts have been generated based on the relevant work in Dr. Higgins' lab.

Yi Wang is working with collaborators to perform the Life Cycle Analysis (LCA; EcoEngineers in Des Moines, Iowa) and Techno-Economic Analysis (TEA; Dr. Haibo Huang from Virginia Tech) on the fatty acid ester production process. The results provides essential evidence that demonstrates the sustainability and economic viability for the bioprocess for ester production.

California

An integrated geospatial forest resource and renewable energy decision support system (FRREDSS) model was developed to determine optimized supply chains and preliminary technoeconomic and environmental performance information for electricity and other products from forest biomass. The modeling approach included spatial mapping of forest resources in California coupled with estimations of harvest simulation and costs for multiple treatment and harvesting system types, feedstock transport, technoeconomic modeling of feedstock processing and conversion, partial lifecycle environmental assessment yielding carbon intensity and criteria pollutant emission impacts, and distribution costs for product delivery into final demand. Geospatial resource data are currently embedded for the Sierra Nevada region of California with a transportation model overlay. A transmission substation data layer is employed to estimate costs of electricity delivery into the grid infrastructure for overall product lifecycle cost estimation.

Illinois

High feedstock cost and low oil yields per unit of land from temperate oilseed crops limit the growth of commercial-scale biodiesel production. Recently, highly productive crops, such as sugarcane and energycane, have been engineered to accumulate triacylglycerides (TAGs) that allow the production of far more industrial vegetable oil than previously possible. A proof-of-concept suggests that biodiesel production from engineered energycane will be possible. However, before making efforts for scale-up,

it is critical to understand the commercial feasibility and economic competitiveness of this process. This study performs techno-economic analysis of a unique biorefinery processing energycane to co-produce biodiesel and ethanol. Comprehensive process simulation models were developed for two scenarios: (i) biodiesel from TAGs and ethanol from fermentation of sugars in juice and (ii) biodiesel from TAGs and ethanol from fermentation of sugars in juice and hydrolysis of carbohydrates in bagasse. Based on the target levels, the analysis was performed for energycane containing 0%, 5%, and 7.7% TAGs (d.b.). The biodiesel from engineered energycane was found economically viable and competitive to soybean biodiesel. Although the capital investment is higher compared to the soybean biodiesel plant, the biodiesel production costs ($0.66–$0.9/L) were lower than soybean biodiesel ($0.91/L). Biorefinery-scenario-1 processing energycane containing 7.7% TAG produces biodiesel with profitability (IRR 7.84) slightly lower than soybean biodiesel (IRR 8.3), but yields five times of biodiesel per unit land and is self-sustainable for energy requirements. The surplus electricity can displace fossil electricity and provide environmental benefits. Monte Carlo simulation indicated that biorefinery is profitable with a 29%–65% probability (NPV > 0) which is largely controlled by feedstock composition and biodiesel market price. It is important to note that energycane can be grown on the marginal rainfed lands in S.E. USA, where soybean would not be viable. Biodiesel from engineered energycane would therefore be complementary to soydiesel in the United States.

Michigan

In the Saffron group, technoeconomic analysis (TEA) of decentralized, depot-based pyrolysis with electrocatalytic hydrogenation and centralized upgrading (Py-ECH), producing liquid hydrocarbon fuel was completed. This TEA was compared to a cellulosic ethanol pathway using consistent assumptions and a discounted cash flow approach. A minimum fuel selling price (MFSP) of $3.62 per gallon gasoline equivalent (GGE) or $0.96 per gasoline liter equivalent (GLE) is estimated for Py-ECH fuel derived from corn stover, which is within the range of selling prices for gasoline over the last decade. A pathway to MFSPs as low as $2.56 per gallon was established.

Also in the Saffron group, the environmental impacts, economic potential, and merits of producing bioenergy from seaweed via biological conversion pathways were evaluated. Included in this analysis were: 1) sugar pathway; (2) volatile fatty acids pathway; and (3) methane pathway to produce ethanol, ethanol and heavier alcohols, and heat and power, respectively. Of these three pathways, the sugar pathway allows for the highest feedstock selling price. Environmentally, seaweed grinding and pumping in the biorefinery was found to be the most sustainable seaweed transportation mode.

Missouri

The University of Missouri aquaculture extension website was launched June 2021; Postings included a) Overview of Aquaculture b) Basic Economies of Fed-Pond Aquaculture, c) Fundamentals of Aquaculture Water Quality, d) Measurement of Aquaculture Water Quality, e) Freshwater Prawn Production, f) Freshwater Prawn Production at Bradford Farms, g) Outdoor Aquaculture Intensification Techniques, h) Zero-Discharge Biofloc Aquaculture, i) Economics of Intensive Pond Aquaculture and, j) Economics of Recirculating Aquaculture. In addition, fact sheets were updated and uploaded including, “Swine Barn Conversion to Aquaculture,” “Buildings for Aquaculture Operations,” “Pond Production of Fresh Water Prawns,” “Paddlefish Production in Ponds,” “Bluegill Sunfish Production in Missouri. Links to Purdue College of Ag website providing enterprise budgets for production of Trout, Bass, Perch, Catfish, Tilapia, Shrimp and Baitfish were loaded onto MU website.

Nebraska

Development of a novel approach to use extension enterprise budgets for sustainability analysis in Life Cycle Assessments (LCAs). This approach enables the use of operation-specific data in evaluating sustainability of farming practices as part of a systems analysis to evaluate sustainability of an agricultural-based bioproduct. Also initiated development of a framework to evaluate the impact of

circularity on a bioproduct facility like an ethanol plant.

Ohio

We conducted TEA and LCA of different agricultural and biobased systems including acetone-butanol-ethanol production from switchgrass, tilapia-lettuce production in aquaponics system, alternative feedstock logistics system for corn, oilseeds , agricultural and municipal waste plastics, and frozen fruits, and production of different biofuels and bioproducts.

Oklahoma

Economic analysis of acetone-butanol-ethanol production methods from non-detoxified switchgrass hydrolysates: Dr. Atiyeh's team from Oklahoma State university and Ohio state University has developed process models for four different butanol production scenarios using C. beijerinckii wildtype (WT) and C. beijerinckii_AKR (AKR) with (INT) and non-intermittent (NO_INT) feeding, to evaluate their techno-economics using SuperPro Designer software. The considered production capacity for the process models was 30 million gallon per year. The production cost includes raw materials, facility dependent cost, utilities and labor. The raw materials costs contributed to 37-38% of the total production cost. The cost of switchgrass delivered at the biorefinery was high due to the resource and time intensive harvest and post-harvest logistics of biomass. The estimated butanol production cost with intermittent feeding was $1.06/L. Further reduction in the cost of butanol can be achieved by optimization of process conditions and genetic modification of microorganisms to increase yield and productivity. The results were published in a peer-reviewed journal.

Pennsylvania

Co-PI: Tom Richard: Continued experimental and modeling efforts to understand and enhance system-level opportunities to find synergies between profitable on-farm biomass production, advanced conversion technologies, and innovative market products. Intensified academic and private sector collaborations on the ecosystem service valuation of perennial energy grasses and energy winter crops for water quality in the Chesapeake Bay region as well as the Upper Mississippi Basin watersheds in Iowa. We continued to quantify carbon offset benefits in forest and cropland bioenergy systems.

Co-PI: Juliana Vasco-Correa: We have developed a superstructure-based model for the assessment of emerging routes for lignin valorization with biological upgrading, which allow us to rapidly compare technologies in terms of economic performance. In another project, we also developed a preliminary techno-economic analysis of small-scale pelleting.

Co-PI: Christine Costello: Quantitative analysis to estimate materials flows of nitrogen, phosphorous, and carbon through agricultural and bioenergy systems. Our lab has made our model to calculate N & P flows nationally available on GitHub. We are currently developing a Chesapeake Bay-specific dataset and modeling framework. Additional model development has begun to represent how cultivation of duckweed using manure can capture and recycle nitrogen on-farm, and potentially reduce nutrient loading to the Chesapeake Bay. Similarly, model development is underway to estimate how N, P & C flows change as prairie grasses and/or anaerobic digestion of grasses with and without manure. We also worked on simulation of future climate in agricultural systems, focused on hydrology. This work uses process model data, historical data and statistical analyses to estimate changes in precipitation, soil water moisture, and crop water use for maize and soybeans into the next 60 years to determine adaptation needs.

Texas

The TAMU research group is developing overall system analysis of the developed thermal conversion technology as contribution to the circular economy. They have adopted the American Society of Agricultural and Biological Engineers (ASABE) recommended protocol for circular bioeconomy systems (CBS) as guide to more comprehensive research and policy makers. Carbon capture and sequestration (CCS) studies has been proposed including carbon footprint (CF) research. The overall goal is to adhere

to sustainable development goals (SDG) outlined by the United Nations.

Tennessee

The impact is to reduce the risks associated with the deployment of biomass supply/logistics and conversion technologies. Reducing this risks is based on creating biomass supply chains that yield predictable quality and quantity of raw ingredients for conversions that produce positive economic outcomes for the served sectors and industries. To do this, TENNESSEE tackles a wide range of problems involving improved field production, enhanced identification of biomass properties, alternative logistics supply systems, and improved conversion processes.

Dr. Li's group made remarkable impacts to the academia, industry, and the public in the past year. Dr. Li's group have contributed 5 publications in high-tier and peer-reviewed journals and 4 technical presentations at international conferences; Dr. Li has also recruited 3 graduate students and 2 undergraduate students. The 2 undergraduate students are female from underrepresented groups. One undergraduate has been hired by ColorTech Inc. after spent about 2 years at Dr. Li's group for assisting bio-derived products research. Lastly, Dr. Li has obtained funding support from Tennessee Corn Promotion Board for his project of catalytic converting corn into value-added chemicals.

The impacts include: (i) advancing science and engineering knowledge to reduce the commercialization risk of biomass thermochemical conversion technologies; (ii) training the workforce for the bioeconomy.

Virginia

Outcome 1. System-level techno-economic analysis (TEA) to evaluate the economic feasibility of converting distiller's grains with solubles (DDGS) to bioactive peptides.

Outcome 2. System-level techno-economic analysis (TEA) to evaluate the economic feasibility of converting corn stover to butyl acetate.

Washington

The techno-economic analysis (TEA) of cellulosic ethanol biorefinery with coproduction of PAN/lignin blend-based CFs using lignin from the cellulosic ethanol process is performed. The sensitivities of the costs of electricity, PAN precursor, nitrogen gas, natural gas and plant overhead etc. to the carbon fiber cost are also analyzed.

Wisconsin

LCA & TEA research was completed on nanocellulose and biochar production and applications. The results will help guide the development of these products.

Impacts

Alabama

1) Developed new bioprocess for biofuel and biochemical production;

2) Secured federal grants for further biomass and biochemical research, education and outreach;

3) Develop connections and collaborations with colleagues from other institutions and stations.

California

Polyhydroxyalkanoates (PHA) is the fastest growing biodegradable bioplastic with its production capacity expected to increase 9-fold by 2025 and its global bioplastic market share to expand to 11.5%. PHA has similar properties to thermoplastics anbipd can be used in a wide range of applications including packaging film and containers. Utilizing low value lactose from large dairy manufacturing sites for PHA production is a scalable solution. The research can be used by others to develop alternative solutions for utilizing low value co-product or waste dairy and other food byproduct streams.Conversion of almond

hulls to protein-enriched animal feed can reduce the almond orchard wastes and create a valuable product. The development of forestry biomass decision support applications directly addresses Objective C/Task 2 to inform the development of sustainable product streams and to help guide research and policy decisions.

Hawaii

Khanal's Lab has been actively involved in renewable energy, environmental biotechnology, waste-to-resources research with focus on sustainability. Specifically, Khanal's research activities on bioconversion of organic wastes into bioenergy, high solids anaerobic digestion for waste remediation and bioenergy production, energy efficient anaerobic wastewater treatment process, micro-aeration-based AD process for enhanced bioenergy generation, high-value agriculture via aquaponics-bioponics. Current work from the Su lab at the University of Hawaii helped to advance our understanding of how underutilized renewable lipids can be utilized as an alternative carbon feedstock for producing useful biobased products. The study has an important positive impact on sustainable valorization of agricultural wastes/byproducts and development of bioeconomy. Du lab has developed an efficient bio-flocculation method to harvest microalgae and novel gene editing toolkits for microalgae.

Illinois

Improving biofuels production process. Use of energycane to produce large quantities of vegetative lipids

Iowa

Both roller milling and high pressure sonication were investigated in order to improve knowledge of processing operations of cereal grains and oilseeds, and their impacts on resulting products.

Kansas

The enabling technologies of utilization of agriculture feedstocks and by-products developed for biobased materials and bioenergy are critical to our sustainable economic development. The new knowledge generated can be useful reference to both academia and industries in the field.

Kentucky

Through the support of S-1075, six graduate students (including two minority and two female students) were trained. The research outcomes were presented at international conferences and published as journal articles. The results of plastic extraction and hydrophobic natural deep eutectic solvents related study lead to two patents/patent applications.

Massachusetts

Research on S1075 has led to the employment of 2 graduate students, one post-doctoral researcher, and 4 undergraduate student researchers. The discoveries made by this small team of researchers have spanned deep sea vent microbes, and both microbial (bacterial and fungal) and invertebrate animals.

Michigan

Bioenergy systems that couple renewable electricity with biomass carbon potentially result in increased fuel energy delivery. When using decentralized pyrolysis as a means of deconstructing biomass prior to electrocatalytic upgrading, co-product biochar can be land applied to increase carbon sequestration and attain carbon negative circularity.

Minnesota

Our work on pretreating animal manures to produce effluent suitable for microalgae and vegetables to grow would have significant impact on alternative biomass production to avoid competing with foods. The major challenges for thermochemical conversion of solid biowastes are the poor quality and stability of the products. Our work on microwave assisted catalytic conversion of biomass and plastic wastes has improved the yield and quality of bio-oil and syngas. These outcomes have positive impacts on the

overall technical and economic performance of thermochemical conversion technologies. Our research projects provided opportunities to undergraduate graduate students and junior researchers to participate in experimental work, data collection, processing and analysis, and scientific writing and presentation. Many of our findings have found their way in classroom teaching. Our mass cultivation and thermochemical conversion facilities were used for demonstration to stakeholders.

Missouri

One of the major advantages of modern aquaculture production technology is the reduction/elimination of threats to local streams and groundwater, while providing a healthy alternative to imported products with locally grown seafood and co-products provided in an environmentally sustainable way.

Montana

Montana is the largest state for industrial hemp production for seed, oil, and biomass, and for camelina seed production for biofuel. Our variety adaptation studies have identified adaptable cultivars for the industry. Our fertility studies will provide guidance to the grower to optimize fertilizer input for industrial hemp and camelina production. The high nitrogen use efficiency genotypes of camelina identified in our research program will reduce the nitrogen input for camelina production in the future.

Nebraska

Involvement with S1075 has provided a connection to other researchers who might be users of the modeling framework.

North Dakota

There were 3 peer-reviewed publications, 2 dissertations, and 11 conference presentations

Ohio

Opportunities to collaborate with researchers from different institutions. Assembling expertise from wide range of researchers on solving related problems of common interest.

Oklahoma

Global generation of municipal solid waste (MSW) is predicted to reach over 2.2 billion tons/year in 2025. Landfilling and incineration, the two most common conventional techniques for MSW processing, negatively impact public health. One of the studies developed and demonstrated electricity generation by co-gasification of two underutilized resources: MSW and agricultural biomass.

The impact of our novel biocatalytic conversion process on the biofuel industry is immense. My research team estimated that a biorefinery using the novel co-fermentation process would produce 29.4 million gallons per year (MGPY) butanol, 9.4 MGPY acetone and 5.6 MGPY ethanol from 2000 dry metric tons of switchgrass per day. This is a total of 44.4 MGPY biofuel and biobased products, which could increase a biorefinery's net revenue by $33 million a year compared with traditional fermentation methods. Traditional ABE technology has the potential to only produce 22.6 MGPY butanol from the same amounts of switchgrass. The co-fermentation economic impact could be extended to the jet fuel and fossil fuel industries.

Pennsylvania

Having the ability to rapidly assess emerging conversion technologies toward developing systems that are economically and environmentally sustainable. Implementation of economically viable and sustainable processes is urgent due to three converging issues: decrease in productive agricultural land; using unsustainable methods to clear land for agricultural production and increasing world population. These intersecting problems is so vast that constructive solutions can only be developed and implemented through collaborations. Replacing existing petroleum-based energy and products with those that are stemming from biomass and other agricultural products will require research and development.

Incorporation of renewable polymers in materials used for additive manufacturing will provide the materials are generally less expensive than those derived from petroleum, so there would be an immediate cost benefit. Furthermore, LCAs and TEAs will be great tools to achieve these goals.

South Carolina

Developed valuable connections resulting in recommendations that keep talent in the biomass research area and allow for further development critical to the long-term success of the committee.

South Dakota

Provide effective technologies to utilize agriculture and forest residues/wastes, energy crops, and other renewable resources for productions of value-added and functional bioproducts. Establish startup companies to commercialize the technologies to promote local economy and increase farmer incomes. Reduce environmental impacts while improving precision agriculture sustainability. Produce healthy and safe foods and functional bioproducts. Provide education and training opportunities for students, farmers, and other stakeholders to meet the social and industrial demands. Disseminate new knowledge and technologies to public and all stakeholders.

Tennessee

The impact is to reduce the risks associated with the deployment of biomass supply/logistics and conversion technologies. Reducing this risks is based on creating biomass supply chains that yield predictable quality and quantity of raw ingredients for conversions that produce positive economic outcomes for the served sectors and industries. To do this, TENNESSEE tackles a wide range of problems involving improved field production, enhanced identification of biomass properties, alternative logistics supply systems, and improved conversion processes.

Dr. Li's group made remarkable impacts to the academia, industry, and the public in the past year. Dr. Li's group have contributed 5 publications in high-tier and peer-reviewed journals and 4 technical presentations at international conferences; Dr. Li has also recruited 3 graduate students and 2 undergraduate students. The 2 undergraduate students are female from underrepresented groups. One undergraduate has been hired by ColorTech Inc. after spent about 2 years at Dr. Li's group for assisting bio-derived products research. Lastly, Dr. Li has obtained funding support from Tennessee Corn Promotion Board for his project of catalytic converting corn into value-added chemicals.

The impacts include: (i) advancing science and engineering knowledge to reduce the commercialization risk of biomass thermochemical conversion technologies; (ii) training the workforce for the bioeconomy.

Texas

The following are the impacts of the TAMU developed thermal conversion technologies:

Reduction of wastes generation in food and animal industry. Cleaner environment coupled with the production of sustainable biofuels and biomaterials. Addresses global warming and circular economy. Mitigation of greenhouse gas emission. Addresses sustainable development goals that recognize ending poverty while improving health and education, reduce inequality and spur economic growth while tackling climate change and working to preserve our oceans and forests.

Virginia

The developed processing technologies coupled with techno-economic analysis have a great impact on developing technically feasible and economically viable routes to convert low-value waste biomass to value-added chemicals, which supports the objectives of the S1075 multistate project.

Washington

The research results have been presented to policy makers, the industry, graduate students and undergraduate students. The results have been disseminated through peer reviewed papers, presentations,

and posters in national and international conferences. We also wrote several technical reviews to support the development of the biomass conversion, biofuels and bioplastics industries. The postdoctoral and graduate student researchers supported by the project were involved in all aspects of the proposed studies, and had cross-training opportunities in multi-disciplinary research area as different subfields, including lignin chemistry, catalytic chemistry, biomass pretreatment, synthetic chemistry and biology, and chemical process design. They took the lead on experimental design, setup, and data analysis.

Wisconsin

Involvement with S1075 has allowed for greater communication for research which has been critical during recent COVID years (due to loss of many conferences)

Target Audience

Alabama

1. Academic researchers and university/college students. 2. Engineers, Scientists, Industries, and Policymakers. 3. K12 students

California

The target audience includes stakeholders involved in the deployment of biofuel systems and researchers participating in biofuel and bioenergy investigations. The research findings and decision support tools can be used by extension and other academic investigators, government policy makers, and private developers to develop and disseminate knowledge about possible environmental impacts and economic implications for biofuel systems and to assist in specific policy and investment decisions. In addition, researchers in the field can use insights of the work to further advance the methods and approaches for enhanced decision support and sustainability assessment.

Hawaii

Biobased industry, farmers, processors, scientists, and policy makers

Illinois

Biofuels Companies. Biomass Producers

Iowa

Processors of cereal grains and oilseeds. These could include livestock feed millers, ethanol plants, and soybean processing companies.

Kansas

Crop growers, farmers, companies will be the immediate beneficiaries of the investigation by finding new applications of soybean meals, oils and its derivatives for adhesives and coatings, agricultural feedstock processing industries, resin and biobased fuel related industries. Oilseeds and biomass related farmers and industries will also benefit from this study to find a way to utilize their products. The general public will benefit from the results, because biobased adhesives and fuels are environmentally friendly. In addition, the findings from this project will advance the bioadhesives and biofuel knowledge base and stimulate future developments within the biobased adhesive and biofuel industry. In addition, biomass and bioenergy industries will be the immediate beneficiaries of the advanced technologies for biofuel production.

Kentucky

Target audiences include the biofuel and bioproduct research community, the farmers and processors, biotechnology industry.

Massachusetts

Researchers involved in biorefinery applications. Ultimately the public will be the audience as research is spun-off to practical applications.

Michigan

Academic and Industrial Professionals

Minnesota

Our research findings were publicized to the academic community through peer-reviewed publications and conference presentations. On-site demonstrations were conducted to showcase our results to a broad range of audiences including academic researchers, government officials, funding agencies, students, entrepreneurs, and the general public. Some research findings were brought to classroom teaching. Graduate and undergraduate students were involved in the research projects.

Missouri

Increasing Missouri and Midwestern aquaculture is part of the University of Missouri's extension goal of sustainably doubling the value of Missouri agriculture by 2030. An aquaculture extension website has been launched. The MU extension team has posted videos and slide-sets to highlight opportunities for aquaculture within Missouri and details on technology needed to implement cost effective seafood production practices.

Montana

Biobased energy and products processors, feedstock producers and buyers, government agencies, researchers, educators, and general public.

Nebraska

Industry professionals and academic researchers working in the area of sustainability analysis and bioproduct development.

North Dakota

Agricultural producers, biofuel and biomass processors, biofuel investors, other researchers, university students

Ohio

The target audiences for this reporting period were scientists, engineers, and representatives from academia, industries and agricultural commodity groups attending professional scientific conferences, meetings, and workshops.

Oklahoma

The target audiences include biofuel and biobased product producers, waste to energy producer, government officials involved in bioenergy policy, farmers interested in biomass production, researchers, and undergraduate and graduate students interested in bioenergy. Other target audiences include chemical, petrochemical, agricultural, biotechnology and environmental industries interested in the conversion of waste streams, coal or natural gas to carbon monoxide, carbon dioxide and hydrogen followed by biological conversion to useful products.

Pennsylvania

The target audiences for this proposed research include the science and engineering research community; biomass processing companies ranging from small start-ups to large multi-national companies; policy analysts and decision makers; potential biomass producers; bio-industry, environmental/water resources/ecosystems managers, waste managers, and the general public. Stakeholders include state and

national organizations, state and federal agencies, companies and industry consultants.

South Caroline

Academic and industry professionals

South Dakota

The target audience includes research professionals, undergraduate and graduate students, farmers and biomass producers, government agencies, and industrial processors

Professionals in the research community: We are targeting agricultural engineers and biomass processing scientists. An understanding of our research results will help them develop hypotheses and effective processes that will advance their own research programs. We will target these individuals through peer-reviewed publications and presentations at scientific and professional meetings.

Undergraduate and graduate students: Undergraduate students are targeted through lab classes and/or summer internship programs. The research program will help them prepare for graduate school or a career in biomass production or processing. Graduate students are targeted by directly participating in research activities for their thesis/dissertations. These students will get professional training to prepare them for their careers, in not only in academia, but also agriculture, food, energy, and biorefinery industries.

Farmers and biomass producers: This audience is targeted because biomass feedstocks will be supplied by farmers. They are targeted through formal and informal classroom instruction (many undergraduate students will choose agriculture, food, energy, and biomass production as an occupation) and extension/outreach activities.

Tennessee

Academia, universities, some related industries Vegetable and specialty crop growers, agricultural plastic manufacturers, scientific community Biomass producers, Production Consultants, logistics managers, conversion managers

Texas

Academic Research Personnel, Practicing Engineers, Extension personnel, Ranchers and Agriculturists, Students and Teachers, Private Investors

Virginia

Food processing industry, bioprocessing industry

Washington

This research-based experiential learning and teaching can help our society to foster future leaders in industry, academia and government in developing sustainable clean technology to produce bioenergy and bioproducts for demands vital to our future. The problems associated with the bioprocessing of biomass to fuels and chemicals are among the most interdisciplinary areas and are true blend of science, technology, engineering and mathematics (STEM).The proposed education program will provide a rich environment to teach K-12, undergraduate and graduate students a general strategy to define and solve open-ended problems that should be valuable to them in dealing with complex real problems as well as develop students' multidisciplinary team working skills. Throughout the project, data relevant to the above hypothesis will be collected through student surveys, science project products, and interviews in order to establish the progress of teaching modules' success at improving the engagement of student participants in STEM learning and their attitudes towards science and STEM careers as well as their working skills. In addition, our studies will be guided by our industrial partners and government agencies to provide valuable data and facilitate near term commercial use. The postdoctoral and graduate student researchers supported by the project were involved in all aspects of the proposed studies, and had cross-training opportunities in multi-disciplinary research area as different subfields, including lignin chemistry,

catalytic chemistry, biomass pretreatment, synthetic chemistry and biology, and chemical process design. They took the lead on experimental design, setup, and data analysis. Our targeted audiences have been our peers at the biomass conversion, alternative jet fuel, environmental engineering and bio-products scientific communities. We have also presented our work to farmers, energy and engineering companies. The results obtained were presented to policy makers, the industry, graduate and undergraduate students. The results have been disseminated through peer reviewed papers, presentation and posters in national and international conferences. We also wrote several technical reviews to support the development of the biomass conversion, bio-products and jet fuel industry.

Wisconsin
Technical audience through papers and presentations.

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Alabama

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2. Y. Wang. Towards energy, environment and health nexus: understanding and manipulating biosystems using metabolic engineering and synthetic biology approaches. International Symposium on Microbiology: One Health 2021 (Virtual). May 12-14, 2021. (Invited talk)

3. H. Goldfine, S. Wang, Z. Guan, Y. Wang. Studies on Three 1-O-acylglycerol-3-P Acyl-transferases in Clostridium beijerinckii. 2021 American Society for Biochemistry and Molecular Biology (ASBMB) Annual Meeting. April 27-30, 2021.

4. J. Zhang, J. Feng, P. Wang, Y. Wang. Genome engineering tools development and metabolic engineering of solventogenic clostridia for biofuel and biochemical production. 2021 Institute of Biological Engineering (IBE) Annual Conference (Virtual). April 9-10, 2021.

5. Wang, Q., B.T. Higgins. 2022. A bacterial pretreatment for enhanced algal biomass production and nutrient removal from undiluted anaerobic digestate AU Huntsville Symposium. March 29.

6. Higgins, B.T., J. Box, E. Childree, Q. Wang. 2022. Leveraging algal-bacterial synergy for

treatment and re-use of wastewater for irrigation. AU Huntsville Symposium. March 29.

7. Blanchard, K., Y. Bao, B.T. Higgins, D. Wells. 2022. Using Reinforcement Learning to Balance Aquaponic Crop Production and Environmental Impact. AI in AG. Auburn University. March 9-11.

8. Smith, J.3, Q. Wang2, B.T. Higgins. 2022. Student Research Symposium. Auburn University. March 28th.

9. Dickson, B.R., G. Au, D. Gomez-Maldonado, B.T. Higgins, M.S. Peresin. 2022 Nanocellulose-based antimicrobial systems for mitigating E. coli outbreaks in water bodies. Student Research Symposium. Auburn University. March 28th.

10. Higgins, B.T., P. Goodling2, M. Thomas2, A.E. Wilson. 2021. Genetic tools for quantifying taste and odor-producing microorganisms in drinking water

California

Hawaii "Du, Z. Co-production of high-value biomaterials using algae-fungi symbiotic system. Annual Meeting of the Phytochemical Society of North America, Jul 24-28, 2022, Blacksburg, Virginia, USA.

Shitanaka T., Marcelino K.R., Surendra K.C., Du Z.-Y., and Khanal S.K. Carbon dioxide nanobubbles as a delivery system to enhance microalgal productivity. Poster Presentation. S-1075: Science and Engineering for a Biobased Industry and Economy, Research Meeting, July 15-16, 2022, Houston, TX, USA.

Chuenchart, W., Surendra K.C., and Khanal S.K. Application of machine learning on performance prediction of co-digestion with microaeration. Poster Presentation. S-1075: Science and Engineering for a Biobased Industry and Economy, Research Meeting, July 15-16, 2022, Houston, TX, USA.

Marcelino K.R., Shitanaka T., Surendra K.C., and Khanal S.K. Application of air nanobubbles in floating-raft aquaponics. Poster Presentation. S-1075: Science and Engineering for a Biobased Industry and Economy, Research Meeting, July 15-16, 2022, Houston, TX, USA.

Khanal, S.K. Chuenchart, W., and Khan, M. Data-driven approaches for modeling anaerobic digestion. 17th World Congress on Anaerobic Digestion, June 17-22, 2022, Ann Arbor, Michigan, USA.

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Kentucky

Danielle Hockensmith, Impact of Physiochemical Characteristics and Distillation Parameters on the Biomethane Potential of Bourbon Stillage (paper #2200922), at 2022 ASABE Annual International Meeting, Houston, TX, July 6-20, 2022.

Gary H. Lopez, Joshua Jackson, Densification of Hemp Floral Biomass and Seed Hulls: Determination of Pellet Physical Characteristics (paper #2200331), at 2022 ASABE Annual International Meeting, Houston, TX, July 6-20, 2022.

Suvro Talukdar, Tyler Barzee. Fungal-Assisted Harvesting of Microalgae: Optimization of Fungal Pellet Loading and Geometry and Lighting Strategy (paper #2200389), at 2022 ASABE Annual International Meeting, Houston, TX, July 6-20, 2022.

Toby A. Adjuik, Sue E. Nokes, Michael D. Montross, Evaluating the Feasibility of using a Lignin-Alginate Hydrogel as a Carrier for Encapsulating and Releasing Rhizobium (paper #2200345), at 2022 ASABE Annual International Meeting, Houston, TX, July 6-20, 2022.

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Michigan

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2. †Saffron, C.M.3 "Thermochemical Conversion Technologies for Biochar Production." Webinar given for Forest Research and Development in collaboration with the U.S. Biochar Initiative and the Southern Regional Extension Forestry. May 19th, 2022.

3. †Saffron, C.M.3 "Production of Biochar." Webinar presented for the Great Lakes Biochar Network (GLBN). November, 2021. Great Lakes Biochar Network - Production of Biochar - Great Lakes Biochar Network (msu.edu)

4. †Saffron, C.M.3 Kasad, M.1 "Technoeconomic and Life Cycle Assessment of Electrobiofuel Production." Presentation given at the 240th ECS Symposium. October, 2021.

5. Kasad, M.1; Saffron, C.M.3 "Electrocatalytic Hydrodeoxygenation of Substituted Guaiacols Using Supported Bimetallic Catalysts." Presentation given at the 240th ECS Symposium. October, 2021.

6. †Saffron, C.M.3 "Carbon-negative Electrobiofuels from Regional Pyrolysis Depots" Presentation given at the Idaho National Labs-Massachusetts Institute of Technology Nuclear Biofuels Workshop. August 2021.

Minnesota

Roger Ruan, Leilei Dai, Dmitri Mataya, Junhui Chen, Kirk Cobb, Nan Zhou, Renchuan Zhang, Lu Wang, Yanling Cheng, Min Addy, Paul Chen, Hanwu Lei. 2022. Complete waste resource utilization for renewable energy production and sustainable development. Recent Advancement in Renewable Energy Resources and Technologies – Guest Speaker Session, ASABE Annual International Meeting, Houston, TX. July 19, 2022.

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Roger Ruan, Leilei Dai, Dmitri Mataya, Junhui Chen, Kirk Cobb, Nan Zhou, Renchuan Zhang, Lu Wang, Yanling Cheng, Min Addy, Paul Chen, Hanwu Lei. 2022. Complete solid and liquid waste utilization for circular economy development. Sixth International Symposium on Circular Economy & Urban Mining. Capri, Italy. May 18, 2022.

Roger Ruan, Paul Chen, Leilei Dai, Kirk Cobb, Dmitri Mataya, Juer Liu. 2022. Catalytic microwave-assisted pyrolysis/gasification for hydrogen production. C-WtHub series: Virtual Lab Visit (VLV). May 4th, 2022.

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Roger Ruan, Paul Chen, Frank Liu, Leilei Dai, Renchuan Zhang, Nan Zhou, Yanling Cheng, Juer Liu, Lu Wang, Dmitri Mataya, Yuancai Lyu, Abigail Chiaokhiao, Hanwu Lei, and Kirk Cobb. 2022. Innovative Technologies for A Sustainable Swine Industry. Walmart Foundation Webinar. March 15, 2022.

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Missouri

Brune, D. E., “Heterotrophic Water Treatment in Intensive and Semi-Intensive Aquaculture” Institute of Biological Engineers Symposium, April 2021.

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Brune, D.E., Paddlewheel Water Mixing in Split-Ponds used for Catfish Production, Presentation at International Agricultural and Biological Engineering Society Meeting, August 2021.

Brune, D. E., 1) Importance of Aquaculture: Impact on US Seafood Supply and Economy, 2) Aquaculture Technology: Ponds to Super-Intensive Production, 3) Aquaculture in the Midwest: Economic Opportunity for Missouri Farmers, MU aquaculture extension website videos, March 2022, Located at; https://extension.missouri.edu/programs/aquaculture-extension.

Montana

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Lim, C., S. Decker, H. Li, J. Lovell, P. Grabowski, J. Schmutz, J. Lachowiec, C. Chen, and C. Lu. 2022. Understanding nitrogen use efficiency (NUE) and oilseed traits in camelina by high resolution genome sequencing and whole genome resequencing. DOE-GSP Conference 2022.

Nebraska

Calderon, H., and Keshwani, D.R. (2022). The value of circularity for a corn-based ethanol biorefinery. 2011 ASABE Annual International Meeting. July 17-20, 2022, Houston, USA

North Dakota

Subhashree, S. N. and Igathinathane, C. 2021. Forage Economics Calculator: A User-friendly Web Tool for Ranchers and Farmers. 2021 NDSU Extension-REC Fall Conference 2021, Radisson Hotel, Bismarck, October 12 – 14, 2021.

Subhashree, S. N., Igathinathane, C., Hendrickson, J., Archer, D., Liebig, M., Halvorson, J., Kronberg, S., Toledo, D., Sedevic, K. 2021. Forage yield prediction using remotely sensed vegetation index and climate data through machine learning. Long–Term Agroecosystem Research 2021 Annual Science Meeting, August 30 – September 1, 2021.

Subhashree, S. N., Igathinathane, C., Hendrickson, J., Archer, D., Liebig, M., Halvorson, J., Kronberg, S., Toledo, D. 2021. Forage economics calculator: A decision support tool for analyzing economic performance of forage operations. Long–Term Agroecosystem Research 2021 Annual Science Meeting, August 30 – September 1, 2021.

Subhashree, S. N., Igathinathane, C., Hendrickson, J., Archer, D., Liebig, M., Halvorson, J., Kronberg, S., Toledo. D. 2021. Ranch Forage Prediction Web Tool. Paper number: 2100885. ASABE 2021 Annual International Meeting (Virtual and On Demand), July 12 – 16, 2021.

Subhashree, S. N., Igathinathane, C., Hendrickson, J., Archer, D., Liebig, M., Halvorson, J., Kronberg, S., Toledo. D. 2021. Forage Economics Calculator – A Web Tool. Paper number: 2100883. ASABE 2021 Annual International Meeting (Virtual and On Demand), July 12 – 16, 2021.

Tulip, S., N. Nahar, M. Yang, E. Monono. 2022. CoRncrete: A Corn-based Material to Replace Cement. Paper No. 2200483 ASABE International Meeting Houston July 17-20, 2022.

Huda, S., N. Sarker, E. Monono. 2022. Optimizing the Production Process of Corn Oil Methyl Ester to Produce Bioresin. Paper No. 2200318 ASABE International Meeting Houston July 17-20, 2022.

Lumu, S., N. Sarker, E. Monono. 2022. Evaluating the Effectiveness of Drying Conditions of Hemp Plants for Cannabidiol Extraction. Paper No. 2200493 ASABE International Meeting Houston July 17-20, 2022.

Ajayi-Banji. I., K. Hellevang, and E. Monono. 2022. Evaluating the Allowable Storage Time of two Soybean Varieties at four Moisture Levels at Typical Storage Temperatures. Paper No. 2200408 ASABE International Meeting Houston July 17-20, 2022.

Adewale Adeniyi, Ibrahim Bello, Taofeek Mukaila, Ademola Hammed: Enzymatic Hydrolysis of Soybean Protein Facilitates Ammonia Production. ASABE, 2022 Annual International Meeting, July 17 – 20, 2022.

Ibrahim Bello, Adewale Adeniyi, Taofeek Mukaila, Ademola Hammed: Kinetics of Ammonium Hydroxide (NH4OH) Extraction of Soybean Protein. ASABE, 2022 annual international meeting, July 17 – 20, 2022.

Ohio

1. A. Khanal, A. Shah. 2022. Evaluating the storage characteristics of whole-plant corn for biobased industries. ASABE Annual International Meeting 2022, July 17-20, Houston, Texas. [Oral]

2. H. Stockham, A. Khanal, A. Shah. 2021. Assessing co-pelletization of agricultural residue and non-recyclable plastic waste. NABEC 2021, July 26, Virtual. [Oral] (Third Place, Oral category)

3. A. Khanal, A. Shah. 2021. Assessing the storage characteristics of whole plant corn for biobased industries. NABEC 2021, July 26, Virtual. [Poster] (First Place, Poster category)

4. A. Shah. 2021. A novel whole-plant logistics system for biobased industry. ASABE Annual International Meeting 2021, July 12-16, Virtual. [Oral]

5. A. Khanal, A. Shah. 2021. Evaluating storage characteristics of whole-plant corn for biobased industries. ASABE Annual International Meeting 2021, July 12-16, Virtual. [Oral]

6. J. Tatum, N. Sintov, A. Shah. 2021. Barriers to Adoption of Improved Grain Storage Technologies for Smallholder Farmers in Developing Countires. ASABE Annual International Meeting 2021, July 12-16, Virtual. [Poster]

7. H. Stockham, A. Khanal, A. Shah. 2021. Physico-thermal properties of co-pelletization of agricultural and municipal wastes. ASABE Annual International Meeting 2021, July 12-16. Virtual. [Oral]

8. J. Tatum, A. Shah. 2021. Evaluation of Grain Quality Impacts of a New Hermetic Storage System for Developing Countries. ASABE Annual International Meeting 2021, July 12-16. Virtual. [Oral]

9. H. Stockham, A. Khanal, A. Shah. 2021. Co-pelletization of corn stover and plastic waste as an alternative fuel for the cement industry. The CFAES Annual Research Conference, April 8, virtual. [Poster]

10. S. Sivaprasad, A. Manandhar, A. Shah. 2021. Fixed-bed continuous remediation of methylene blue dye using hydrochar derived from sewage sludge digestate. The CFAES Annual Research Conference, April 8, virtual. [Poster]

11. A. Shah, A. Manandhar, S. Sivaprasad. 2021. Remediation of methylene blue from water using hydrochar produced from anaerobically digested effluent from sewage sludge. ASABE Annual International Meeting 2021, July 12-16, Virtual. [Poster]

12. J. Vasco-Correa, L. Huezo, A. Shah. 2021. Hybrid biorefinery integrating anaerobic digestion and hydrothermal carbonization. International Conference for Bioresource Technology for Bioenergy, Bioproducts & Environmental Sustainability (BIORESTEC). May 17-19, virtual. [Oral].

13. J. Vasco-Correa, L. Huezo, A. Shah. 2021. Integrating anaerobic digestion and hydrothermal carbonization for the development of a hybrid biorefinery. IBE Annual Conference, April 9-10, virtual. [Oral].

14. A. Khanal, A. Shah. 2022. Evaluating the techno-economics of whole-plant corn logistics for biobased industries. ASABE Annual International Meeting 2022, July 17-20, Houston, Texas. [Oral]

15. A. Manandhar, A. Shah. 2022. Life cycle assessment of frozen mango logistics. ASABE Annual International Meeting 2022, July 17-20, Houston, Texas. [Oral]

16. A. Manandhar, A. Shah. 2022. Life cycle assessment of biodegradable plastic film production using biobased feedstocks. ASABE Annual International Meeting 2022, July 17-20, Houston, Texas. [Poster]

17. A. Khanal, A. Shah. 2021. Techno-economic evaluation of hemp seed, oil and fiber production in the U.S. NABEC 2021, July 26, Virtual. [Oral]

18. H. Stockham, A. Khanal, A. Shah. 2021. Techno-economic analysis of co-pelletization of agricultural residue and plastic waste for cement production. ASABE Annual International Meeting 2021, July 12-16. Virtual. [Poster]

19. A. Manandhar, S. Khanal, A. Shah. 2021. Techno-economic analysis of switchgrass based combined heat and power system. ASABE Annual International Meeting 2021, July 12-16, Virtual. [Oral]

20. A. Khanal, A. Shah. 2021. Techno-economic analysis of hemp production and logistics in the U.S. ASABE Annual International Meeting 2021, July 12-16, Virtual. [Oral]

21. A. Manandhar, S. Khanal, A. Shah. 2021. Techno-economic analysis of implementing UAV technologies for crop health monitoring. ASABE Annual International Meeting 2021, July 12-16, Virtual.

[Oral]

22. H. Stockham, A. Khanal, G. N. Courtright, B. Roe, A. Shah. 2021. Life cycle greenhouse gas emissions assessment of dairy manure management via ensilage. ASABE Annual International Meeting 2021, July 12-16. Virtual. [Poster] (ASABE Student Presentation Competition Award)

23. A. Manandhar, S. Khanal, A. Shah. 2021. Techno-economic analysis of implementing unmanned aerial systems for corn crop health monitoring. The CFAES Annual Research Conference, April 8, virtual. [Poster] (Third place, Postdoc category))

24. E. Shrestha, A. Manandhar, F. Michel, A. Shah. 2021. Life cycle assessment of spinach grown in an urban farm in Mansfield, Ohio. The CFAES Annual Research Conference, April 8, virtual. [Poster] (Second place, Research staff category)

25. A. Khanal, A. Shah. 2021. Techno-economic comparison of hemp production and processing for grain, Cannabidiol (CBD) and fiber. The CFAES Annual Research Conference, April 8, virtual. [Poster]

Oklahoma

1- Iloba, I., C. Okonkwo, H.K. Atiyeh, V. Ujor and T. Ezeji ""The effect of biochar on ethanol production by Saccharomyces cerevisiae using anaerobic digestion effluent as nutrient source"", ASM Microbe 2022, Washington, D.C, June 9-13, 2022. Poster.

2- Thunuguntla, R, X. Sun, H. Zhang and H.K. Atiyeh "Effects of biochar source and production parameters on microbial conversion of C1 gases to C2-C6 products, ASABE 2022 Annual International Meeting; Huston, Texas, July 17-20, 2022. Oral.

3- Thunuguntla, R., H.K. Atiyeh, R. L. Huhnke and R. S. Tanner, "Comparison of five acetogens for production of C2 – C6 alcohols and acids from CO2", 2021AIChE Annual Meeting, Boston, MA, November 7-12, 2021. Virtual-Oral.

4. Ouedraogo, A. and A. Kumar. Landfill waste segregation using transfer and ensemble machine learning. S-1075 The Science and Engineering for a Biobased Industry and Economy. Houston, TX. Jul 15-16, 2022.

5. Ouedraogo, A., Kumar, A., Wang, N., Sallam, K., and Frazier, R. Advanced automation technologies for gasification at distributed-scale: A state-of-the-art critical review. 2022 Annual International Meeting of ASABE, Houston.

Pennsylvania

Stauffer, H., R. Clark, E. Webb, J. Field and T.L. Richard. 2021. Climate resilience: modeling the impacts of yield variability on switchgrass supply chains. IBE Conference. April.

Stauffer, H., R. Clark, E. Webb, J. Field and T.L. Richard. 2021. Climate resilience: modeling the impacts of yield variability on switchgrass supply chains. Consortium for Bioenergy Innovation Annual Science Meeting, June.

Liu, J. 2021. Opportunities and Challenges in Developing an Industrial hemp-based Products System. University and Industry Consortium (UIC) Spring Meeting, June 22-24, 2021, Fort Collins, CO (Invited panel speaker).

Iram, A., A. Demirci, and D. Cekmecelioglu. 2021. Enhanced production of cellulase and hemicellulase in DDGS-based media by optimizing nitrogen source and salts. 43rd Symposium on Biomaterials, Fuels and Chemicals. Abstract # 43371. (Virtual).

Iram, A., A. Demirci, and D. Cekmecelioglu. 2021. Comparison of conventional carbon sources with dilute acid and steam treated DDGS on the cellulase and hemicellulase production by fungal strains. 43rd Symposium on Biomaterials, Fuels and Chemicals. Abstract # 43373. (Virtual).

Demirci, A. 2021. Fermentation: Research, facilities, and training programs at Penn State. Refresher Training on Fermentation. Reckitt Nutrition. (Virtual; Invited Speaker)

Iram, A., D. Cekmecelioglu, and A. Demirci. 2021. The effect of dilution factor, agitation, and aeration on the biomass and hydrolytic enzyme production by Aspergillus niger strains in the DDGS-based media. Northeast Agricultural and Biological Engineering Conference Abstract # 21-009 (Virtual).

Iram, A., D. Cekmecelioglu, and A. Demirci. 2021. Comparison of carbon sources with dilute acid and steam treated DDGS on the cellulase and hemicellulase production by fungal strains. Northeast Agricultural and Biological Engineering Conference Abstract # 21-010 (Virtual).

Demirci, A. 2021. Production of value-added products by microbial fermentation. BIO Turkey – International Biotechnology Congress (Virtual).

Iram, A., A. Demirci, and D. Cekmecelioglu. 2022. Optimization of different media components and fermentation parameters to maximize the production of hydrolytic enzymes using distillers dried grains with solubles (DDGS) by Aspergillus niger. Annual International Meeting of The Institute of Biological Engineering. Athens, GA.

Iram, A., A. Demirci, and D. Cekmecelioglu. 2022. The effect of various pre-treatment methods on DDGS to produce total reducing sugars, furfurals and use of pretreated and untreated DDGS for the productions hydrolytic enzyme by fungal strains. Annual International Meeting of The Institute of Biological Engineering. Athens, GA.

Iram, A., D. Cekmecelioglu, and A. Demirci. 2022. Optimization of different fermentation parameters to maximize the production of hydrolytic enzymes using distillers dried grains with solubles (DDGS) by Aspergillus niger. Northeast Agricultural and Biological Engineering Conference. Edgewood, MD.

Iram, A., D. Cekmecelioglu, and A. Demirci. 2022. The effect of pre-treatment methods on DDGS to produce hydrolytic enzyme by fungal strains. Northeast Agricultural and Biological Engineering Conference. Edgewood, MD.

Lope, J., Yazdanpanah, N., Berenjian, A., and Demirci, A. 2022. Synchronized Mixing, Bubble Size Distribution, and KLa High-Fidelity Simulation for Optimization, and Scale-up for Benchtop. Pharmaceutical Discovery, Development and Manufacturing Forum. Biofilm Bioreactor. AIChE Annual Meeting. Phoenix, AZ. Abstract # 642189.

Iram, A., A. Demirci, and D. Cekmecelioglu. 2022. The optimization of inoculum, agitation, and aeration for production of hydrolytic enzymes in DDGS-based media by Aspergillus niger. ASABE Paper No. 2200146. American Society of Agricultural Engineers. St. Joseph, MI. 14 pp.

Iram, A., A. Demirci, and D. Cekmecelioglu. 2022. The effect of dilution factor, agitation, and aeration on cellulase and hemicellulase production in the DDGS-based media by Aspergillus niger strains. ASABE Paper No. 2200147. American Society of Agricultural Engineers. St. Joseph, MI. 13 pp.

Salis, H.M. 2022. ""Building an Engineering Discipline for Synthetic Biology"", Carnegie Science Center and Bioengineering. Stanford University. May 27. (Invited)

Salis, H.M. 2022. ""Building an Engineering Discipline for Synthetic Biology"", Genomatica Inc. San Diego, CA. May 25. (Invited)

Salis, H. M. 2022. ""Building an Engineering Discipline for Synthetic Biology: Automated Design of Genetic Systems,"" Synthetic Biology Engineering Evolution Design, AIChE, Arlington, VA. May 4. (Invited)

Salis, H. M. 2022. ""Model-predictive Design of Synthetic Promoters to Control Transcriptional Profiles in Bacteria,"" ACS Spring Meeting, American Chemical Society, San Diego. March 24.

Salis H.M. 2021. Model-predictive Design of Genetic Systems for Reprogramming Cellular Functions. NSF Workshop: Systems and Control Theory for Synthetic Biology. Arlington, VA. November 4-5. (Invited)

Salis H.M. 2021. Model-predictive Design of Genetic Systems for Reprogramming Cellular Functions. Princeton University. Chemical and Biological Engineering. Princeton, NJ. October 13. (Invited)

Catchmark, J. M. 2022. Barriers for food packaging. Meeting with Nestle, Penn State University, University Park, PA. October 12.

Catchmark, J. M. 2021. Sustainable water repellant textiles. Meeting with Tanitex, Penn State University, University Park, PA. November 12.

Catchmark, J. M. 2021. Starch based barriers,"" Meeting with Tate and Lyle, Penn State Univeristy, University Park, PA. June 16.

Nazemi, P. and Catchmark, J. M. 2021. Application of starch and cellulose-based PPC materials for improving barrier properties in food packaging. International ACS conference: Macromolecular Chemistry: The Second Century, ACS, Virtural. International. April 5-16.

Lin, W.-S. and Catchmark, J. M. 2021. Sustainable packaging adhesives prepared with polysaccharide polyelectrolyte complexes,"" International ACS conference: Macromolecular Chemistry: The Second Century, ACS, Virtual. International. April 5-16.

Vasco-Correa, J. 2022. Socio- and Technoeconomic Implications of Fungal Biomaterials. Fungal Biomaterials and Biofabrication Workshop, Penn State's Convergence Center for Living Multifunctional Material Systems, State College, PA, May 13.

Gonzalez, C., Vasco-Correa, J. 2022. Modeling the biofilm phenomena in methane-contaminated air biofilters. Biorenewables Symposium, Center for Biorenewables, University Park, PA, April 14.

Wu, Y., Vasco-Correa, J. 2022. Process design of lignin valorization with biological upgrading. Biorenewables Symposium, Center for Biorenewables, University Park, PA, April 14.

Wu, Y., Gonzalez Arango, C., Chmely, S., Vasco-Correa, J. 2021. Superstructure optimization as a systems approach to identify optimized pathways for lignin valorization. Institute for Operations Research and the Management Sciences (INFORMS) Annual Meeting. Anaheim, CA, October 24-27. Poster.

Wu, Y., Gonzalez Arango, C., Chmely, S., Vasco-Correa, J. 2021. Optimization and evaluation of lignin valorization superstructure. Institute for Computational and Data Sciences (ICDS) Symposium. State College, PA. October 6-7..

Vasco-Correa, J. 2021. Sustainable bioeconomies: bioprocess development as a climate change solution. International Seminar in Chemical Engineering, Instituto Tecnológico de Aguascalientes, Aguascalientes, Mexico. October 20 (Invited).

Peacock, H.V., Vasco-Correa, J. 2021. Life-cycle assessment of integrated anaerobic digestion with hydrothermal carbonization. Northeast Agricultural and Biological Engineering Conference (NABEC). Virtual, July 25-28.

Vasco-Correa, J. 2021. Systems analysis for the development of biorenewables. Northeast Agricultural and Biological Engineering Conference (NABEC). Virtual, July 25-28.

Wu, Y., Gonzalez, C., Chmely, S., Vasco-Correa, J. 2021. A systematic analysis and comparison of lignin valorization approaches using superstructure optimization.

Chmely, S. 2022. ""Panel on Advanced Biomaterials. 2022. Biorenewables Symposium on

Biorenewables in a Decarbonized Economy, PSU Center for Biorenewables, University Park, PA. April 14.

Chmely, S. 2022. ""Biorefining as America's Newest Frontier. Regional Opportunities for Biomass and Bioproducts Graduate Seminar. The Mid Atlantic Biomass Consortium (MASBio), Live and Online. April 4.

Godwin, J. A., Babusci, J. P., & Chmely, S. 2022. Catalytic depolymerization of CELF Lignin using mixed-metal spinel-group catalysts. ACS Spring 2022, American Chemical Society, San Diego, CA. March.

Chmely, S. 2021. Biorefining as America's Newest Frontier. American Institute of Chemical Engineers Rocky Mountain Local Section On-line Meeting, American Institute of Chemical Engineers (AIChE) Rocky Mountain Local Section (RMLS), Live and Online. November 9.

Chmely, S. 2021. Frontiers in Biorefining: Chemicals and Products from Renewable Carbon. Auburn University Biosystems Engineering Fall Seminar Series. Department of Biosystems Engineering, Auburn University, Live and Online. October 28.

Arya, A., and Chmely, S. 2021. 3D printing with Kraft lignin by stereolithography to produce sustainable thermoset materials. Northeast Agricultural and Biological Engineering Conference (NABEC), Live and Online. July.

Battisto, E. W., & Chmely, S. 2021. Use of Cellulose Nanofibrils to Improve the Mechanical Properties of 3D-Printed Composites. Northeast Agricultural and Biological Engineering Conference (NABEC), Live and Online.

Chmely, S. 2021. 3D Printing: Sustainable additive manufacturing and photopolymerizations with lignin. Research Experience for Teachers (RET) Mixer, PSU Center for Nanoscale Science MRSEC, Live and Online.

Irmak. S. 2022. Improving catalytic activity of supported precious metal catalysts for hydrogen production by hydrothermal conversion processes. International 23rd World Hydrogen Energy Conference, Istanbul, Turkey. June 26-30.

Yi, H., Lanning, C., Wamsley, M. Slosson, J. C., Dooley, J. H., and Puri, V. 2021. Comparison of three biomass flowability models using cubical triaxial tester data sets. ASABE International Meeting. (Virtual). July 12-16.

Yi, H., Lanning, C., Wamsley, M., Slosson, J. C., Dooley, J. H., and Puri, V. 2021. Flow behavior prediction of milled biomass feedstocks out of a gravity hopper. ASABE International Meeting. (Virtual). July 12-16.

Yi, H., Lanning, C., Wamsley, M., Slosson, J. C., Dooley, J. H., & Puri, V. 2021. Variations in the bulk physical and mechanical properties of milled corn stover and woody biomass due to the moisture content. ASABE International Meeting July 12-16.

de Lima Casseres dos Santos, Lucas, Z. Chowdhury, A.E. Frank, C.D. Campbell, N. F. Guzman Amezquita, and C. Costello. 2022. Quantifying the potential change in net anthropogenic nitrogen and phosphorous inputs to the Chesapeake Bay watershed due to the introduction of perennial species as a source of Renewable Natural Gas production. International Symposium on Sustainable Systems and Technologies (ISSST). Pittsburgh, PA. June 20-23.

Falcucci, D., J. Gutierrez-Lopez, C. Costello, R. McGarvey. 2022. Life cycle assessment of waste management systems in two different municipalities: Columbia, MO and York, PA. ISSST, Pittsburgh, PA. June 20-23.

Z.U. Md Chowdhurry, Algren, M., J.S. Richter, A.E. Landis, C. Costello. 2021. Estimating nitrogen and

phosphorous flows embodied in manufactured foods and per capita nutrient footprints in the United States. ISSST. June 21-24.

Algren, M., T.T. Burke, Z.U. Md Chowdhurry, C. Costello, A.E. Landis. 2021. Assessing the potential of phosphorous loss mitigation strategies to eliminate both net anthropogenic phosphorous inputs and mineral P demand in the United States. ISSST. June 21-24."

South Carolina

Tan A, T Walker, D Vanegas, 2022, Hydroponic Wastewater Reuse for Sustainable Urban Agriculture, IBE oral presentation, Athens, GA.

Anderson S, S Mokalled, C Mcmahan, T Walker, 2021, Exploratory Analysis in Kinetic Modeling of Biodiesel Production: Models and Parameter Estimation, IBE virtual meeting.

South Dakota

1) Lin Wei*, Yajun Wu, Zhisheng Cen, Emmanuel Arkon-Mensah, Surbhi Gupta. 2021. Applications of different control release fertilizers in corn greenhouse trials, Paper #: 2100091. ASABE Annual International Meeting, online virtual conference on July 12-16, 2021.

2) Robiul I. Rubel, Lin Wei*, 2021. Improve biochar-based control release fertilizer's performance by coating multiple layers of polylactic acid, Paper #: 2100092. ASABE Annual International Meeting, online virtual conference on July 12-16, 2021

3) Lin Wei*, Robiul I. Rubel, Kasiviswanathan Muthukumarappan. 2021.Plasma-enchance chemical deposition system for future graphene deposition. Paper #: 2100095. ASABE Annual International Meeting, online virtual conference on July 12-16, 2021

4) Nadee Kaluwahandi, Lin Wei, Kasiviswanathan Muthukumarappan*, 2021. Inactivation of E. coli and quality change in beef using cold plasma. Paper #: 2100867. ASABE Annual International Meeting, online virtual conference on July 12-16, 2021.

5) Nadee Kaluwahandi, Kasiviswanathan Muthukumarappan, Lin Wei*, 2021. Effect of cold plasma on inactivation of E. coli, Salmonella cerro, Salmonella, and Enterotoxigenic E. coli, and quality change in beef. IFT 2021 annual meeting, online virtual conference on July 19 – 23, 2021.

6) Nadee Kaluwahandi, Kasiviswanathan Muthukumarappan, Lin Wei*, 2021. Effect of cold plasma on inactivation of E. coli and quality change in beef. IFT and Honor Society of Phi Tau Sigma, University of Minnesota Chapter, Speedy Science™ 2021, online virtual conference on March 26, 2021.

Tennessee

Rithany Kheam, Mi Li et al. Totally Chlorine-Free Peracetic Acid Pulping for Nanocellulose Isolation. *ACS Spring 2022 International Conference*, March 2022. (Oral presentation)

Di Xie and Mi Li. Effect of Lignin Molecular Weight on Structural and Thermal Properties of Synthetic Lignin-grafted-poly(ε-caprolactone). *ACS Spring 2022 International Conference*, March 2022. (Oral presentation)

Kailong Zhang, Mi Li et al. Development of Antimicrobial Films with Cinnamaldehyde Stabilized by Ethyl Lauroyl Arginate and Cellulose Nanocrystals. *ACS Spring 2022 International Conference*, March 2022. (Oral presentation)

Mi Li et al. Surface Characterization of Technical Lignins using Inverse Gas Chromatography. *Sorption Science Symposium 2021*, Sept 2021. Virtual. (Poster presentation)

S.V. Pingali (speaker), V.S. Urban, H.M. O'Neill, D.G. Hayes, 2021, Bicontinuous microemulsion (BμE) as a membrane-mimic to stabilize and enable structural studies of membrane proteins, American Crystallographic Association Annual Meeting, virtual, 3 August 2021

Madrid, B. (speaker), S. Wortman, D.G. Hayes, J.M. DeBruyn, C. Miles, M. Flury, T.L. Marsh, S.P. Galinato, K. Englund, S. Agehara and L.W. DeVetter. 2021. End-of-Life Management Options for Agricultural Mulch Films in the United States. Poster presentation. American Society for Horticultural Science (ASHS) Annual Conference. Aug. 5- Aug. 9. Denver, CO.

D.G. Hayes (invited), Biobased Surfactants: Overview and Recent Trends, Future of Surfactants Conference, Boston, 23-24 September 2021

D.G. Hayes (invited), Biobased Surfactants: Overview and Recent Trends, Wuhan Polytechnic University (China; virtual), September 2021

D.G. Hayes (invited), Biobased Surfactants: Overview and Recent Trends, AOCS China Section Conference, Shanghai / virtual, November, 2021

M Oehler (poster presenter), DG Hayes, D D'Souza, Encapsulation of melittin in bicontinuous microemulsions for topical delivery, American Oil Chemists' Society Annual Meeting, Atlanta, May, 2022

DG Hayes (invited), Sustainability aspects of the production and life stages of surfactants. American Oil Chemists' Society Annual Meeting, Atlanta, May, 2022

Texas

Beeravalli, Vijayalaxmi, Nanjappa Ashwath, Mohammad G. Rasul, Masud Khan, Sergio C. Capareda, and Basavaraj Patil. 2022. A Proposed Framework for Estimating Missing Values in Biofuel Feedstock Selection. 2022 IEEE 7th International Conference in Technology (I2TC), Pune, India. April 07-09, 2022 at Pune, India.

Keynote Speaker (Invited):

Capareda, Sergio C. 2022. Biofuels and Biopower Production and Including Biomass Characterization. Plenary Speaker for the 2022 Annual Meeting of the Philippine Society of Agricultural and Biosystems Engineers, 33rd Philippine Agricultural Engineering Week and 8th ASEAN Regional Convention held on April 25-27, 2022, Quezon City, Philippines.

Capareda, Sergio C. 2022. Sustainable Food and Bioenergy Systems Research and Commercialization for a Circular Economy. Plenary Speaker for the 1st International Conference on Engineering and Agro-Industrial Technology (iCEAT 2022) on February 23-24, 2022, via Zoom and livestreamed in UPLB-CEAT social media platform. Organized by the College of Engineering and Agro-Industrial Technology (CEAT), University of the Philippines at Los Baños, Laguna, Philippines.

Capareda, Sergio C. 2022. Comprehensive Research on Renewable Energy and Sustainability for a Circular Economy. Lecture presented for 15 Petroleum and Chemical Engineering students of Adamson University, Manila, Philippines regarding their On the Job Training (PJT) Program with Kaltimex Energy, held on 5 August 2022, Makati City, Metro Manila, Philippines.

Posters Presented

Habib, Mohammad Ruzlan, El Jirie Baticados, Eunice Arzadon, and Sergio Capareda. 2022. Batch pyrolyzed biooil assessment as an alternative fuel from plastic resins and waste rubber tire at different temperature/using silica-alumina catalyst. Poster presented at the 2022 Annual Meeting of the USDA Multi State Committee 1075 The Science and Engineering of a biobased Industry and Economy, held from July 14-16, 2022 at Huston, Texas

Virginia

1. Lobeda K., Jin Q.*, Wu J., Zhang W., Huang H.*. Lactic acid production from food waste hydrolysate by Lactobacillus pentosus. Oral Presentation. IFT, 2021. (online)

2. 261st ACS National Meeting, San Diego, CA, March 20 – 24, 2022. Poster: Evaluation of surface

acetylated bacterial cellulose for antibacterial wound dressing applications. Timothy Bertucio, Naimat Bari, Jackie Zhu, Bahareh Behkam, John B Matson, Roman Maren

3. 261st ACS National Meeting, San Diego, CA, March 20 – 24, 2022. Continuous flow biocatalysis with in-line monitoring through Raman spectroscopy. Gurkeerat Kukal, Roman Maren

4. 261st ACS National Meeting, San Diego, CA, March 20 – 24, 2022. Radial vs. tangential alignment of cellulose nanocrystals in dried droplets: A matter of "perspective". Roman Maren, Cailean Pritchard, Fernando Navarro, Michael Bortner"

Washington

1. Xiaolu Li, and Bin Yang*, "A Redox Proteomics Approach to Understanding of Lignin Conversion in Rhodococci" 44th Symposium on Biomaterials, Fuels and Chemicals (SBFC), New Orleans, LA, May 3rd, 2022.

2. May 3rd, 2022Xiaojun Yang, Maoqi Feng, Jae-Soon Choi, Harry M. Meyer III, Bin Yang*, "Depolymerization of The Lignin Modeling compounds and Corn Stover Lignin with Bulk Molybdenum Carbide Catalysts" 2021 AIChE Annual meeting, Boston, MA. Nov. 8th, 2021.

3. Zhangyang Xu, Joshua Heyne, Mark Feng, David Daggett, Karl Seck, and Bin Yang. "Minimization of Jet Fuel Emissions via Optimization of J-A1 Fuel with The Lignin Based Jet Fuel Compositions and Processing", 2021 JCATI Symposium, Seattle, WA, April 12, 2021.

4. Bin Yang*, "Advanced Lignin-BasedbJet Fuel" 44th Symposium on Biomaterials, Fuels and Chemicals (SBFC), New Orleans, LA, May 1st, 2022.

5. Zhangyang Xu, Kendall Martin, John R. Cort, Yunqiao Pu, Arthur J. Ragauskas, Tujin Shi, Bin Yang. "Understanding of Bacterial Lignin Depolymerization Mechanisms by Pseudomonas putida through Secretomic Analysis". 43rdSymposium on Biotechnology for Fuels and Chemicals (Virtual). April 26th, 2021.

6. Xiaolu Li, Weijun Qian, Bin Yang. "Potential redox-dependent regulation in oleaginous Rhodococcus sp. converting lignin". 43rdSymposium on Biotechnology for Fuels and Chemicals (Virtual). April 26th, 2021.

7. Fitria, Jian Liu, Bin Yang. "Understanding Effects of Plant Mineral/Ash in Biomass on Biomass Pretreatment and Enzymatic Hydrolysis of Corn Stover". 43rdSymposium on Biotechnology for Fuels and Chemicals (Virtual). April 26th, 2021.

Wisconsin

1. K. Sahoo, R. Bergman, T. Runge, S. Mani, Life-cycle assessment and techno-economic analysis of biochar produced from forest residues using smaller-scale portable and large-scale fixed systems. ASABE Annual Conference, 2021.

2. S. Mani, K. Sahoo, K.C. Das, J. Tumuluru, J. Dalhen, L. Schimlack, R. Bergman, An Overview of Machine Learning Tools to Predict Biomass Conversion Performances. ASABE Annual Conference, 2021

3. K. Sahoo, R. Bergman, T. Runge, S. Mani, Life-Cycle Assessment of Redwood Lumber Products in the United States, SWST, 2021.

4. K. Sahoo., R. Bergman, T. Runge, Cradle-to-gate Life Cycle Assessment of Cellulosic Fiberboard Production in North America, Forest Products Society, 2021

5. Ning Li, Jee-Hwan Oh, Jan Peter van Pijkeren, George Huber, and Xuejun Pan. Synthesis of prebiotic oligosaccharides from mono- and di-saccharides in inorganic ionic liquid. The Symposium on Sustainable Production of Value-Added Materials, Green Chemicals and High-Energy Fuel from

Lignocellulosic Biomass at the Pacifichem 2021 Virtual Congress, December 16–21, 2021.

6. Yang Liao and Xuejun Pan. Fabrication and application of aerogels from cellulose and whole biomass via dissolution, gelation and regeneration in inorganic ionic liquid. The Symposium on Sustainable Production of Value-Added Materials, Green Chemicals and High-Energy Fuel from Lignocellulosic Biomass at the Pacifichem 2021 Virtual Congress, December 16–21, 2021.

7. Xuejun Pan. Lignin depolymerization in a molten salt hydrate (lithium bromide trihydrate). 2021 AIChE Annual Meeting, November 7–11, 2021, Boston, MA.

8. Xuejun Pan. Fabrication of nanocellulosic materials from cellulose and lignocellulose using molten salt hydrate and their environmental and energy applications. The 3rd International Symposium on Nanocellulosic Materials. November 20–21, 2021, Guangzhou, China.

9. Ning Li, Zheng Li, Xiaohui Yang, and Xuejun Pan. How lignin is depolymerized in solid state. Sustainable Materials Research Summit (SMART) Annual Meeting (2021), August 15–17, 2021.

10. Xuejun Pan. Cleavage of lignin ether bonds in a concentrated aqueous solution of lithium bromide (a molten salt hydrate). Biomaterials, biofuels, and biochemicals from lignocelluloses (Symposium in honor of Prof. Ann-Christine Albertson and Prof. Runcang Sun Anselm Payen Awards. 2021 ACS Spring meeting (virtual), April 5, 2021.

11. Zheng Li, Ning Li, and Xuejun Pan. Insights into the cleavage of lignin ether bonds in a molten salt hydrate (lithium bromide trihydrate). The 2nd Lignin Symposium, Guangdong University of Technology, Guangzhou, China, January 8–10, 2021.

12. Mairui Zhang, Gyu Leem, Yang Liao, Xuejun Pan, Chang Geun Yoo. Fabrication of ydrogel/aerogel from recycled biomass. 2021 AIChE Annual Meeting, November 7–11, 2021, Boston, MA

Theses and Dissertations

Alabama

1. Dillon Sprague, MS student, 12/2021. Thesis: “Solids Retention Governs Nitrification of Poultry Processing Wastewater using an Algal-bacterial Consortium.”

2. Jessa Cherones, MS student, 7/2022. Thesis: “Promoting Nitrification in Poultry Processing Wastewater Treatment Using Microalgae and Biochar.”

3. Vivek Patil, PhD student, 3/2021. Dissertation: “Stabilization Strategies for Preventing Secondary Reactions During Lignin Depolymerization and Valorization.

California

Li, Kaiyan. 2022. Integrated Economic and Environmental Modeling of Forest Biomass-to-Electricity in California. M.S. Thesis, University of California, Davis, California.

Wang, Ke. 2022. Bioprocess Development for Production of Polyhydroxyalkanoates from Organic Feedstocks. PhD Dissertation, University of California, Davis

Monroe H. 2021 Conversion of Almond Hulls into Protein-Rich Animal Feed MS thesis University of California, Davis, 202

Hawaii

Renisha Karki (M.S.). Anaerobic co-digestion with cow manure and coffee pulp: Evaluation of process instability.” (Summer 2021).”

Kentucky

Adjuik, Toby, ""EXPLORATION OF LIGNIN-BASED SUPERABSORBENT POLYMERS (HYDROGELS) FOR SOIL WATER MANAGEMENT AND AS A CARRIER FOR DELIVERING RHIZOBIUM SPP. (2022). Theses and Dissertations--Biosystems and Agricultural Engineering. 91. https://uknowledge.uky.edu/bae_etds/91

Hunter, Jameson R., "Extraction of Micro- and Nano-Plastic Particles from Water Using Hydrophobic Natural Deep Eutectic Solvents" (2021), Theses and Dissertations--Biosystems and Agricultural Engineering. 79. https://uknowledge.uky.edu/bae_etds/83

Massachusetts

1) Non-thesis MS. Eileen Black Spring 2022.

2) Thesis MS. Dana Sebestyen. June 2021.

Minnesota

Renchuan Zhang Ph.D. Bioproducts and Biosystems Engineering 2021

Thesis: An innovative thermal-vacuum stripping assisted thermophilic anaerobic digestion process and system for complete utilization of liquid swine manure.

Nan Zhou Ph.D. Bioproducts and Biosystems Engineering 2021

Thesis: Catalytic microwave-assisted pyrolysis for energy production from biomass and plastic wastes.

Missouri

Chen, Jianyue, Fermentative production of Xylitol from Hemicellulose Hydrolysate by Candida tropicalis. Master's thesis, University of Missouri, August 2021.

Yang, Shuhong , From Biomass to Wearable Devices: Laser-Induced Graphene Derived from Lignin for Ultrasensitive Sensing. Master's thesis, University of Missouri, August 2021

Nebraska

Monhollon, Luke (2020). Incorporating Spatial Variability into Integrated Models of Agricultural Practices and Sustainability (Masters Thesis). University of Nebraska Lincoln.

North Dakota

Subhashree, S. N. (2022). Rangeland forage growth prediction, logistics, energy, and economics analysis and tool development using open-source software. Department of Agricultural and Biosystems Engineering, North Dakota State University, Fargo, ND. ProQuest Number: 29060597.

Hammed, A. M. (2021). Process development for effective, recoverable and reusable magnetic nanobiocatalysts for biomass hydrolysis (Order No. 28776554). Available from Dissertations & Theses @ North Dakota State University; ProQuest Dissertations & Theses Global. (2615147454). Retrieved from https://ezproxy.lib.ndsu.nodak.edu/login

Ohio

1. A. Khanal. 2022. Feasibility of Whole-plant Corn Logistics for Biobased Industries. The Ohio State University

2. H. Stockham. 2021. Co-pelletization of corn stover and plastic waste as an alternative fuel. The Ohio State University.

Pennsylvania

Stauffer, H. 2021. Climate resilience: modeling the impacts of yield variability on switchgrass supply chains. M.S. Thesis. Pennsylvania State University. University Park, PA.

Herbstritt, S. 2022. Re-envisioning agriculture as sustainable multifunctional landscapes. Ph.D. Dissertation. Pennsylvania State University. University Park, PA.

Hirl, K. 2022. Robust and efficient anaerobic digestion of lignocellulose. Ph.D. Dissertation. Pennsylvania State University. University Park, PA.

Attia Iram. 2022. Microbial production of cellulases and hemicellulases using distillers' dried grains with solubles (DDGS) as the feedstock. Ph.D. Dissertation.

Hai Nguyen. 2022. Data-driven assessment of climate change impacts on agriculture in the Southeast of the United States. Ph.D. Dissertation. Pennsylvania State University. University Park, PA.

Evan Battisto. 2022. Additive manufacturing of sustainable composite materials containing cellulose nanomaterials. M.S. Dissertation. Pennsylvania State University. University Park, PA.

Morgan Roggenbaum. 2022. Engineering Transcriptional Logic within Bacteria using Multiplex, Modular CRISPRi Circuit Arrays. M.S. Dissertation. Pennsylvania State University. University Park, PA.

South Carolina

Ning Zhang, 2021, Pretreatment of Cellulosic Biomass Through Bioleaching to Reduce Inorganic Ingredients, Ph.D. Dissertation. Clemson University.

Virginia Evaluation of Surface Acetylated Bacterial Cellulose for Antibacterial Wound Dressing Applications, Timothy Joseph Bertucio, Department of Sustainable Biomaterials, Virginia Tech, May 2022.

Tennessee

Yang Li, M.S., Biosystems Engineering Technology, Major advisor: Dr. Abdoulmoumine. Thesis title: Deep learning-based prediction of clogging occurrences during lignocellulosic biomass feeding in screw conveyors. University of Tennessee Master of Science degree.

Conner Pope, M.S., Biosystems Engineering, Major advisor (Co-Major advisors: Dr. Abdoulmoumine and Dr. Nicole Labbé). Thesis title: CO2 Adsorption using functionalized MOF/Biochar composites produced from the pyrolysis of pine, hybrid poplar, and switchgrass. University of Tennessee Master of Science degree.

Washington

Zhangyang Xu. Ph.D. Thesis: "Fundamentals of Bioconversion of Biorefinery Wastes to Lipids by Rhodococcus Strains", Washington State University, Richland, Washington, May, 2022. "

Wisconsin

"William Yamada - Biomass bale detection and localization using aerial imagery (December 2021)

Synergistic activities

Alabama

1) Dr. Yi Wang collaborates with the Virginia station; we work together to obtain a DOE grant and submit several other grant applications. Wang also provided the engineered strains for their project for the PI at the Virginia station.

2) Investigators serve on the review panel for several grant agencies in United States.

California

Collaboration included researchers from the University of Maryland and the University of California, Berkeley. Collaboration on bioplastics production included researchers from Kansas State University and USDA ARS Western Regional Research Center.

Hawaii

Su lab is actively collaborating with Dr. Yinjie Tang of the Washington University in St. Louis in the State of Missouri.

Khanal's lab is actively collaborating with the following national and international collaborators:

Prof. Karthik Chandran, Columbia University: Nitrogen Transformations in Aquaponic

Prof. Lutgarde M. Raskin, University of Michigan: Microbial Community Analysis in AD System Digesting Cellulosic Biomass

Prof. Hong Liu, Oregon State University: Machine learning applications in anaerobic digestion.

Dr. Bongkeun (BK) Song Ph.D., College of William & Mary: Microbial communities in NB-aerated aquaponics

Dr. Deb Jaisi, Delaware University: Chemical Characterization of Biochars for Sulfide Removal from Biogas

Prof. Sushil Adhikari, Auburn University: Integrated Anaerobic Biorefinery and Thermochemical Conversion

Prof. Jeffrey Tomberlin, Texas A& M University: Black Soldier Flies (BSF) for Organic Waste Valorization.

Kentucky

UK researchers have worked with researchers at 14 states including Kansas, Louisiana, Ohio, Virginia, Vermont, Florida, Idaho, North Carolina, Nebraska, Michigan, Mississippi, Tennessee, California, and Iowa on joint proposals and publications

Massachusetts

Collaborative research and patent application: Univ. North Texas – formaldehyde emission from wood.

Minnesota

We collaborated with 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. We continue to work with agencies and companies including Minnesota Metropolitan Council Environment Services, Holistic Health Farms, Forsman Farms, Resynergi and Minesga.

Missouri

Co-listings with North Central Regional Aquaculture Center; https://www.ncrac.org/

Montana

Chen's group at Montana State University has been working with University of Kentucky conducting multi-state hemp variety trials. Chen's group also worked with Virginia Tech to evaluate hemp protein characteristics. Chen's group is currently participating a DOE funded camelina project led by Dr. Chaofu Lu at Montana State University which involves many scientists from DOE lab at Berkley University, UC Davis, USDA-ARS Pullman etc.

Nebraska

Development of educational video games related to research models in partnership with IANR Science Literacy (visit growable.unl.edu)

Ohio

Collaboration with researchers from different institutions while gathering expertise to solve problems of common interest.

Oklahoma

Collaborated with Thaddeus Ezeji, Ohio State University, Ohio and Ajay Shah, Ohio State University, Ohio. Also collaborated with industry (Texoma Manufacturing, OK).

Pennsylvania

Co-PI (Dr. Richard) directs the Northeast Sun Grant Center of Excellence for USDA; serves as Deputy Technical Director of the DOE's National Risk Assessment Partnership for geologic carbon storage (consortium of five DOE National Labs (2011-present) as well as serves as co-chair of the National Council for Science and the Environment's Energy Education Community of Practice (2017-present). A major agricultural equipment company CNH provided field harvesting equipment and operator team for the field studies. In addition, Idaho National Lab provided field supplies and analyzed field crop samples. Co-PI (Dr. Costello) co-chaired three sessions of the International Symposium on Sustainable Technologies, June 2021. These sessions included curated presentations about methods and case studies of sustainability assessment of systems, e.g., life cycle assessment focused on waste management, bioprocesses, and nutrient cycling from leading research universities and federal research laboratories. Co-PI (Dr. Chemely) has been working with investigators at the University of Tennessee Institute of Agriculture (UTIA) and the University of Tennessee College of Veterinary Medicine (UTCVM). Co-PI (Dr. Catchmark) has been serving on the College of Agricultural Sciences Entrepreneurship and Innovation Board. Co-PI (Dr. Vasco-Correa) is part of the council for the Institute of Biological Engineering (IBE), the vice-chair of the Processing Technical Community of the American Society of Agricultural and Biological Engineers (ASABE), and the co-convener of the Bioeconomy Solutions Critical Issues Initiative of the Penn State Institute for Sustainable Agricultural, Food, and Environmental Science (SAFES). Co-PI (Dr. Chemly) has been working with investigators at the University of Tennessee Institute of Agriculture (UTIA) and the University of Tennessee College of Veterinary Medicine (UTCVM) and West Virginia University on the as part of a USDA-funded SAS project.

South Dakota

Collaborated with Mississippi State University and University of South Florida to submit proposal of clean hydrogen production from mixture of biomass and plastic wastes for DOE 2022 RFP

Tennessee

Collaboration with Oak Ridge National Laboratory, University of North Texas, TX Kansas State University, KS, Auburn University, AL, Nanjing Forestry University (China).

Co-chair, ES-220 Conversion of Biomass to Biofuels, ASABE AIM 2021

Organizer, ACS Annual Conference CELL Division, Fall 2021 and Spring 2022

Vice-president, ES-220 Bio-based Energy, Fuels and Products Committee, ASABE

Texas

TAMU Established collaboration with the following Research Institutions and Researchers: Pacific Northwest National Laboratory (PNNL) (Dr. Marifel Olarte), Penn State University (PSU) (Dr, Meng Wang), Montana State University Northern (MSUN) (Dr. Randy Maglinao)

Virginia

1. Collaborating with researchers at Auburn University to conduct system-level techno-economic analysis for the conversion of corn stover to butyl acetate.

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

3. Collaborating with researchers at the University of Georgia to advance our understanding of the structure-property-relationships of polysaccharides.

Washington

Collaboration with PNNL, NREL, ORNL Collaboration with Texas A&M Collaboration with University of Tennessee Collaboration with University of North Dakota.