S-1075 Multistate Regional Project

The Science and Engineering for a Biobased Industry and Economy

2018 – 2019 Annual Report

Submitted by Scott Pryor, PhD

North Dakota State University

S1075 Chair for 2018-2019

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

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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]

Alabama
In the past year, we continue to quantify properties of softwood and hardwood biomass that are important to the storage, preprocessing and transportation of these feedstocks. In addition, we also extend such efforts to other types of biomass, including energy crops and waste streams from pulp and paper industries.

Iowa
The flammability characteristics of fast pyrolysis biochars was assessed with test methods EPA 1030 and ASTM 4982 so as to give guidance for those who ship/store biochar.

Kentucky
We investigated dilute acid pretreatment, enzymatic hydrolysis and fermentation of eleven hemp varieties for biofuel production. Results show ethanol yield in the range of 70-90 gallons /dry ton hemp stem with the highest ethanol yield of 91.1 gallons /dry ton obtained from Futura 75, while lowest ethanol yield of 70.6 gallons /dry ton obtained from Codimone. Based on the agronomic data, the per hectare yield for fiber only variety ranged 2933.3 kg to 8340.3 kg, while for the dual variety it ranged 3582.2 kg to 7665.5 kg. Agronomic data of per hectare yield of industrial hemp stem alone was at a similar level to the other energy crops such as switchgrass and sorghum. In addition to the stems, field trial for the dual variety also showed a grain yield of 1082.7 kg/ha for Bialobrzeskie, whereas Santhica 27 obtained a grain yield of 554.8 kg/ha. Preliminary cost analysis indicates that dual-purpose variety has advantages over fiber only varieties, with Bialobrzeskie and NWG 331 generating higher per hectare gross profit than the other varieties.

Minnesota
We continue to study cultivation of algae for biomass production from wastewaters. Algae cultivation is used as an important module in our overall wastewater treatment and utilization system. Wastewater is thermophilically digested. The effluent is used to cultivate algae and then hydroponic vegetables. To improve the thermophilic AD process, we are investigating new methods to strip inhibitive ammonia and hydrogen sulfide and use biomass to improve the carbon to nitrogen ratio of the AD substrates. Our results show significant improvement in methane production and reduction in ammonia nitrogen in the effluent. Cultivation of microalgae on the effluent and co-cultivation of algae and vegetables were tested. The results show that the AD pretreatment greatly improved nutrient profile of animal manure and reduced the need to dilute the effluent for algae and vegetable growth. We are investigating the use of TiO2 photocatalyst to improve the removal and energy efficiency and biochar to further remove nutrients and particles.

Montana
1) MT S U is currently working on sugarbeet production for sugar and bioenergy feedstock. Conventional production has negative economic and environmental impact. Therefore, we are developing no-till production technique to reduce soil erosion, fuel consumption, and improve yield and economic benefits.
2) MT S U is evaluating dry peas for protein production. MT S U is also collaborating with Virginia Tech to evaluate protein contents and characteristics of different varieties of peas grown in different environments.
3) MT S U is currently evaluating industrial hemp as potential bioenergy or bio-product feedstock. This is the first year study and it has showed some promise. Results will be reported next year.

North Dakota
Efficient and cost-effective methods are necessary to preserve sugars in beet juice to enable year-long end-processing into bioproducts. A study on this was published in December 2018 that evaluated the effectiveness of preserving beet juice using organic acids. Hence, organic could be produced in-situ from a fraction of sugars in beet juice to preserve the remaining sugar fraction. The preserving acids and remaining sugars may then serve as fermentation substrates in other bioprocesses. Six organic acids (acetic, butyric, citric, lactic, propionic, and pyruvic) were used in three storage experiments where beet juice was stored at four pH levels (5.3, 5, 4.25, and 3.5) and at 22.5 for 21 - 38 days. Butyric, citric, and propionic acids helped preserve at least 92% of sugars at pH 4.5, and lactic acid only at pH 3.5. Meanwhile acetic and pyruvic acids helped preserve up to 88% of sugars at pH 3.5 during the storage period. Changes observed

in the stored beet juice mainly occurred within the first 10 days and thereafter the juice appeared stable. Future research goal will be focused on developing methods to achieve the needed desired storage conditions and validating storage techniques through final fermentations of stored beet juice.

Two new simulation developments were added to infield biomass bale logistics. The concept of headland was incorporated into a previous infield biomass bale aggregation simulation model. The headland is a peripheral strip harvested first to enable the turning of other large equipment within the field space. In addition, a more general logistics collection distance and track-impacted area model was updated to calculate as a function of the number of bales rather than assume a fixed number of bales.

Ohio
We focused on analyzing the logistics, costs and emissions for different feedstocks for the biobased industries, which included corn stover, miscanthus, pennycress (an oilseed), and Taraxacum kok-saghyz (TK) (an alternative rubber crop).

Production and logistics system for pennycress seeds was developed since it is a new oilseed crop. The pennycress production and logistics system included seeding, fertilizing, pesticide spraying, harvesting and handling, transporting to the country elevator, drying and storing in metal silos. The cost of production, harvest and post-harvest logistics, transport and drying and storage of oilseeds was in the range 170-230 $/metric ton (t) for pennycress. Cost of producing pennycress contributed to ~75% of the total pennycress production and logistics cost, primarily due to the costs of seeds and fertilizers.

We are currently analyzing the logistics systems for corn stover, miscanthus and TK rubber dandelion.

Pennsylvania
We have modelled feedstock production and harvesting strategies that spatially identify and efficiently manage economically marginal subfield areas. This year we developed and applied a high resolution biophysical and economic model to identify unprofitable areas, which in test counties were between 8 and 15% of annual cropland, much of which can be profitably converted to perennial biomass production where biomass markets are available. We are also characterizing feedstock characteristics along the value chain.

A project on quantified the effect of mechanical conditioning on the bulk density of miscanthus bales has been studied. The field study was carried out in Easton, Illinois and data collected included time and motion, fuel use and bale densities. The flail conditioning system performed better while mowing the miscanthus crops with higher travel speed, field capacity, and field efficiency. The roll conditioning system, on the other hand, performed better when baling roll-conditioned crop windrows. Flail conditioned bales had 5% higher density than roll-conditioned ones."

Tennessee
1) Switchgrass supplied via logistics chains of bulk-format versus bale-format were evaluated by the University of Tennessee and collaborators from harvest to processed feedstock delivered to a biorefinery. Field performance data measured under actual operating conditions for both systems served as the basis to conduct cost analysis per delivered dry ton. for a representative-sized biorefinery (371,870 dMg year-1). Analyses this year focused on the supply of round bales stored in 244 stacks adjacent to switchgrass production fields at an average travel distance of 72 km from the biorefinery. All logistics were assumed as separate tracks for harvest versus biorefinery supply, in order to maintain regular deliveries to the biorefinery without weather-related interruptions as experienced during harvest conducted from Nov. 1 to Mar. 1 each year. Round bales were harvested, transported to field side and stacked using tractors, and were handled henceforth using telehandlers to load and unload trucks and to feed grinders at the biorefinery. Equipment not used year-round were allocated moderate usage to other crops and applications to realistically spread fixed cost to other uses. Costs were conducted at diesel fuel costs of $0.53 L-1, $0.92 L-1, and $1.32 L-1 since actual diesel fuel prices varied during field performance measurements. Total feedstock costs varied from $54.59 to 67.93 dMg-1 for biofinery-delivered round bales of switchgrass after size reduction processes along with associated dust collection, to reduce environmental impact.

2) Examination of lignocellulosic biomass particle mechanics and its implications for conveyance

----- Synopsis: Over the last decade, substantial government and private sector investments have been made to establish a commercial biorefining industry that uses lignocellulosic biomass as feedstock. These efforts have focused on technology demonstration and deployment, biomass production, and developing logistics and supply chain systems to support the biorefining industry. As progress is being made in each of these areas, it has become apparent in recent years that technical challenges at the interface of the feedstock handling and conversion systems have received less attention despite the frequent occurrence of feeding and handling problems in integrated biorefineries and their impact on the efficiency operation of conversion reactors. This imbalance is the primary motivation for this activity. Our efforts have thus far been focused on carefully examining critical lignocellulosic conveyance systems in the thermochemical biorefineries to better understand relevant stress conditions of lignocellulosic biomass particle assemblies and to develop methods to rationally and experimentally extract particle and bulk scale properties necessary for accurately modeling specific conveyance processes through using a discrete element modeling framework.

Texas
Continued gasification research at Texas A&M University has generated licensing agreement from a couple of new private companies for the current year as follows:
1. Monte Cristo Gasifiers, LLC, Lincoln, Nebraska, (c/o CEO, David Blythe) Feedstock is poultry litter.
2. Creative Mills Solutions, LLC, Brooklet, Georgia, (c/o CEO, Gary Vande Linde). Feedstock is wood wastes.

These private groups have renewed contract with TAMU Sponsored Research Services at TAMU. The TAMU group helped build a commercial 0.5 MW system for each group and assisted in commissioning of the units. We have begun the pre-commercialization work with these companies.

A couple of interested parties is also seeking license of the TAMU gasification technologies as follows:
1. Namoi Cotton Limited, Toowomba, Australia (c/o John Haigh, Commodities Technical Officer) and
2. Teys Australia Lakes Creek Plant, Teys Group, Australia (c/o Michael Thomson, Communication and Stakeholder engagement Officer, Central Queensland University, Rockhampton, Australia)

These groups have started to develop contract with TAMU Sponsored Research Services at TAMU. The TAMU group will help build a commercial 1.5 MW system for each group and assisted in the design and construction. We will begin the pre-commercialization work with these companies shortly.

Washington
Our work in the feedstock supply area has focused on wheat straw and algae. USA is among the top five wheat producers, supplying an estimated 47.37 MMT in 2017/2018. Winter wheat accounts for 74% of the total wheat production, with the Pacific Northwest (PNW: Washington, Oregon, and Idaho) contributing 17%. Due to this high production, wheat straw is among the primary agricultural residues along with the residues of corn, barley, oats, and sorghum. We investigated 30 winter wheat varieties commonly grown in Pacific Northwest area and then selected the best varieties. Based on our findings, we assert that winter wheat can be developed as a dual-purpose crop by selecting appropriate genotypes to realize the potential of producing grain and cellulosic ethanol. Results also indicated that higher lignin content in wheat straw led to lower sugar yield. Further breeding efforts can be carried out to obtain more promising wheat varieties as a dual-purpose crop. Among the 30 tested varieties, Weatherford was selected as the best for dual-purpose wheat because it ranked highest in straw yield and potential sugar production per ha and 6th-highest in grain yield. Complementary to our wheat straw research effort, we investigated algal biomass production via mixotrophic process, including using mixotrophic growth mode as an effective way to increase productivity and exploring high-value coproduct possibilities to lower the cost of algae-based biofuels and bioproducts.

Wisconsin
We investigated the supply chain for biorefineries to demonstrate the economics and sustainability metrics of hub and spoke supply chain model.

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) We are investigating the production of epoxy from lignin via the hydrothermal liquefaction process (supported by a USDA-NIFA grant).
2) In another project supported by USDA-NIFA, we are engineering Clostridium strains for fatty acid production. Fatty acid esters, which are composed of fatty acid and alcohol moieties, are highly hydrophobic and can easily be separated from fermentation broth. Furthermore, esters have a much higher value as fuels or chemicals than their component fatty acid or alcohol precursors (as a food flavoring and various other industrial applications).
3) We also investigated the production of crude cellulase enzymes in house for biomass hydrolysis for the possible viable biofuel production from lignocellulosic biomass. For biomass saccharification, enzymes accounts for a big cost. It is highly desirable to achieve low-cost enzyme production on site for efficient biomass saccharification and biofuel production. We have an innovative Trichoderma sp. that can produce high level of cellulolytic and xylanolytic enzymatic activities as well as high Î²-glucosidase and Î²-xylosidase activities. We are using this strain to produce crude cellulase enzymes on-site for biomass hydrolysis.

California
An integrated system for producing Polyhydroxyalkanoates (PHA) from food waste was developed. Polyhydroxyalkanoates (PHA) is high-value polyesters with similar properties to conventional thermoplastics and is one of the major materials used for the manufacturing of biodegradable plastics. The developed PHA production system includes several processes, including carboxylate production by anaerobic fermentation, nutrients recovery and microbial PHA production using H. mediterranei. Glucose, volatile fatty acids (VFA), and fermented food waste were tested as substrate. H. mediterranei showed very good growth on these substrate with PHA yield from glucose and VFAs determined to be 0.2 gPHD/g glucose and 0.3 g PHA/g total carboxylates, respectively. Research continued on producing biofertilizers and biopesticie from anaerobically digested food waste. Digestate biofertilizer products had desirable chemical physicochemical characteristics for crop production. Economic model was developed and used to analyze the cost of biofertilizer products with the following findings. Biofertilizers are potentially cost-competitive with mineral and organic fertilizers. Solid products can be economically transported much farther than liquid products. Specific total costs range between $35-37 per ton of processed digestate. Model is particularly sensitive to changes in permeate selling price, capacity, capital cost, and energy cost. (Ruihong Zhang)

Strategies were developed for accumulating plant nutrients and/or biopesticides in agricultural soils following application of solid and liquid wastes from almond and tomato processing. Nematode and weed control was demonstrated with subsequent persistence of phytonutrients in the soil after degradation of the biopesticides (Chris Simmons)

A recombinant strain and a fed batch strategy were developed to co-ferment gluconate and glycerol to ethanol. Gluconate, an oxidized cellulose degradation product, could be produced from cellulosic biomass. Glycerol is a cheap and renewable resource for fuels and chemicals production and is available as a byproduct of biodiesel production. When gluconate and glycerol were used as the sole carbon source by Klebsiella oxytoca BW 21, ethanol yield was about 62%-64%. Co-utilization of both gluconate and glycerol in batch fermentation increased the yield of ethanol to about 78.7%. Decreasing by-product formation by deleting the pta, frd, ldh, pflA, and pduC genes in strain BW21 increased the ethanol yield to 89.3% in the batch fermentation of a glycerol-gluconate mixture. Continuous fed-batch fermentation was used to solve the utilization rate mismatch problem for gluconate and glycerol. An ethanol yield of 97.2 % was achieved in continuous fed-batch fermentation of these two substrates, and glycerol was completely used at the end of the fermentation. (Zhiliang Fan).

Conversion processes to valorize residues from almond production (almond hulls and shells) are being developed. In one project, almond hulls are enzymatically liquefied and fermented for maximal production of essential amino acid enriched protein for use as animal feed. In another project, almond production residues are fractionated to convert

lignin and hemicellulose fraction to glycolipids and fatty acids, and the cellulose fraction to high-value nanocellulose for use as biomaterials. (Tina Jeoh)

Illinois

1. Hydrothermal pretreatment coupled with disk milling was found to improve glucose and xylose yields in sorghum bagasse. This method was found to be more effective than hot water pretreatment.
2. Hydrothermal pretreatment was used to increase oil concentrations and improve saccharification of solids in corn germ meal, which has high concentrations of cellulose, hemicellulose and lignin.

Iowa

Microbial biosurfactant produced on soybean hull hydrolysate were effective as antimicrobial agents against foodborne pathogens Escherichia coli O157:H7 and Listeria monocytogenes, thus, showing potential to be used in food safety applications.

Kentucky

Alkali treated corn stover lignin was depolymerized by catalytic transfer hydrogenolysis (CTH) in supercritical ethanol with a Ru/C catalyst. The biooil was then sequentially extracted utilizing hexane, petroleum ether, chloroform and ethyl acetate as solvents in order of less polar to polar. The raw bio-oils and sequentially extracted fractions were compared for differences in monomeric and oligomeric phenolic compounds via gel permeation chromatography and GC/MS. Antimicrobial properties of these fractions were screened against gram-positive (Bacillus subtilis, Lactobacillus amylovorus, and Staphylococcus epidermidis), gram-negative bacteria (Escherichia coli) and yeast (Saccharomyces cerevisiae) by examining inhibitions to microbial growth. The average raw oil conversion yields from CTH were 49.21%, and during sequential extraction chloroform extracted 50% of the total oil weight while hexane was 25%, petroleum ether 8%, ethyl acetate 5%, and the water fraction contained 9%. GPC results showed a significant decrease in average molecular weight (Mw) of corn stover lignin (4339.1) after it was converted to raw oil (925.1) and the sequential extraction fractions (970-1099). The raw bio-oil was primarily comprised of hydroxycinnamic acid derivatives without C-C double bonds, alkylated phenols, and methoxylated phenols. The GC/MS data also suggests that the total identifiable monomer extraction yeild did not correlate to solvent polarity but to the order of extraction. The raw bio-oil was an effective antimicrobial agent to all tested organism besides L. amylovorous at concentrations less than 3 mg/ml. In terms of the sequential extraction fractions, total monomer concentration and the presence of specific monomers (i.e. homosyringic acid and vanillin) has correlations to antimicrobial activity, but the exact mode of action or antimicrobial activity of unidentified oligomers/compounds remains unclear.

Isoflavones are of interest to cattle producers as a replacement for the use of antibiotics as growth promoters. Isoflavones typically found in red clover are formononetin, biochanin A, daidzein and genistein. Surprisingly little work has been done on the effect of drying and storage conditions on the persistence of isoflavones in the red clover, but of course the clover must be dried and stored if the material is to be available year round. The objective of this study was to quantify the persistence of isoflavones in the red clover during the drying process and the storage process.

This project aims to study the effect of storing baled red clover, at relative humidities of 20%, 40% and 60% at 30Â°C, on the concentration and form of isoflavones in the hay over a time period. For preliminary studies fresh-cut red clover was packed in miniature bales, and then dried in 40% and 60% relative humidity chambers, to mimic the storage conditions of hay on the farm. The results indicate that the isoflavones persisted under these storage conditions. The isoflavone with the highest concentration in red clover, as indicated with HPLC-UV analysis, after a 4-month period, was formononetin followed by biochanin A, with minimal amounts of daidzein and genistein. To analyze the statistical significance of the data, the p-value of 0.05 was used as a threshold. A null hypothesis in this situation means there is no difference in isoflavone content, contained in red clover, stored in 40% and 60% relative humidity chambers after 4 months. The rejection of the null hypothesis concludes that the isoflavone content of red clover, stored in 60% relative humidity chamber, is higher than the isoflavone content of red clover, stored in 40% relative humidity chamber, in the 4-month period. The null hypothesis was rejected for values less than 0.05, therefore, data indicates isoflavone persistence is affected by the storage conditions of the red clover. Future work will focus on how much effect the storage conditions have on the kinetics of the degradation/interconversion of these isoflavones.

Michigan

Engineering Tools for Modeling of Polar Fluids

1. Recognizing that ethanol in gasoline is the most widely used biofuel, use of molecular simultations and quantum mechanical calculations has resulted in improved spectroscopic methods for study of alcohols in hydrocarbons such that the intregration of the entire hydroxyl infrared absorbance band can now be related reliably to formal concentration.
2. A new model permits improved representation of dilute alcohols in hydrocarbons.
3. An Aspen Plus user model has been developed and will become availble publicly in the fall to facilitate improved industrial modeling of separation processes for hydrogen bonding molecules in solution.

Bio-oil upgrading

1. The slate of model compounds transformed by electrocatalytic hydrogenation has been expanded using ruthenium on activated carbon cloth catalysts. Evidence of complete deoxygenation is observed when 4-propylguaiacol is converted to propylcyclohexane.

Fermentation

1. Two papers have been prepared to disseminate an algorithm for designing microbubble-sparged reactors that achieve high gas mass transfer rates more cost effectively than current methods. The first paper reviews advantages and disadvantages of alternative microbubble-generation methods for commercial-scale reactors, and the second presents mathematical models and an algorithm to design commercial-scale reactors aerated with ejector-style microbubble generators.

Digesters

1. A mechano-biological one-pot process has been developed to convert lignocellulosic biomass (solid digestate from animal manure, corn stover, switchgrass, and miscanthus) into mono-sugars with high yield and high titer.
2. Micro-particles of biochar and activated carbon as the conductive particles have been studied to enhance archaeal population in anaerobic digestion and further enhance methane production from organic wastes.

Minnesota

We continue to study microwave assisted pyrolysis and gasification of biomass to produce biofuels and bioproducts. We focused on catalytic pyrolysis using ZSM-5 and Y-zeolite catalysts and co-pyrolysis of biomass and waste plastics. The catalysts, used in-situ and ex-situ, significantly improved the hydrocarbon quality and the addition of waste plastics to the biomass helps improve the hydrocarbon yields. Experiments were also conducted to investigate the effect of hydrothermal pretreatments of biomass on the formation of aromatics during co-pyrolysis of corncob and polyethylene. It was found the pretreatment improved the aromatic yield, which can be attributed to several factors, including improved levoglucosan yields due to the removal of alkali and alkaline earth metals, hemicellulose decomposition, furan formation, and higher carbon content as a result of the pretreated biomass. Another major development is that we have successfully designed and constructed a new prototype continuous microwave assisted pyrolysis and gasification system that has much better feedstock handling capability and heating characteristics. More experiments using this new system are under way.

Mississippi

Dr. Fei Yu's Bioenergy Research Group at Mississippi had continue to investigate the biogas reforming and catalytic conversion for liquid hydrocarbons production. We designed nickel based nano catalysts for methane dry reforming with addition of carbon dioxide for syngas production. Furthermore biogas based syngas could be used for liquid biofuel production via catalytic conversion. We also developed iron based nano catalysts for liquid hydrocarbon production during catalytic conversion. The pyrolyzed biochar was also evaluated as catalyst support for bioenergy research.

Nebraska

Poly-hydroxybutyrate (PHB) production processes from both sugars and lignin were developed. Glucose, xylose and arabinose are the main sugars derived from pretreatment and hydrolysis of grasses, crop residues and corn fiber. Burkholderia sacchari DSM 17165 is a bacterium that can convert glucose, xylose and arabinose into PHB. The effects of sugar ratio, sugar concentration, and molar C:N ratio on PHB production were studied using a seven-run mixture design for sugar ratio combined with a 32 full factorial design. A polynomial model was built based on

experimental data and optimum conditions for different sugar streams were derived and validated. Highest PHB production (3.81 g/L) was achieved with arabinose at a concentration of 25.54 g/L (no glucose or xylose) and a molar C:N ratio of 74.35.

Also, PHB production by Cupriavidus necator DSM 545 using alkaline pretreatment liquor (APL) containing lignin from corn stover was studied. Plackett“Burman and central composite designs were applied to improve PHB production by empolying a supplement system consisting of oxidative enzymes (laccase, aryl alcohol oxidase (AAO)), mediators (ABTS, HOBT), DMSO, silica nanoparticle Aerosol R816 and surfactant Tween 80. First, screening experiments under Plackett-Burman design showed R816, ABTS and Tween 80 could significantly enhance PHB production. Additional experiments showed that HOBT and DMSO could be removed, and laccase and AAO needed to remain in the system. Second, a central composite design was applied to obtain the optimum supplemental levels of R816, ABTS and Tween 80. Under optimum conditions, theoretical maximum PHB production (1.9 g/L) was close to experimental PHB production (2.1 g/L). With the supplement system, a 10-fold increase was achieved compared to PHB production (0.2 g/L) without any supplements.

A flow cytometry method was developed to measure PHB content through fluorescence intensity after fluorescence staining in APL containing insoluble particles. A linear model with good fitness (R2=0.9939) was constructed to predict PHB concentration (0.2-2.1 g/L). A linear model (R2=0.8614) to predict cell number based on fluorescence intensity was also established.

North Dakota
The benefits of using pelleted corn stover compared to loose corn stover with low severity soaking in aqueous ammonia pretreatment and reduced enzyme loadings were studied. Loose and pelleted corn stover were treated with the same set of pretreatment and hydrolysis conditions. A range of low to high severity pretreatment conditions and enzyme loadings were tested to determine conditions to achieve 90% glucose yields. Glucose yields from pelleted biomass reached 90% with reduced pretreatment severities, enzyme loadings, hydrolysis time, or various combinations of these. At the highest enzyme loadings, use of pelleted corn stover enabled reductions in hydrolysis time up to 58%. It also allowed 80% reduction in enzyme loading at higher pretreatment conditions. At moderate pretreatment levels, either enzyme loadings can be reduced by 40% or hydrolysis time by up to 48%. Using pelleted biomass as a biorefinery feedstock allows flexibility in production with different processing options.

Superparamagnetic iron oxide nanoparticles (SPIONs) are a potential carrier for cellulases and accessory enzymes that can facilitate enzyme recovery and reuse. Improvement of SPION synthesis needs to overcome challenges of scalability, cost of production, environmental impacts and process and product control. Therefore, a tubular electrochemical reactor has been developed and the effects of reaction conditions on SPIONs characteristics were investigated. Spherical SPIONs were synthesized with varied size distributions depending on reaction conditions. Increasing electrolyte flow rate and current density caused a decrease in SPION size. X-ray diffraction crystal analysis revealed the presence of magnetite, graphite, and goethite. The productivity of the tubular electrochemical system was 7.29 mg SPION per min at optimum conditions (time: 5 min, current density: 30 mA/cm2, and flow rate: 18.6 g per s). The continuous tubular electrochemical method will offer advantages of scalability, electrolyte reuse, and SPION size control with the ultimate goal of reducing SPION production and biomass hydrolysis costs.

Ohio
Our focus was on waste valorization, primarily through anaerobic digestion (AD) and hydrothermal carbonization (HTC) of the digestate produced to produce hydrochar, as well as evaluating different pretreatment/preprocessing methods of the lignocellulosic biomass. Research thus far have shown promising results for HTC as volume reduction has been achieved in the amount of digestate produced after AD. Also, the separation of the solid and liquid streams after AD was easier for HTC treated digestate.

Oklahoma
Syngas Generated from Co-gasification:
Municipal solid waste (MSW) was mixed with switchgrass and co-gasified using Oklahoma State University's patented 60-kW downdraft gasifier. The general composition of the MSW was: food (14.6%), paper (27%), yard trimmings (13.5%), plastics (12.8%), metals (9.1%), rubber, leather and textiles (9%), wood (6.2%), and other (7.8%). Proximate analysis (weight %, dry basis) showed that MSW consisted of 77.5% volatile matter, 8.7% fixed carbon

and 13.7% ash, and had 4% moisture content (wet basis). Switchgrass consisted of 78.6% volatile matter, 17.5% fixed carbon and 3.9% ash, and had 8% moisture content. Ultimate analysis (weight %, dry basis) showed carbon, hydrogen, oxygen, and nitrogen to be 50.7%, 6.1%, 29.1%, and 0.14%, respectively, for MSW, while switchgrass was 49.6%, 5.7%, 40.4% and 0.30%, respectively. Feedstock was gasified at 0, 20 and 40% co-gasification ratios (CGRs), which is the ratio of MSW content in the feedstock mixture. Maximum temperatures in the reactor's combustion zone ranged from 700-900oC with an average temperature of 800oC. Syngas was cleaned using a cyclone separator and wet-scrubbed using an acetone-water mixture. The maximum heating value of syngas were 6.91, 7.74, and 6.78 MJ/Nm3 for CGRs of 0, 20, and 40%, respectively.

During this period, we also investigated devolatilization of food waste components. Food wastes differ in composition based on their sources and hence are difficult to use in gasification and pyrolysis technologies. The objectives of this study were to investigate the thermal devolatilization kinetics and pyrolysis products of three representative food components: lipids, carbohydrates, and protein. Devolatilization of carbohydrates and proteins occurred up to 600Â°C with a total weight loss of 90%. In particular, dextrose, sucrose, histidine, and phenylalanine exhibited a combined two-reaction decomposition scheme, whereas starch and valine exhibited a single-reaction scheme. Sucrose had a higher activation energy than dextrose as more energy was needed to cleave glyosidic linkages. Valine had the lowest activation energy (70.2 kJ mol-1) of all the protein model compounds due to its simple structure. However, the lipids primarily vaporized below 400Â°C and did not decompose. Pyrolysis products of carbohydrates were largely composed of furan and sugar-based compounds, whereas those of proteins varied depending on the type of protein. Because lipids mainly vaporized, only slight conversion (<1%) into different lipid types and hydrocarbons was observed.

Oregon
1. Developed ultra-high solid hydrolysis reactor for lignocellulosic biomass. The reactor can handle biomass concentrations up to 55% (w/w) and produces glucose or ethanol at ~225 g/L and ~105g/L titers during hydrolysis or SSF processes.
2. OSU developed a novel method that uses instantaneous mixing torque and rotational speed to estimate insoluble solids and glucose concentrations during enzymatic hydrolysis of biomass. This method is cost-effective for real-time monitoring and control of enzymatic hydrolysis and potentially scalable.

Pennsylvania
We have investigated microbial conversion of biomass into methane and carboxylic acids through various modes of anaerobic mixed culture fermentation, with a strong emphasis on mechanical cotreatment (milling during fermentation, mimicking the rumination and cud-chewing of a cow). This year we were able to demonstrate a 20% increase in methane production through cotreatment of switchgrass.

The project to produce hydrolytic enzymes production from distillers dried grains with solubles (DDGS) for cellulosic biomass hydrolysis for biofuels and other uses. In this study, it was proposed that DDGS can replace the high-cost feed-stocks to produce these enzymes. To achieve this goal, nine microbial strains have been evaluated to explore the potential of DDGS as the main carbon source for the enzyme productions. Maximum cellulase production of 1.030 IU/ml was observed for Aspergillus niger (NRRL 1956) on the eighteenth day and maximum xylanase of 34.8 IU/ml was produced by Aspergillus niger (NRRL 567) on day twelfth of shake-flask of fermentation. It was also observed that the bacterial enzyme production was relatively low as compared to the fungal enzyme production. This study shows that DDGS can be an efficient substrate for T. reesei and A. niger for the productions of cellulase and xylanase, respectively. Next phase of the study will further optimize the productions of cellulase and xylanase by these microorganisms in terms of growth parameters and media by using bench-top bioreactors.

In another project, ethanol production in biofilm reactor with non-sterile carob extract media and application of mathematical models to ethanol fermentation in biofilm reactor with carob extract and have been studied. The logistic model for cell growth, Luedeking-Piret model for ethanol production and Modified Luedeking-Piret model for substrate consumption were studied. Kinetic parameters were determined by fitting the observed values of the models. This study verified the potential of carob extract-based medium for increased economical production of ethanol. In conclusion, the ethanol production in a biofilm reactor is growth-associated since Î± (gP/gX) was greater than Î² (gP/gX.h) and Media D and E increased the economic production of carob extract-based ethanol.

The Salis Lab developed a new metabolic engineering technique that enables the simultaneous and stable regulation of 20+ gene expression levels (intracellular enzyme concentrations) through the introduction of a single, compact DNA cassette. To do this, they co-express 20+ single-guide RNAs in bacterial cells for CRISPR-mediated gene regulation (using deactivated Cas9SP) within a single contiguous expression cassette, called an Extra Long sgRNA Array, that is inserted into the bacteria™s genome. Importantly, in this project, the Salis lab designed and characterized toolboxes of highly non-repetitive promoters, sgRNA handles, and transcriptional terminators so that the Extra Long sgRNA Array does not have any repetitive DNA sequences, and therefore can be stably expressed inside the cell without triggering genetic instability. The Salis lab demonstrated the applications of ELSAs across three examples, including a metabolic engineering example where several enzyme expression levels in E. coli were knocked down to redirect metabolic flows and increase succinic acid production by 160-fold. This project also resulted in a new algorithm, the ELSA Calculator available at https://salislab.net/software/design_elsa_calculator, that automatically designs the sequence of an Extra Long sgRNA Array to regulate up to 28 targeted genes in a desired bacterial host.

In another project, the Salis Lab developed a new algorithm, the Non-Repetitive Parts Calculator, that automatically designs very large toolboxes of highly non-repetitive genetic parts, which are needed to engineer genetic systems without triggering genetic instability. Using the algorithm, we designed, constructed, and characterized 4350 highly non-repetitive bacterial sigma70 promoters with transcription rates that varied across a 1150000-fold range. We also designed, constructed, and characterized 1600 highly non-repetitive yeast Pol II promoters with transcription rates that varied across a 10000-fold range. These toolboxes of highly non-repetitive genetic parts enable large-scale genetic systems engineering without triggering genetic instability, for example, when growing cultures in large bioreactors.

South Dakota
South Dakota has explored innovative processing pathways to develop produce green diesel and/or bio jet fuel from non-food vegetable oils. The non-food oilseed crops, such as camelina, carinata, brown mustard, sunflower, canola, field pennycress, and flax seeds, were used to extract vegetable oils and then upgraded into advanced biofuels. moreover, the oilseed meal were further processed into value-added products. The research team also converted other biomass feedstocks including wood sawdust, corn stover, prairie cordgrass, etc. into bio-oils and thus upgraded into hydrocarbon "drop-in" fuels through pyrolysis and HDO processes. The pyrolysis by product biochar was used to develop activated carbon, graphene, and absorbents for use in super capacitor, biosensor, and smart packaging and smart fertilizer applications.

Tennessee
1) About 63 to 84% of lignin isolated from switchgrass, yellow pine and hybrid poplar was converted into valuable chemicals like phenols, eugenol, and guaiacol, using supercritical ethanol as solvating agent and FeNiB as catalyst at operating conditions of 320 oC for 4 hours.

2) The chemicals obtained from catalytic up-grade of lignin can be utilized in bioplastic applications via acrylate pre-modification.

3) Acrylate-modified lignin monomers can used in fabrication of advanced materials such as 3D printing with stereolithography. Lignin derived chemicals exhibit UV-scattering ability which can be successfully harnessed to control the critical laser dosages of 3D printers. This is a novel and high-value application for lignin-derived chemicals.

4) Process development for railroad tie valorization and conversion via the thermochemical route
---Synopsis: Last year, we reported on our on-going efforts to establish the technical feasibility of extracting and recovering preservatives from treated wood, e.g. used railroad ties and utility poles. These materials could only be incinerated or landfilled as they are considered hazardous wastes under new guidelines of the Environmental Protection Agency (EPA) due to the presence of known carcinogenic agents in the preservatives. We demonstrated that, using a combination of thermal treatments and chelating extraction, we could desorb (~97 % of main organic preservative, creosote, at the most severe conditions. We have also demonstrated that we could extract copper naphthenate, another common and problematic preservative found in treated wood. Its removal from used treated wood is critically important to the treated wood industry to reduce cost associated with disposal by incineration. In the end, we improve the quality of the remaining solids and, therefore its value, by increasing the specific energy content

and reducing the ash content. We carried out a technoeconomic analysis to evaluate the economics of a nth plant based on the technology investigated.

Texas
TAMU Beta Lab has completed the design and development of a 20-kW power generation system from waste oil. A student group volunteer was tasked to operate the system and net-meter the power output to the TAMU grid. The student group collects waste oil from nearby fast food restaurants, process the oil at Beta Lab and operate the system as part of their groups fund raising project.

Virginia
An integrated process to fully utilize each component of grape pomace was developed for the production of oil, polyphenols, biochemicals and biochars. The developed process will potentially enable grater commercialization of food waste materials.

A wet fractionation process was developed to process brewer's spent grain, a waste materials from brewing, to high protein powders and high fiber products. Further experiments were conducted to demonstrate that the produced high protein powders were effective to replace expensive fishmeal in shrimp diets. This finding would not only provide a sustainable protein source to the aquaculture industry, but also create a unique way to solve the waste disposal problems in the brewery industry.

Washington
Our outcomes under this objective include advance the science and technologies in the following areas: (1) Biomass pretreatment, (2) biochemical conversion, (3) thermochemical conversion, and (4) co-product development.
In the pretreatment area, our research effort aims at developing a sustainable biomass pretreatment process that reduces the processing cost for liberating sugars from lignocellulosic biomass, thus improving economics of cellulosic based biofuels. Two strategies were explored: hydrothermal liqufection (HTL) and nature-inspired biomimicry approach. HTL focued on understanding aqueous biomass interactions at various temperature and pressure combinations as a first step to characterize a water-based pretreatment options. We studied water solvation effects on biomass reaction kinetics, mass transfer, and solubility. We clarified the relationship between pretreatment conditions and process configurations to explain how pretreatment conditions affect total sugar and lignin yields from biomass. With nature inspired biomimicry approach: we built upon previous work studying how biological systems in nature such a white-rot fungi and termite degrade plant cell wall. We discovered that the biological systems employ radicals for deconstruction of lignin. We designed a radical based system and prove the concept at the laboratory level and evaluated their effectiveness on lignin deconstruction and downstream release of sugar after the pretreatment.
In the bioconversion area, we focused developing cell factory to convert the cellulosic sugars produced from the above efforts will be converted to biofuels and biochemicals. We have developed a synthetic biology platform using Yarrowia lipolytica, an oleaginous yeast that has high capacity for synthesizing lipid based chemicals. We have design Y. lipolytica to different cell factories by installing special pathways for target biofuel and biochemical molecules. Examples of these molecules include fatty alcohols and dicarboxylic acids.

In the thermochemical area, we revealed that Inexpensive transition metals, including Fe, Ni, Cu, Zn, were severally co-loaded with Ru on HY zeolite to form bimetallic and bifunctional catalysts. These catalysts were subsequently tested for HDO conversion of softwood lignin and several lignin model compounds. Results indicated that the inexpensive earth abundant metals could modulate the hydrogenolysis activity of Ru and decrease the yield of low molecular weight gaseous products. Among these catalysts, Ru-Cu/HY showed the best HDO performance, giving the highest selectivity to hydrocarbon products.

In the co-product area, we focused on development of new strategies to characterize bio-char and engineering strategies to produce environmental adsorbents. Our experimental studies with commercially available model compounds and density functional theory (DFT) calculations of unknown compounds were very useful to inform new deconvolution strategies for the analysis of XPS, Raman and NMR spectra derived from cellulose, hemicellulose, lignin and proteins. These new deconvolution strategies allowed us to identify and quantify structures relevant for the removal of pollutants. We also developed new methods to characterize the chemical composition of bio-oils: New hybrid analytical approaches based in GC/MS, GC-FID, UV-Fluorescence, HPLC, LC-MS, TG-MS, Py-GC/MS,

GPC, NMR, Karl Fischer titration, solvent extraction and precipitation techniques were used to quantify the content of individual compounds, the content of functional groups and the content of chemical families present in bio-oils.
We also studied lignin-based thermosets and thermoplastic polymer blends with high lignin content. We explored a novel, effective and eco-friendly method for lignin modification, for example, modification of lignin in solid-state reactions, in aqueous medium, etc. In addition, we explored new synthesis methods and applications of bio-based self-healing polymers. We developed high performance self-healing thermosets based on the mechanism of vitrimer using abundantly available vegetable oils as feedstocks. We selected vegetable oil, rosin, dienephiles, lignin and other renewable chemicals and oligo polymers as feedstocks for the preparation of biobased self-healing polymers and build the structures of the polymer on reversible Diels- Alder addition and transesterification reactions. Some of the accomplishments under this objective were reflected in the publications under a different section of this report.

Wisconsin
We researched using a molten salt hydrate systems to produce fractionate biomass, produce fermentable sugars, and produce nanocelluose.

We investigated producing several products from a gamma-valerolactone solvent-based fractionation system to produce products from the cellulose, lignin and hemicellulose streams.

We investigated new methodologies to lower the cost of producing nanomaterials from biomass.

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

We have a new faculty member working in the Life-Cycle Assessment of biofuel and biochemical production. We now conduct a LCA analysis project related to the energy, nutrients, vegetables and fish production in an aquaponics system. We have also started a Life-Cycle Assessment for Biological Systems class for both undergraduate students and graduate students at Auburn University.

Calfornia

Integrated systems modeling and spatial analysis is ongoing as part of the development of a decision support application to determine optimized supply chains for electricity and fuels from biomass. The modeling approach includes spatial mapping of forest resources in California, including dead and dying stock that represent significant fire hazard, coupled with GIS estimations of transport distances and costs, technoeconomic modeling of feedstock processing and conversion, and distribution costs for product delivery into final demand. Lifecycle modeling is included to evaluate environmental impacts and related outcomes. A web application is in development to provide general access for project evaluation, policy assessment, and improved resource management strategies. (Bryan Jenkins)

Michigan

1. Problems of cellulosic biofuels scale and the resulting poor competitiveness can in part be overcome by dispersed pretreating and pelletizing of cellulosic biomass
2. Use of pretreated crop residues in integrated biofuel-livestock production systems can increase per acre agricultural output without increasing the acres cultivated
3. Changing the national Renewable Fuel Standard by allowing more non-compliant biofuel to participate would increase overall greenhouse gas reductions

Bio-oil upgrading

4. A technoeconomic analysis for converting modified sorghum that co-produces plant oils reveals a markedly better value proposition when both ethanol and biodiesel are cogenerated as fuel products, i.e. the additional capital cost for transesterification is justified.
5. A decision support system was constructed and verified for placing biomass torrefaction depots in solid fuel supply chains to ultimately make electrical power.
6. Problems of cellulosic biofuels scale and the resulting poor competitiveness can in part be overcome by dispersed pretreating and pelletizing of cellulosic biomass
7. Use of pretreated crop residues in integrated biofuel-livestock production systems can increase per acre agricultural output without increasing the acres cultivated
8. Changing the Renewable Fuel Standard to meet an overall greenhouse gas reduction target rather than a per gallon target would increase overall GHG reductions.

North Dakota

While the production costs and logistical benefits of biomass pelleting have been widely discussed in literature, the downstream economic benefits of processing pelleted biomass have been largely neglected. To investigate those economic benefits, we performed a comparative techno-economic analysis of producing ethanol using loose and pelleted forms of biomass. A spreadsheet model was developed based on a National Renewable Energy Laboratory (NREL) process model. The pretreatment and hydrolysis input data were based on our lab results while additional process assumptions were based on other published studies. The biorefinery operates at a 2000 metric tons (dry) per day capacity. Analysis showed that using a pelleted biomass is more economical than using loose or baled biomass.

The lowest minimum ethanol selling price (MESP) for pelleted biomass was $0.58 per gal less than the lowest MESP for loose biomass. Among all processing conditions analyzed, MESP for ethanol produced with pelleted biomass was always lower than when produced with loose biomass. Shorter pretreatment and hydrolysis times, higher pretreatment solids loadings, lower ammonia requirements, and reduced enzyme loadings were the primary factors contributing to lower MESP with pelleted biomass.

Ohio

Techno-economic feasibility of producing novolac resins by substituting the phenols used in the process conventionally obtained from petroleum, with biooil obtained from fast pyrolysis of pine wood chips was studied. The total cost of producing novolac resin was comparable to the cost of novolac resin produced from petroleum. It was found that biooil could replace up to 50% of the petroleum-based phenols by mass without compromising resin yield. In order to improve the economics of novolac resin production from biobased-sources, technologies for improving the extraction of phenol from biooil should be developed and implemented.

Techno-economic analysis of lactic acid production from corn grain, corn stover and miscanthus through three fermentation pathways, including bacteria, fungi and yeast, was conducted. The total lactic acid production costs for all feedstocks and through different pathways were comparable to lactic acid produced from petroleum. The total production cost for lactic acid production using yeast was the lowest for both corn grain and corn stover because yeast can withstand the acidic conditions created by lactic acid production and there is no need for neutralization during the fermentation process. Identification of micro-organisms that can withstand the acidic fermentation conditions can improve the economy of the process.

Life cycle analysis of lactic acid production from corn grain, corn stover and miscanthus was done to evaluate the environmental impacts. The global warming potential (GWP) for biobased lactic acid produced through different pathways were 63-88% lower than that for petroleum based. Among the three pathways used for lactic acid production, yeast had the least GWP because neutralization process was not required, which meant chemicals and energy requirements for the process was lower. Thus, improvement of process efficiencies that can improve the economics of the process can also increase the environmental benefits of producing lactic acid from biobased feedstock.

Oregon

1. OSU developed a new time-variant input-output model for understanding the Food-energy-Water nexus. A case study for middle Columbia basin was conducted.
2. Detailed techno-economic analyses and LCA were conducted for to assess if the combination of approaches involving surfactants addition at high solids enzymatic hydrolysis and fermentation using fed-batch technique will improve the economic performance and reduce the environmental impacts of the overall process
3. A methodology for conducting an integrated techno-economic analysis and LCA for Bioprocess Design was developed and used for evaluating the efficacy of the surfactant addition in cellulosic ethanol process.
4. A model predictive controller coupled with economic and environmental constraints for optimum algal production was developed and tested.

Pennsylavnia

We did 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. We have 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 continue our work to quantify carbon offset benefits in forest and cropland

bioenergy systems, including opportunities for Biomass Energy Carbon Capture and Storage (BECCS). We gave conference presentations and are completing papers on several of these topics as indicated below

We explored perspectives of airport management on aviation biofuels in the Pacific Northwest of the USA. This study studied perspectives of airport management on aviation biofuels in the Pacific Northwest of the USA by administering an online survey of airport managers in FAA certified airports in the region. Respondents provided their opinions on factors important for sustainable aviation fuel (SAF) development in the Pacific Northwest, including perceptions of various potential drivers and barriers to scale-up in the region. Most respondents indicated that policy certainty to attract capital, higher oil prices, and technology breakthroughs are required for a viable industry, and they also indicated that government intervention is important to ensure successful adoption and implementation. Respondents indicated that aviation biofuel tax credits, a system to issue and trade sustainable biofuel certificates, and fuel sustainability certification criteria are required policies/protocol to ensure viability. We suggest that a regional approach to examining barriers, drivers, and policy requirements provides more nuanced perspectives regarding key development and scale-up issues.

Texas

Texas A&M University (TAMU) AgriLife Research (AgriLife), through the research effort of Dr. Capareda has continually improved the state-of-the art fluidized bed gasification technology using various biomass wastes. The emphasis for this year is the continuous commercialization efforts to bring this research output into the hands of private communities. Monte Cristo Gasifiers has sold a 0.5 MW commercial unit in Germany.

The mobile gasification unit developed at TAMU AgriLife Research will be purchased by Arriba Energy, Houston, Texas (c/o Renato Nuguid, CEO) for deployment in a wastewater treatment facility.

Texas A&M AgriLife Research has also completed research on developing technologies for biodiesel. The current biodiesel work is the development of complete 20 kW power generation system using waste oil. A group of TAMU student volunteers has developed a simple protocol to gather waste oil from nearby restaurants near camps, convert this into certified biodiesel fuel at the BioEnergy Testing and Analysis Laboratory (BET Lab) and ran the generator with 100% biodiesel. The power output will be net-metered to the TAMU grid.

The highlight of this year research at Texas A&M AgriLife Research is the development of advanced graphene research. Dr. Capareda was successful in seeking grants (Hatch Project) to develop a manufacturing facility for making graphene from various agricultural crop residues via fast pyrolysis. Beta Lab has now facilities for making and evaluating graphene sheets through the acquisition of the following equipment.

a. Raman Spectrophotometer for initial screening and purification of bio-char
b. XRD Equipment for final purification of bio-char, and
c. Chemical Vapor Deposition (CVD) equipment for making graphene sheets

Beta Lab will be making new materials from carbon such as capacitors, new battery systems, graphene powders for making graphene ink and many more graphene based materials, the strongest material ever developed. These materials may also be used for waste treatment.

Washington

Our work in this area focused on two areas: the demonstration of a new bio-refinery concepts and techno-economic analysis (TEA) of biorefinery processes. The new biorefinery concept was tested at laboratory scale to transform crude bio-oils into new transportation fuels. The main efforts included development of solvent extraction separation techniques followed by-product development. The proposed bio-refinery targets the production of high value products from C1-C4 molecules (acetol, hydroxyacetaldehyde, and acetic acid), pyrolytic lignin, pyrolytic humins, and

anhydrosugars. The TEA work centered around lignin. Utilizing lignin feedstock for production of high energy density jet fuel along with cellulosic ethanol offers a significant opportunity to enhance the overall operation efficiency, carbon conversion efficiency, economic viability, and sustainability of biofuels and chemicals production. A patented catalytic process to produce lignin-substructure-based hydrocarbons in the jet fuel range from lignin was developed. Comprehensive techno-economic analysis of this process was conducted through process simulation in this study. Discounted Cash Flow Rate of Return (DCFROR) method was used to evaluate a 2,000 dry metric ton/day lignocellulosic ethanol biorefinery with co-production of lignin jet fuel. Minimum selling price of lignin jet fuel at a 15% discount rate was estimated to range $6.35~$1.76/gal depending on lignin flowrate capacity and conversion. With production capacities of 1.5~16.6 million gallon jet fuel per year, capital costs ranged $21.4~$39.6 MM (million)/yr. Overall, coproduction of jet fuel from lignin improved the overall economic viability of an integrated biorefinery process for corn ethanol production by raising co-product revenue from jet fuels. The reduction of minimum ethanol selling price was directly affected by the minimum jet fuel selling price, a direct function of plant productivity.

Wisconsin

We created spatial decision tools to minimize environmental impacts on stover removal.

We investigated additive impacts on greenhouse gas emission for anaerobic digesters.

Impacts

Alabama
1) Develop connections and collaborations with colleagues from other institutes.
2) Developed new bioprocess and projects for biofuel and biochemical production;
3) Secured federal grants for further biomass and bioenergy research, education and outreach;
4) Developed new courses in the biomass and bioenergy area, which will help train the next generation of workforce for the future bioeconomy.

Calfornia
The development of the forestry biomass decision support application informs the development of sustainable product streams and to help guide research and policy decisions. California in particular, but the western U.S. more generally, has experienced disastrous wildfires in the past two years that call for more extreme management strategies that benefit from the availability and development of bioenergy and bioproduct industries and improved decision tools to support feasible project development. Innovative technologies were developed to convert food waste and other agricultural and food byproducts into feed, biofuels, biofertilizer and biopesticide. Applications and deployment of these technologies will lead to valorization of biomass materials, increasing the sustainability of agricultural and food systems and accelerate the development of bioeconomy.

Illinois
Hydrothermal and disk milling pretreatment methods have potential to be effective in converting biomass to biofuels and bioproducts, with lower environmental impact and better economic feasibility that harsher pretreatment methods.

Iowa
1) Optimized processes and technologies for biosurfactant will lead towards sustainable biochemicals/biobased products with food safety implications.
2) Novel biochemical production processes were developed and tested for biorefining of soy, sugarcane bagasse, food waste, and other low value products to produce ethanol and biobutanol. Each of these systems were modeled to understand cost implications and potential environmental impacts.

Kentucky
The combined evaluations on hemp varieties illustrate that industrial hemp has significant potential to become a promising regional commodity crop for producing both biofuels and value-added products.

The antimicrobial study provides insights into the types of lignin derived compounds that confer antimicrobial activity and that compounds can be preferentially extracted from lignin bio-oil using a simple liquid to liquid extraction method.

Missouri
Deployment of cost effective algal bioenergy systems needs bridging applications yielding algal biomass while simultaneously providing profitable products within the same aquatic footprint. . The brine shrimp, Artemia, is ideally suited for rapid and efficient uptake and conversion of algal cultures into higher-value animal biomass. However, brine shrimp demonstrate growth and survival characteristics very different from other aquatic organisms. Quantitative understanding of these differences is critical to design and operation of successful brine shrimp culture. In particular, key design components and processes include, 1) Automated high density Artemia culture with continuous solids removal, 2) Optimum control of culture pH, and ammonia and CO2 levels and, 3) Continuous automated Artemia nauplii production. This work provides system design and operational parameters obtained from successful operation of pilot-scale prototypes installed and demonstrated at the University of Missouri.

Minnesota
Current major biofuels production is competing with food and feed demands, prompting the need to use non-food biomass feedstock for biofuel production. Our work on pretreating animal manure to produce effluent suitable for microalgae to grow would have significant impact on alternative biomass production. Thermochemical conversion of lignocellulosic biomass feedstock is a platform which can provide short and mid-term solutions. The major challenges for thermochemical conversion are the poor quality of the biofuel 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 wastewater based algae and hydroponic vegetable production technology also provides significant environmental benefits in addition to production of valuable biofuels, bioproducts, foods, and feeds.

Montana
Our research showed that we can produce similar sugarbeet yield under no-till compared to conventional tillage, and save $110 in fuel, machinery, and labor costs. Montana ranks 6th in the nation in sugarbeet production. The sugar industry in eastern Montana (and western North Dakota) contributes substantially to the regional economy. Protecting soil and environment is important to the sustainability of bio-feedstock production and supply.

Plant proteins have gained enormous attention in the past years as alternatives to animal proteins. Pulse proteins represent an attractive alternative due to their non-genetically modified status, neutral flavor profiles and low risk for allergen. Characterizing pea proteins produced by different varieties of peas grown in different environment will help producers to select variety and environment to produce high quality peas with end user desired specifications.

Mississippi
In collaboration with Choctaw Coal Energy, a local private company, we are designing a mobile bio-refinery system to convert waste flare off gas into liquid biofuel.

Nebraska
A new proposal is being developed for the USDA Sustainable Agricultural Systems program involving three S1075 members, M. Wilkins (NE), J. Shi (KY) and Y. Zheng (KS). The initial letter of intent was encouraged for a full proposal submission. A preproposal to DOE EPSCOR involving Wilkins and Zheng was developed in December 2018, but it was not encouraged for a full proposal.

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

Oklahoma
We demonstrated co-gasification of two underutilized resources: MSW and switchgrass (an agricultural biomass).

We investigated devolatilization of food waste components to dmeonstrate that food wastes that differ in composition based on their sources and hence are difficult to use, can be used in gasification and pyrolysis technologies.

New Syngas fermentation strains have been discovered and characterized for the ability to make C2 to C6 alcohols and fatty acids.

Oregon
1. A new design of horizontal ultra-high solids reactor was developed.
2. A new method for in situ-real time monitoring of insoluble solids was developed.
3. A model predictive controller was developed for algal pond control.
4. A time-variant input-output model was developed for understanding the Food-energy-Water nexus on a watershed scale.
5. A design methodology for incorporating the TEA and LCA into early-stage bioprocess design was developed and tested.

Pennsylvania
Increased use of economically-viable and sustainable processes will require deliberate development and refinement of novel technologies. Implementation of economically viable and sustainable processes is urgent due to three converging issues: decrease in productive agricultural land due to urbanization pressures; using unsustainable methods to clear land for agricultural production; and increasing world population with a rising per capita energy use and consumption of animal protein. Global population will reach 9 billion by 2050. The breadth of these intersecting problems is so vast that constructive solutions can only be developed and implemented through collaborations that

cross traditional disciplinary boundaries. Replacing existing petroleum-based energy and products with those that are stemming from biomass and other agricultural products will require research and development.

South Dakota
1). A proprietary accurately controlled catalytic fast pyrolysis (ACCFP) process was developed by integrating biomass fast pyrolysis with novel multifunctional catalysts to directly convert lignocellulosic biomass into biofuels. Different heterogenous catalysts were synthesized by combing different transition metals (e.g. Fe, Ni, Mo, Zn, Cu) and noble metals (such as Pt, Pd, Ru) with the support materials of zeolite, alumina oxide, and activated carbon.
2).A process of directly isolating nanocellulose from biomass feedstocks was also developed by integrating mechanical and chemical approaches. By using the technology, we successfully produced cellulose nanocrystal (CNC) and cellulose nanofiber (CNF) from wood sawdust, prairie cordgrass, and corn stover at 87%, 79%, and 75% efficiencies, respectively.The CNC and CNF were used to develop biopolymer nanocomposites and smart fertilizer.
3). The research results were published in over 8 papers in professional journals and conferences.

Tennessee
The complexities to supply a commercially-consistent feedstock of biomass at predictable specifications involves target specifications for conversion, but also required specifications of biomass feedstock for efficient handling, conveyance, and reduced plugging.

Organosolv fractionation of lignocellulosic biomass yields low molecular weight lignin with high purity that could be used in the development of variety of materials and chemicals. Lignin could be used as a renewable substitute for petroleum-derived phenols and acrylates, by employing the aforementioned techniques for chemical modification and up-gradation.

Used treated wood represents a cheap, niche supply of biomass for thermochemical conversion, if the preservatives can be economically and sustainably removed. Results demonstrated that preservatives can be recovered and reused at high rates while enhance the biomass properties for thermochemical conversion.

Texas
The impacts of Texas A&M AgriLife Research related to involvement with S 1075 are as follows:
1. Helped with pre-commercialization of TAMU gasification technology by developing commercial-sized systems and assisted with commissioning
2. Development of new advanced research in the development of graphene materials from agricultural and waste bio-char for manufacture of advanced bio-materials such as capacitors, semi-conductors, adsorbents and filters and graphene ink for 3D printers
3. Power generation from biodiesel from waste oil and net meter the electrical power to the grid while developing smart grid systems.
4. Development of phot-bioreactor for advanced nutraceuticals production such as protein and the most potent antioxidant asthaxantin from micro-algae.
5. Development of advanced pyrolysis research for purified carbon production

Virginia
Involvement with S1075 provides a unique platform to communicate bioprocessing knowledge and findings, especially in the development of sustainable technologies to convert biomass resources to value-added products.

Washington
Our work produced a large amount of new information disseminated through scientific publications. The information contributed to the advancement of science and technology related to biorefinery and industrial biotechnology. It is anticipated that these results will have positive impact to the development of rural economy, enhancement of the energy security and combating climate change.

Wisconsin
Improved AD technologies for rural communities; Developed novel high-solids reactor; developed novel biobased nanomaterials.

Target Audience

Alabama
Engineers, Scientists, Industries, Policymakers, K-12 and college students.

California
The target audience includes stakeholders involved in the deployment of biorefinery systems and researchers participating in biofuel and bioenergy investigations. The scientific community, policy makers, industry and other stakeholders interested in bioenergy production and biomass conversion.

Illinois
1. Researchers working to convert biomass from various feedstocks into biofuels and bioproducts.
2. Policy makers seeking to understand progress being made in conversion of biomass into fuel ethanol using sustainable process methods.

Iowa
Biorefineries, R&D scientists, government scientists, government regulatory bodies

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.

Kentucky
Industrial hemp growers and the biofuel research community;
The biofuel research community and researchers interested in lignin-derived antimicrobials;
Researchers interested in providing isoflavones to cattle in a sustainable manner.

Michigan
Academic and Industrial Professionals

Missouri
This work will increase knowledge and understanding of the current "state of the art" of limited and zero discharge aquaculture and bioenergy co-production and environmental benefits, enhancing the potential for Midwestern farmers to successfully operate environmentally compatible seafood production into their existing farming activities, enhancing income and quality of life for rural Missourians.

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 audience 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.

Montana
Farmers, sugar industry, pea industry, protein industry, and general public consumers.

Mississippi
Our target audience for this work includes commercial growers and manufacturers of biofuels and other scientists in the field of biomass and bioenergy, or gas conversion into liquid fuels.

Nebraska
Ethanol production facilities, plastics companies, other bioprocess engineering researchers.

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
Scientists, engineers, graduate students, postdoctoral fellows, product developers, and the public.
Oregon "1. Professional peers (Faculty and graduate students at peer institutions)
2. Stakeholders in mid-Columbia basin (Farmers, City officials, Oregon DEQ)

Pennsylvania
The target audiences for this research include a) the science and engineering research community, b) biomass processing companies ranging from small start-ups to large multi-national companies, c) policy analysts and decision makers, and d) potential biomass producers and the general public. Stakeholders include state and national organizations, state and federal agencies, companies and industry consultants. There is also strong public interest in understanding the environmental impacts of the biomass production and processing technologies as well as comparisons to conventional petroleum-derived products. These various stakeholders are being engaged through ongoing extension education programming that includes public presentations, short courses, websites (www.bioenergy.psu.edu, eXtension, and NEWBio.psu.edu), scientific journal articles and extension publications. The project results will be benefit biomass producers, the bioprocessing/fermentation industry and the rural public in general as a result of production of value-added products and bioenergy from raw agricultural products or by-products.

South Dakota
1). Public customers: This audience was targeted because the bio-based products developed from this project will be ultimately used by public customers. The audience was targeted through publications of the research results, conferences, workshops, and extension/outreach activities.
2). Farmers and biomass producers: This audience was targeted because biomass feedstocks for production of bio-products in the future will be supplied by farmers and producers. They were targeted through formal and informal classroom instruction (many undergraduate students will choose food, energy, and biomass production as an occupation) and extension/outreach activities.
3). Research community: We are targeting agricultural engineering and food processing scientists. An understanding of our research results will help them develop new hypotheses that will advance their own research programs. We targeted these individuals through peer-reviewed publications and presentations at scientific meetings.
4). Undergraduate and graduate students: Undergraduate students have been targeted through a summer internship program. The program will help the students prepare for graduate school or a career in precision agriculture, food engineering, and biomass production. Graduate students will directly participate in the research project and get professional training to be ready for their career in food, energy, and biorefinery industries in the future.

Tennessee
Original Equipment Manufacturers (OEM) are targeted for the design, manufacture, and market equipment systems related to the harvest, handling, storage, transport, densification, pre-processing, and conversion of biomass to fuel and co-products.

Farm producers, biomass supply logistics firms, truckers, and biorefineries are targeted for the impact of supply logistics on conversion processes.

Treated wood producers as well as biorefiners and biomass suppliers looking for cheaper feedstock to blend at a depot. A local treated wood supplier, Nisus Corporation, was consulted and involved in the project.

The targeted audience for this activity includes academics at universities and Department of Energy national laboratories and, potentially, lignocellulosic biomass technology developers.

Texas
The list of targeted audiences are as follows:

1. Academic Research Personnel
2. Practicing Engineers
3. Extension personnel
4. Ranchers and Agriculturists
5. Students and Teachers
6. Private Investors

Virginia
Food processing companies, brewery industries, aquaculture industry

Washington
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
Scientists, producers, and policy-makers in bio-based product industries.

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Wisconsin

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2) Burch, T., S. Spencer, S. Borchardt, R.A. Larson, and M. Borchardt. 2018. Fate of Manure-Borne Pathogens during Anaerobic Digestion and Solids Separation. Journal of Environmental Quality, 47(1):336-344.
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4) Xuejun Pan. Fractionation, Conversion, and Valorization of Lignocellulosic Biomass in Inorganic Ionic Liquid (molten salt hydrate). 2018 AIChE Annual Meeting, October 28-November 2, 2018, Pittsburgh, PA.
5) Ning Li, Yanding Li, Chang Geun Yoo, Xiaohui Yang, Xuliang Lin, John Ralph, and Xuejun Pan. Solid-state depolymerization and isolation of lignin from lignocellulosic biomass. 2018 AIChE Annual Meeting, October 28-November 2, 2018, Pittsburgh, PA.
6) Xuejun Pan. Solid-state depolymerization: an innovative approach to isolate good lignin from lignocellulose for valorization. Xiamen Forum on Biomass Frontiers 2018, October 19-22, 2018, Xiamen, China.
7) Yang Liao and Xuejun Pan. Fabrication of cellulose and whole biomass aerogels directly from ground Douglas fir using a molten salt hydrate as solvent. 2018 International Conference on Nanotechnology for Renewable Materials. June 11-14, 2018, Madison, WI.
8) Xuejun Pan. Applications of molten salt hydrates in fractionation, conversion, and valorization of lignocellulosic biomass. 255st ACS National Meeting & Exposition, March 18-22, 2018, New Orleans, LA.
9) Ning Li, Li Shuai, Chang Geun Yoo, Yanding Li, Xiaohui Yang, Shuting Zhang, Xuliang Lin, John Ralph, and Xuejun Pan. Solid-state depolymerization and fractionation to produce uncondensed lignin from lignocellulosic biomass for valorization. Lignin Gordon Research Conference. August 5-10, 2018, Easton, MA.
10) Yang Liao, Shu-Ching Yang, Ning Li, KG Karthikeyan, and Xuejun Pan. Fabrication and functionalization of 1D and 3D cellulose-based nano-materials. 2018 Nanoscale Science and Engineering for Agriculture and Food Systems, Gordon Research Conference. June 3-8, 2018, South Hadley, MA
11) Yang, Qiang, and Troy Runge. ""Cross-linked Polyethylenimine for Selective Adsorption and Effective Recovery of Lignocellulose-Derived Organic Acids and Aldehydes."" ACS Sustainable Chemistry & Engineering (2018).
12) Chen, Mingjie, Troy Runge, Lingling Wang, Ruimin Li, Jing Feng, Xiu-Lin Shu, and Qing-Shan Shi. ""Hydrogen bonding impact on chitosan plasticization."" Carbohydrate polymers 200 (2018): 115-121.
13) Kumar, Sandeep, Vivek Ahluwalia, Pranati Kundu, Rajender S. Sangwan, Sushil K. Kansal, Troy M. Runge, and Sasikumar Elumalai. ""Improved Levulinic Acid Production from Agri-residue Biomass in Biphasic Solvent System through Synergistic Catalytic Effect of Acid and Products."" Bioresource Technology 251 (2018): 143-150.
14) Elumalai, Sasikumar, Bhumica Agarwal, Troy M. Runge, and Rajender S. Sangwan. ""Advances in Transformation of Lignocellulosic Biomass to Carbohydrate-Derived Fuel Precursors."" In Biorefining of Biomass to Biofuels, pp. 87-116. Springer, Cham, 2018.
15) Kim, Seungdo, Xuesong Zhang, Bruce Dale, Ashwan Daram Reddy, Curtis Dinneen Jones, Keith Cronin, Roberto Cesar Izaurralde, Troy Runge, and Mahmoud Sharara. ""Corn stover cannot simultaneously meet both the volume and GHG reduction requirements of the renewable fuel standard."" Biofuels, Bioproducts and Biorefining 12, no. 2 (2018): 203-212.

Related Presentations

Alabama

1. Q. Wang2, B.T. Higgins. 2019. Use of Activated Sludge to Overcome Algal Inhibition during Growth on Anaerobic Digestate (oral). Annual International Meeting of American Society of Agricultural and Biological Engineers. July 7-10, Boston, MA.
2. B.T. Higgins, David Blersch, Daniel Wells, Terry Hanson. 2019. Life Cycle Assessment of Aquaponics Systems (oral). Annual International Meeting of American Society of Agricultural and Biological Engineers. July 7-10, Boston, MA.
3. B.T. Higgins, Kristin Chaump. 2019. Biological Phosphorus Mineralization in Poultry Litter as a First Step Toward Sustainable Nutrient Recycling (oral). Annual International Meeting of American Society of Agricultural and Biological Engineers. July 7-10, Boston, MA.
4. B. Holmes3, B.T. Higgins. 2019. Modeling of photosynthetic aeration for energy-efficient wastewater treatment. Undergraduate Research Symposium, Auburn, AL
5. K. Fogelman, J. Stoeckel, H. Abdelrahman, B. Higgins, H. Peng2, B. Helms. 2019. Evaluating the Feeding Ecology of Endemic Freshwater Mussels (Unionidae) in Central Texas Using Stable Isotope and Fatty Acid Analysis. FMCS, San Antonio, Texas.
6. K. Fogelman, J. Stoeckel, H. Abdelrahman, B. Higgins, H. Peng2, B. Helms. 2019. Evaluating the Feeding Ecology of Endemic Freshwater Mussels (Unionidae) in Central Texas Using Stable Isotope and Fatty Acid Analysis. SFAAS 2nd Annual Symposium, Auburn AL. Won 1st prize.
7. K. Fogelman, J. Stoeckel, H. Abdelrahman, B. Higgins, H. Peng2, B. Helms. 2019. Evaluating the Feeding Ecology of Endemic Freshwater Mussels (Unionidae) in Central Texas Using Stable Isotope and Fatty Acid Analysis. Auburn Research Symposium, Auburn AL.
8. M.R. Smith, T. Hanson, B.T. Higgins, D. Wells, D. Blersch. 2019. Developing a life cycle assessment framework for a decoupled aquaponics system. World Aquaculture Society, New Orleans, LA.
9. H. Peng2, L. Bashan, and B.T. Higgins. 2019. Investigating impacts of Azospirillum brasilense on green microalgae UTEX 2714 and production of biofuel precursors. Poster. National Biodiesel Conference and Expo, San Diego, CA.
10. Wang, Q.2, B.T. Higgins. 2019. Use of photocatalytic nanomaterials for volatile fatty acid removal from anaerobic digestate leads to improved algal growth. Presented at the Annual International Meeting of American Society of Agricultural and Biological Engineers. July 7-10, Boston, MA.
11. P. JimÃnez-Bonilla*, Jie Zhang, David Blersch, Yifen Wang, Luz-Estela Gonzalez-de-Bashan, Y. Wang**. srpB efflux pump from Pseudomonas putida increases robustness of Clostridium saccharoperbutylacetonicum N1-4 for biobutanol production. 2019 ASABE Annual International Meeting. Boston, MA, July 07-July 10, 2019.
12. P. JimÃnez-Bonilla*, David Blersch, Yifen Wang, Luz-Estela Gonzalez-de-Bashan, Y. Wang**. Exploring polycationic surfaces on the cell adsorption immobilization for acetone-butanol-ethanol (ABE) fermentation. 2019 ASABE Annual International Meeting. Boston, MA, July 07-July 10, 2019.
13. Jie Zhang*, Jun Feng*, Pixiang Wang*, Y. Wang**. Systematic genome engineering of solventogenic clostridia for biofuel and biochemical production. 41st Symposium on Biotechnology for Fuels and Chemicals, Society of Industrial Microbiology and Biotechnology. Seattle, WA, April 28-May 1, 2019.
14. Pixiang Wang*, Benedict Okeke, Y. Wang**. Enhanced isopropanol-butanol-ethanol (IBE) production using engineered Clostridium strain from switchgrass with Trichoderma in-house enzymes for biomass hydrolysis. 41st Symposium on Biotechnology for Fuels and Chemicals, Society of Industrial Microbiology and Biotechnology. Seattle, WA, April 28-May 1, 2019.
15. P. JimÃ©nez-Bonilla*, Y. Wang**. Exogenous efflux pump expression increase robustness against biomass hydrolysates inhibitors on fermentations of the hyperbutanol producer C. saccharoperbutylacetonicum N1-4. 41st Symposium on Biotechnology for Fuels and Chemicals, Society of Industrial Microbiology and Biotechnology. Seattle, WA, April 28-May 1, 2019.
16. Y. Wang**, J. Zhang*, W. Hong, P. Wang*, S. Wang*. Develop CRISPR-Cas genome engineering tools and engineer solventogenic clostridia for biofuel and biochemical production. Clostridium XV-International Conference on the Genetics, Physiology and Synthetic Biology of Solvent- and Acid-forming Clostridia. Technical University Munich in Freising, Bavaria, Germany, September 18-20, 2018.

17. P. Wang*, Y. Wang**. Efficient isopropanol-butanol-ethanol (IBE) production from lignocellulosic biomass by acetic acid thermal pretreatment with Clostridium saccharoperbutylacetonicum N1-4. Thermal & Catalytic Sciences Symposium (TCS) 2018. Auburn, AL, October 8-10, 2018.

Calfornia

1. Barzee, T. and R. Zhang. 2018 Sustainable Bio-Fertilizer from Anaerobically Digested Organic Wastes. Poster Presentation at California Bioresource Alliance Symposium, Sacramento, CA. November 15-16.
2. Barzee, B., A. Chio, C. Yothers, A. Edalati, A.Franz, and R. Zhang. 2018. Microalgae Cultivation on Processed Anaerobic Digestates Poster Presentation at California Bioresource Alliance Sympoisum, Sacramento, CA. November 15-16.
3. Wang, K., S. Cai, C. Chang, A. Edalati, J. Pan, Z. Fan and R. Zhang. 2018. Production of Biodegradable Plastics from Organic Waste. Poster Presentation, California Bioresource Alliance Sympoisum, Sacramento, CA. November 15-16.
4. Zhang, R. Using Food and Agricultural Waste to Power Sustainable Society. SCFIC2019: Convergence of Ag-Food-Consumer: From Sustainable Agriculture to Personalized Nutrition. Disneyland Hotel, Anaheim, CA. March 6, 2019.
5. Zhang, R. Powering Sustainable Society with Food and Agricultural Waste. BBC 2019-Biofuels and Bioenergy Conference. San Francisco. April 29, 2019.
6. Wang, K., S. Cai, C. Chen, J. Fan and R. Zhang. 2019. Production of Biodegradable Plastics from Food Waste. Presentation at ASABE Annual International Meeting. Boston, July 8.
7. Barzee, T., A. n Edalati, H. El-Mashad, B. Jenkins, J.Rapport and R. Zhang. 2019. Economic Analysis of Producing Solid and Liquid Biofertilizers from Anaerobic Digestates. Presentation at ASABE Annual International Meeting. Boston, July 9.
8. Zhou, M., T. Kasuga, X. Lu, Z. Fan 2019Direct conversion of pretreated wheat straw to cellobionic acid without any enzyme addition and the effect of lignin and lignin degradation products on the conversion system. Presentation at Symposium on Biotechnology for fuels and chemical Seattle, April 28th, 2019

Iowa

1. Oliviera, M. C. T. B., and K. A. Rosentrater. 2018. Characterization of sugarcane with focus on bioenergy production. ASABE Annual International Meeting, Detroit, MI, July 29-Aug. 1, 2018.
2. Muhammad, N. I. S. and K. A. Rosentrater. 2018. Techno-economic analysis of food waste to liquid fuels. ASABE Annual International Meeting, Detroit, MI, July 29-Aug. 1, 2018.
3. Mahmud, N. and K. A. Rosentrater. 2018. Economic comparison of biobutanol refining using low moisture anhydrous ammonia (LMAA) pretreatment and different downstream processing methods. ASABE Annual International Meeting, Detroit, MI, July 29-Aug. 1, 2018.

Kentucky

1) Kalinoski, R., Shi, J., 2018 AIChE Annual Meeting, ""Exploring Antimicrobial Properties of Lignin Derived Compounds and Materials,"" AIChE, Lecture, International, Pittsburg, PA, United States. (October 30, 2018).
2) Muley, P., Boldor, D., Shi, J., Lynn, B. C., 2018 AIChE Annual Meeting, ""Microwave Assisted Lignin Depolymerization Using Deep Eutectic Solvents,"" AIChE, Poster, International, Pittsburg, PA, United States. (October 29, 2018).
3) Stevens, J., Mobley, J., Das, L., Rodgers, D., Shi, J., 2018 AIChE Annual Meeting, ""Towards Biocatalytic Lignin Valorization in Aqueous Ionic Liquids Using Thermophilic Laccases,"" AIChE, Lecture, International, Pittsburg, PA, United States. (October 29, 2018).
4) Li, W., Amos, K., Li, M., Pu, Y., Ragauskas, A. J., Debolt, S., Shi, J., 2018 AIChE Annual Meeting, ""Characterization of Deep Eutectic Solvent Extracted Lignin Streams from Endocarp Biomass,"" AIChE, Lecture, International, Pittsburg, PA, United States. (October 28, 2018).
5) R. Oyetunji, SE Nokes and Mi.Flythe. ""The Effect of Drying Rate and Storage Conditions onthe Persistence of Isoflavones in Red Clover Hay"", 2019 ASABE annual meeting, Boston, MA (July 8, 2019)
6) RM Kalinoski, J Shi, ""Antimicrobial Properties of Lignin Derivatives from Thermochemical Depolymerization"", 2019 ASABE annual meeting, Boston, MA (July 8, 2019)
7) C Liu, ZW Wang, J Shi, ""Valorization of Steam Explosion-Pretreated Biosolids for Value-Added Enzymatic Bioproducts"", 2019 ASABE annual meeting, Boston, MA (July 8, 2019)

8) A Olaleye, RM Kalinoski, J Shi, ""Production of Lipo-chitooligosaccharides from Bradyrhizobium japocicum Grown on Food Waste"", 2019 ASABE annual meeting, Boston, MA (July 9, 2019)
9) W Li, YT Cheng, J Shi, ""Understanding Co-Pyrolysis of Lignin with Silicon Nanoparticles"", 2019 ASABE annual meeting, Boston, MA (July 9, 2019)

Michigan

1. Xu, M., Uludag-Demirer, S., Smerigan, A., Fang, D., Zhou, L., Liu, Y., Liao, W. 2019. Effects of biochar and activated carbon on anaerobic digestion of a nitrogen-rich organic waste " swine manure. Oral presentation at the 2019 ASABE Annual International Meeting, Boston, MA. July 8-10
2. Liao, W. 2019. A food-energy-water nexus solution to sustainably manage organic wastes. Oral presentation at the 2019 ASABE Annual International Meeting, Boston, MA. July 8-10
3. Zheng, Y., Clements, D., Cheng, S., Liu, Y., Liao, W. 2019. Synergistic integration of gas separation and algal cultivation to capture CO2. Oral presentation at the 2019 ASABE Annual International Meeting, Boston, MA. July 8-10
4. Liao, W. 2019. A self-sustaining wastewater utilization integrating solar-bio-nano-technologies. Oral presentation at the 2019 Water for Food Global Conference. Lincoln, NE. April 29-30
5. Liao, W. 2018. An integrated algae solution to address carbon dioxide and wastewater challenges of the power industry. Oral presentation at the 2018 Algae Biomass Summit. Houston, TX. October 14-17
6. Uludag-Demirer S., Olson, N., Ives, R., Nshimyimana, JP., Rusinek, C., Rose, J., Liu, Y., Liao, W. 2018. Techno-economic analysis of electrocoagulation on water reclamation and pathogen reduction of a high-strength organic wastewater. Oral presentation at the 2018 ASABE Annual International Meeting, Detroit, MI. July 29-August 1
7. Zhong, Y., Frost, H., Liao, W. 2018. An energy-neutral and chemical-free feedstock treatment process to generate mono-sugars for lignocellulosic biorefining. Oral presentation at the 2018 ASABE Annual International Meeting, Detroit, MI. July 29-August 1
8. Liu, Y., Song, L., Liao, W. 2018. Algal protein extraction by ball mill. Oral presentation at the 2018 ASABE Annual International Meeting, Detroit, MI. July 29-August 1
9. DeMaet, A.M.; Killian, W.G.; Killian, W., Viscometric Analysis Of Hydrogen Bonding Systems, ACS CERM 2019 Molecules to Materials, Midland, Michigan, June 3-8, 2019
10. Killian, W.G.; Peereboom L.; Storer, J.A., Norfleet, A.T., Jackson, J.E., Lira, C.T. Improved Methods for Obtaining Thermodynamic Model Parameters from Spectroscopy, Presented at the 2019 Midwest Thermodynamics and Statistics Mechanics Conference, Urbana, IL, June 2-4, 2019.
11. Killian, W.G.; Bala, A.M.; Peereboom, L.; Liu R.; Mathias, P.M.; Patel, N.C.; Cheluget, E.L.; Frank, T.C.; Peng, Y.; Gupta, S.; Lira, C.T. Implementation of Wertheim Theory for the Gamma-Phi Approach of Phase Equilibria Modeling, Presented at the 2019 International Conference on Properties and Phase Equilibria for Product and Process Design, Vancouver, Canada, May 12-16, 2019.
12. Bala, A.M.; Killian, W.G.; Peereboom, L.; Mathias, P.M. ; Patel, N.C.; Cheluget, E.L.; Frank, T.C.; Peng, Y.; Gupta, S.; Lira, C.T. Spectroscopy and QM/MM Simulations for Improved Modeling of Hydrogen Bonding,, ACS Spring Regional Meeting.
13. Killian, W.G.; Lira, C.T.; Killian, W. Effects of hydrogen bonding self-association on the viscosity of alcohol hydrocarbon mixtures, presented at the Schaap Chemistry Symposium, Holland Michigan, July 11-12, 2019. Exxon presentation
14. Jackson, J.E.; Kakeshpour, T.; Wu, J.; Bala, A.M.; Killian, W.G.; Lira, C.T. ""Adventures with Hydrogen Bonds: Modulation of Association Energetics, Spectroscopy, and Phase Equilibria"" presented to Exxon-Mobil, Fall 2018.
15. Saffron, C.M. Towards carbon-negative bioenergy and bioproduct systems using renewable electricity Presentation given at the Nanjing Agricultural University. December 2018. Nanjing, Peoples Republic of China.
16. Saffron, C.M. Towards carbon-negative bioenergy and bioproduct systems using renewable electricity Presentation given at the Zhejiang University. December 2018. Hangzhou, Zhejiang, Peoples Republic of China.
17. Saffron, C.M.; Das, S.; Garedew, M.; Fasahati, P.; Sak, R.; Jackson, J.E. Towards Carbon-Negative Bioenergy and Bioproduct Systems using Renewable Electricity. Plenary presentation given at the American Institute for Chemical Engineering Annual Meeting. 2018. Pittsburgh, PA.

18. Das, S.; Saffron, C.M. Kinetic Parameter Estimation for Electrocatalytic Hydrogenation of Model Compounds Derived from Fast Pyrolysis of Biomass. Poster given at the American Institute for Chemical Engineering Annual Meeting. 2018. Pittsburgh, PA.
19. Das, S.; Saffron, C.M. Techno-Economic Analysis of Biofuels Production via Localized Fast Pyrolysis and Electrocatalytic Upgrading. Poster given at the American Institute for Chemical Engineering Annual Meeting. 2018. Pittsburgh, PA.
20. Zhang, Z.; Saffron. C.M. Investigation of pyrolysis reaction pathways using isotopically labeled plant cell culture. Poster given at the TCS Symposium on Thermal and Catalytic Sciences for Biofuels and Biobased Products. October 2018. Auburn, GA.
21. Das, S.; Saffron, C.M. Life cycle assessment of biofuels production via localized fast pyrolysis and electrocatalytic upgrading. Poster given at the TCS Symposium on Thermal and Catalytic Sciences for Biofuels and Biobased Products. October 2018. Auburn, GA.
22. Sak, R.; Das, S.; Fasahati, P.; Saffron, C.M. Environmental Impact of Decentralized Electrocatalysis for Upgrading Bio-Oil to Make Liquid Fuel. Presentation given at the American Society of Agricultural and Biological Engineers. 2018. Detroit, MI.
23. Sak, R.; Saffron, C.M. Thermochemical Conversion of Biomass. Presentation given to 4-H students at MSU summer camp. July 25th, 2018. East Lansing, MI.

Missouri

1. Brune, D.E., Algal-Derived Feed and Renewable Fuel from Integrated Aquaculture Processes, World Aquaculture International Symposium, New Orleans, La., March 2019.
2. Brune, D.E., Algal-Derived Feed and Renewable Fuel from Integrated Aquaculture Processes Water, Food and Energy, Biofuels & Bioenergy Conference, San Francisco Calif., July 2019.
3. Brune, D. E., Jonathan Pote and Craig S. Tucker, Partitioned Pond Aquaculture: Split Pond vs. Partitioned Aquaculture System Performance, World Aquaculture International Symposium, New Orleans, La., March 2019.
4. Gregory Schwartz and David E. Brune, Modeling Oxygen and Nitrogen Dynamics in the Partitioned Aquaculture System, World Aquaculture International Symposium, New Orleans, La., March 2019.

Minnesota

1. Roger Ruan. 2019. Development of intensive pulse light technology for powdered foods disinfection. IFT Symposium on Intensive Pulse Light Technology Development and Application. IFT International Annual Meeting, New Orleans, LA.
2. Roger Ruan, Paul Chen, Min Addy, Yanling Cheng, Renchuan Zhang, Lu Wang, Peng Peng, Yiwei Ma, Kirk Cobb, Kuan Ding, Aoxi He, Jie Liu, Yaning Zhang, Richard Griffith, Shiyu Liu, Nan Zhou, Xiangyuan Deng, Hunwen Zhou, Hanwu Lei, Yunpu Wang, Yuhuan Liu. 2019. Microwave-assisted catalytic fast pyrolysis process and system for complete solid wastes utilization, Internaional Conference on Sustainable Solid Waste Treatments and Managements, Yangling, Shangxi.
3. Roger Ruan. 2019. Innovative Biorefining Technologies for Complete Solid and Liquid Waste Utilization and Treatment. In Symposium on Biofuels and Sustainable Development, International conference on Biofuels and Bioenergy, Theme: Water, Food, and Energy, April 29 - May 01, 2019, San Francisco, California.
4. Roger Ruan, Peng Peng, Paul Chen, Charles Schiappacasse, Nan Zhou, and Yanling Cheng. 2019. Development of non-thermal plasma (NTP) for sustainable agricultural applications. Mechanical Engineering Department Seminar, University of Minnesota. Minneapolis, MN.
5. Roger Ruan. 2019. Sustainable Food Production/Processing and Circular Economy Technologies. Agricultural Research Organization " Volcani Center, Institute of Soil, Water and Environmental Science, Newe Ya'ar Research Center, Israel.
6. Roger Ruan, Peng Peng, Paul Chen, Charles Schiappacasse, Nan Zhou, Yanling Cheng, and Min Addy. 2019. Non-Thermal Plasma (NTP) Ammonia Synthesis and Nitrogen Fixation. Lorentzen Investments " U of MN Ammonia Research Meeting, UMN.
7. Roger Ruan and Brian Bauer. 2019. Biomass to Energy Conversion Technologies. Forest Stewardship Campaign Initial Summit, Santa Rosa, CA."

Montana

1. Lu, Chaofu, C. Chen, T.P. Durrett, and S. Hulbert. 2018. Advancing camelina for bioenergy production through genetic, agronomic, and biotechnology approaches. 2018 ASA and CSSA Meeting, November 04-07, Baltimore, MD.
2. Mohammed, Y.A., and C. Chen. 2018. Evaluation of agronomic management practices for organic chickpea production. 2018 ASA and CSSA Meeting, November 04-07, Baltimore, MD.
3. Chen, C., A, Nilahyane, and R. Keshavarz Afshar. 2018. Nitrogen and water management of sugarbeet under no-till. 2018 ASA and CSSA Meeting, November 04-07, Baltimore, MD.
4. Chen, C., Y.A. Mohammed, and Zach Miller. 2018. Variety selection and integrated practices for weed control in organic chickpea production. 2018 Montana Organic Growers Association Conference. December 6-8, Great Falls, MT.
5. Chen, C. R. Keshavarz Afshar, and Y. Mohammed. 2018. Intensified dryland cropping systems for food and biofuel feedstock production. 2nd International Conference on Energy Research and Technology (ICERT™18), August 19-21, 2018, Madrid, Spain.

Mississippi

1. Dou, J., and F. Yu. 2019. Sandwiched SiO2@Ni@ZrO2 as a Coke Resistant Nanocatalyst for Carbon Dioxide Reforming with Addition of Methane. The 3rd International Conference on Bioresources, Energy, Environment, and Materials Technology 2019 (BEEM2019) . Hongkong, China. June 12-15, 2019. Poster Presentation.

Nebraska

1. Li., M., N. Wijewardane, Y. Ge, M. Wilkins 2019. Multivariate near infrared spectroscopy for predicting polyhydroxybutyrate production cultured on alkaline pretreatment liquor from corn stover. 2019 ASABE Annual Meeting, Boston, Massachusetts, USA, July 7-10, 2019.
2. Li, M., M.R. Wilkins, K., Eskridge. 2018. Statistical modeling to optimize lignin conversion to polyhydroxybutyrate by Cupriavidus necator. 2018 AICHE Annual Meeting, Pittsburgh, PA, USA, October 28 " November 2, 2018. Oral
3. Li, M., M.R. Wilkins. Quantitation of polyhydroxybutyrate production in alkaline pretreated liquor produced by corn stover alkaline pretreatment. 2018 ASABE Annual Meeting, Detroit, Michigan, USA, July 29-August 1, 2018. Poster
4. Wilkins, M.R., K., Eskridge, M. Li. 2018. Mixture-process variable experimental design to optimize sugar mixture (glucose, xylose and arabinose) conversion to polyhydroxybutyrate by Burkholderia sacchari. 2018 AICHE Annual Meeting, Pittsburgh, PA, USA, October 28 " November 2, 2018. Oral

North Dakota

1. Dooley, J., Igathinathane, C., Comer, K., Fasina, O., Kenney, K., Mani, S., and Sokhansanj, S. Needs and Benefits of ASAE/ASABE Standards, Engineering Practices, and Technical Data Applicable to Biomass and Related Industrial Feedstocks. ASABE Paper No. 1800514, ASABE Annual International Meeting, July 29 " August 1, 2018, Detroit, Michigan, USA (Oral Presentation).
2. Pandey, R,. Nahar, N., Pourhashem, G., and S.W. Pryor. 2019. Process Benefits of Using Biomass Pellets in a Cellulosic Biorefinery, Poster No. M52. 41st Symposium on Biotechnology for Fuels and Chemicals. Seattle WA. Apr 28-May 1, 2019. (poster)
3. Pryor, S.W., Zholobko, O., Hammed, A., and A. Voronov. 2019. Development of a continuous tubular electrosynthesis method for cellulolytic magnetic nanobiocatalyst production, Poster No. S35. 41st Symposium on Biotechnology for Fuels and Chemicals. Seattle WA. Apr 28-May 1, 2019. (poster)
4. Shafer, E., Thompson, B., Nahar, N., Pandey, R., and Pryor, S.W. 2018. Use of Pelleted Biomass to Increase Glucan Loadings in Simultaneous Saccharification and Fermentation. Governor School Students Presentation, North Dakota State University, Fargo, ND, July 12 (Oral and Poster Presentation).

Ohio

1. A. Khanal, S.H. Mousavi-Avval, A. Shah. 2019. Evaluating the physical and compositional characteristics of corn residues during the drydown period. ASABE Annual International Meeting 2019, July 7-10, Boston, MA.
2. Manandhar, A. Shah. 2019. Evaluating uncertainties in feedstock supply systems for a lignocellulosic biorefinery. ASABE Annual International Meeting 2019, July 7-10, Boston, MA.

3. L. Huezo, A. Manandhar, A. Shah. 2018. Techno-economic analysis of corn grain harvest and transportation. ASABE Annual International Meeting 2018, July 29-Aug 1, Detroit, MI.
4. A. Manandhar, A. Shah. 2018. Feedstock logistics for an integrated corn stover and energy crop based lignocellulosic biorefinery. ASABE Annual International Meeting 2018, July 29-Aug 1, Detroit, MI.
5. S.H. Mousavi Avval, A. Khanal, A. Shah. 2018. Pennycress feedstock logistics system for renewable jet fuel (RJF) production. ASABE Annual International Meeting 2018, July 29-Aug 1, Detroit, MI.
6. Manandhar, A. Shah. 2018. Techno-economic analysis of corn grain logistics from the field to biorefinery. S-1041 Annual Meeting 2018, July 9-10, Madison, WI. [Poster]
7. L. Huezo, J. Vasco, A. Shah. 2019. Hydrothermal carbonization of anaerobic digestion effluent of sewage sludge. ASABE Annual International Meeting 2019, July 7-10, Boston, MA.
8. J. Vasco-Correa, R. Capouya, T. Mitchel, Y. Li, A. Shah. 2018. Fungal pretreatment of miscanthus for fermentable sugar production: experimental and techno-economic evaluation. CFAES Annual Research Conference 2018, April 27, Wooster, OH. [Poster]
9. Khanal, G. Steinbeck, S. Khanal, A. Shah. 2019. Life cycle assessment of corn stover collection for biobased industries in Ohio integrating crop modeling. ASABE Annual International Meeting 2019, July 7-10, Boston, MA.
10. Manandhar, A. Shah. 2019. Techno-economic analysis of lactic acid production using corn stover. ASABE Annual International Meeting 2019, July 7-10, Boston, MA.
11. Manandhar, A. Shah. 2019. Life cycle assessment of lactic acid production using corn grains and stover. ASABE Annual International Meeting 2019, July 7-10, Boston, MA. [Poster]
12. J. Vasco Correa, A. Shah. 2019. Life cycle assessment of biochar and hydrochar production from anaerobic digestion effluent and land application. ASABE Annual International Meeting 2019, July 7-10, Boston, MA.
13. L. Huezo, A. Shah. 2019. Techno-economic analysis of a combined anaerobic digestion and hydrothermal carbonization system for sewage sludge processing. ASABE Annual International Meeting 2019, July 7-10, Boston, MA.
14. S. H. Mousavi Avval, A. Shah. 2019. Techno-economic analysis of pennycress conversion to aviation biofuel. ASABE Annual International Meeting 2019, July 7-10, Boston, MA.
15. S. H. Mousavi Avval, A. Shah. 2019. Environmental life cycle assessment of pennycress production as feedstock for aviation biofuel. ASABE Annual International Meeting 2019, July 7-10, Boston, MA.
16. A. Manandhar, A. Shah. 2019. Process-based life cycle assessment of lactic acid production from corn stover and miscanthus. CFAES Annual Research Conference 2019, April 22, Columbus, OH. [Poster]
17. J. Vasco-Correa, A. Shah. 2019. Technical, economic and environmental performance of soy methyl ester emulsions applied to aging asphalt roofing. CFAES Annual Conference. Wooster, OH. April 22, 2019. Poster.
18. S. H. Mousavi-Avval, A. Shah, E. Grotewold, A. P. Alonso. 2019. Techno-economic, Energy and Greenhouse Gas Emissions Analyses of Pennycress Production and Logistics for Aviation Biofuel. 2019 Genomic Sciences Program Annual Principal Investigator (PI) Meeting, February 24 " 27, Tyson Corner, VA. [Poster]
19. A. Khanal, S. Khanal, S.H. Mousavi-Avval, A. Shah. 2018. Greenhouse gas emissions from corn stover collection for cellulosic biofuel production. Tripartite Collaborative 2018, October 26-27, Columbus, OH.
20. Manandhar, A. Shah. 2018. Life cycle assessment of lactic acid production using corn stover and switchgrass. Tripartite Collaborative 2018, October 26-27, Columbus, OH.
21. S.H. Mousavi Avval, A. Shah. 2018. Life cycle energy and exergy analyses of pennycress production and logistics. ASABE Annual International Meeting 2018, July 29-Aug 1, Detroit, MI.
22. J. Wang, A. Shah. 2018. Techno-economic analysis of citric acid production via different conversion systems. ASABE Annual International Meeting 2018, July 29-Aug 1, Detroit, MI.
23. J. Wang, A. Shah. 2018. Techno-economic analysis of levoglucosan production via fast pyrolysis of cotton straw in China. ASABE Annual International Meeting 2018, July 29-Aug 1, Detroit, MI. [Poster]
24. Y.Y. Li, A. Shah, G. Li. 2018. Life cycle assessment of corn residues management and utilization practices in China. ASABE Annual International Meeting 2018, July 29-Aug 1, Detroit, MI.
25. L. Huezo, A. Khanal, A. Shah. 2018. Techno-economic analysis of corn and soybean production in Ohio. ASABE Annual International Meeting 2018, July 29-Aug 1, Detroit, MI.
26. A. Khanal, A. Manandhar, A. Shah. 2018. Techno-economic analysis of the production of novolac resin by partial substitution of petroleum-based phenol with phenolic compounds present in bio-oil derived from fast pyrolysis of pine wood. ASABE Annual International Meeting 2018, July 29-Aug 1, Detroit, MI.
27. Manandhar, A. Shah. 2018. Techno-economic analysis of lactic acid production using corn stover and switchgrass. S-1041 Annual Meeting 2018, July 9-10, Madison, WI. [Poster]

28. Manandhar, A. Shah. 2018. Techno-economic analysis of corn grain logistics from the field to biorefinery. S-1041 Annual Meeting 2018, July 9-10, Madison, WI. [Poster]

Oklahoma

1. N. Indrawan, P. R. Bhoi, A. Kumar, and R. L. Huhnke. Mobile-scale power generation from MSW and switchgrass: Gasification, engine power generation and engine emission performance. 2018 Thermal & Catalytic Sciences Symposium (TCS), Oct 8-10,2018 Auburn, AL
2. N. Indrawan, A. Kumar, P. Bhoi, R. L. Huhnke. Power. Generation from Co-Gasification of Municipal Solid Wastes and Biomass: Engine Power and Emission Performance. 2018 Annual International Meeting of ASABE, Detroit, MI, Jul 29-Aug 1, 2018.
3. Xiao Sun, Hasan K. Atiyeh, Ajay Kumar, Hailin Zhang, Ralph S. Tanner. Biochar Enhanced Alcohol Production from Syngas by Clostridium carboxidivorans. 2018 AIChE Annual Meeting. Pittsburgh, PA, October 28 November 2, 2018
4. Sun, X., H. K. Atiyeh, R. L. Huhnke and R. S. Tanner Comparison of New Syngas-Fermenting Acetogens for Ability to Produce of Alcohols and Fatty Acids, S-1075- Science and Engineering for a Biobased Industry and Economy, National Renewable Energy Laboratory, Golden, CO , July 29-30, 2019. Poster.
5. Sun, X., H. K. Atiyeh, Y. A. Adesanya, H. Zhang, C. Okonkwo and T. Ezeji ""Enhanced Acetone-Butanol-Ethanol Production by Clostridium beijerinckii Using Biochar, 2019 ASABE Annual International Meeting, Boston, Massachusetts, July 7-10, 2019. Oral.
6. Adesanya, Y.A., H. K. Atiyeh, X. Sun, C. Okonkwo, V. Ujor and T. Ezeji ""Butanol Production from Non-Detoxified Switchgrass Hydrolysate Using New Inhibitor Tolerant Strains of Clostridium beijerinckii, 2019 ASABE Annual International Meeting, Boston, Massachusetts, July 7-10, 2019. Oral.
7. Sun, X., H. K. Atiyeh, R. L. Huhnke and R. S. Tanner ""Alcohol Production by New Syngas Fermenting Microorganisms, 2019 ASABE Annual International Meeting, Boston, Massachusetts, July 7-10, 2019. Oral.
8. Marsh, W., Murdoch, R., Loffler, F., Mark, K., Atiyeh, H., Fathepure, B. Applying a Halophilic Mixed-Culture to Remediate Hydrocarbon Contaminated Produced Water. Microbiology and Molecular Genetics Symposium, Oklahoma State University, Stillwater, OK. April 12, 2019. Poster.
9. Marsh, W., Murdoch, R., Loffler, F., Mark, K., Atiyeh, H., Fathepure, B. Degradation of Environmental Pollutants in Toxic Produced Water. Annual Interdisciplinary Toxicology Symposium, Oklahoma State University, Stillwater, OK. March 8, 2019. Poster.
10. Sun, X., Y. Adesanya, T. C. Ezeji and H. K. Atiyeh, Butanol production from switchgrass with genetically modified microorganisms, CEAT Research Week, Stillwater, OK, USA, February 28, 2019. Poster.
11. Adesanya, Y., X. Sun, T. C. Ezeji and H. K. Atiyeh, Effect of Biomass Pretreatment on Butanol Production from Switchgrass, FAPC-OK Research Symposium, Stillwater, OK, USA, February 26, 2019. Poster.
12. Pamula, A., D. J. Lampert and H. K. Atiyeh, Assessment of the Environmental Impacts of Switchgrass to Jet Fuel, FAPC-OK Research Symposium, Stillwater, OK, USA, February 26, 2019. Poster.
13. Adesanya, Y., X. Sun, T. C. Ezeji and H. K. Atiyeh, Effect of Biomass Pretreatment on Butanol Production from Switchgrass, ASABE Oklahoma Section Annual Meeting-three minute presentations, Stillwater, OK, USA, February 22, 2019. Oral.
14. Sun, X., H. K. Atiyeh, A. Kumar, H. Zhang and R. S. Tanner Biochar Enhanced Alcohol Production from Syngas by Clostridium carboxidivorans, 2018 AIChE Annual Meeting, Pittsburgh, PA, October 28 " November 2, 2018. Oral.
15. Atiyeh, H. K., P. Munasinghe, K. Liu, R. S. Tanner and T. Ezeji ""Co-Fermentation of Sugars and Gases for Enhanced Alcohols Production"", 2018 ASABE Annual International Meeting, Detroit, Michigan, July 29-August 1, 2018. Oral.
16. Sun, X., H. K. Atiyeh, R. S. Tanner, A. Kumar and H. Zhang ""Enhanced Ethanol and Butanol Production from Synthesis Gas Using Biochar"", 2018 ASABE Annual International Meeting, Detroit, Michigan, July 29-August 1, 2018. Oral.
17. Dang, J., H. K. Atiyeh and N. Wang ""Development of a Mid-Infrared Sensor for Measurement of Dissolved Carbon Monoxide during Syngas Fermentation"", 2018 ASABE Annual International Meeting, Detroit, Michigan, July 29-August 1, 2018. Oral.

18. Sun, X., H. K. Atiyeh, H. Zhang and R. S. Tanner Enhanced Ethanol Production from Syngas Using Medium with Poultry Litter Biochar, S-1041- Science and Engineering for a Biobased Industry and Economy, Annual Meeting and Symposium, USDA Forest Products Laboratory, Madison, WI, July 9-10, 2018. Poster.

19. Dang, J., H. K. Atiyeh and N. Wang Development of a Dissolved Carbon Monoxide Sensor for Syngas Fermentation Bioreactors, S-1041- Science and Engineering for a Biobased Industry and Economy, Annual Meeting and Symposium, USDA Forest Products Laboratory, Madison, WI, July 9-10, 2018. Poster.
20. Sun, X., H. K. Atiyeh, Y. Adesanya, H. Zhang, C. Okonkwo and T. Ezeji Enhanced Acetone-Butanol-Ethanol Production by Clostridium beijerinckii Using Biochar, ASABE 2019 Annual International Meeting, Boston, Massachusetts, July 7-10, 2019 (10 pages), Paper number: ASABE -1900256. St. Joseph, Mich.: ASABE.

Oregon

1. Kadhum, H. and Murthy, G.S. 2018. Ultra high solid biomass hydrolysis and fermentation. Proceedings of 52th Annual Convention of Indian Society of Agricultural Engineers (ISAE). Anand, India.
2. Kadhum, H.J., Mahapatra, D.M., and Murthy, G.S. 2018. On the techno-economic feasibility of recycling hydrolyzed biomass to improve cellulose conversion. ASABE Abstract No. 1800620. ASABE, St. Joseph, MI.
3. Kadhum, H.J., Mahapatra, D.M., and Murthy, G.S. 2018. A comparative account of glucose yields and bioethanol production from SSF and SHF at high solids loading with variable PEG concentration. ASABE Abstract No. 1800644. ASABE, St. Joseph, MI.
4. Tabatabaie, S.M.H., and Murthy, G.S. 2018. Development and application of a quantitative framework for food-energy-water nexus in the Pacifc Northwest, USA. ASABE Abstract No. 1800228. ASABE, St. Joseph, MI.

Pennsylvania

1. Richard, T.L. Marginal Land Reconsidered: Risk and Resilience in Space and Time. Modeling Approaches to Develop Sustainable Biofuels: A Joint Bioenergy Research Center Workshop. May 2, 2019. Chicago, IL.
2. Richard, T.L. Toward a Carbon Negative Bioeconomy: Status and Prospects for Renewable Energy in US Agriculture. The 20th Agriculture, Forestry and Food Industry Future Creation Forum. Korean Institute for Planning and Evaluation in Food, Agriculture and Forestry. December 7, 2018. Daejeon, South Korea.
3. Amador-Diaz et al. 2018. Cotreatment enhanced mixed culture fermentation of switchgrass. Presented at Symposium on Biotechnology for Fuels and Chemicals, April 28 " May 2, 2018, Clearwater, FL.
4. Amador-Diaz et al. 2018. Mechanical cotreatment to enhance the anaerobic digestion of switchgrass. Presented at Institute of Biological Engineering annual meeting, April 5 " April 7, 2018, Norfolk, VA.
5. Herbstritt, S. K. Sciaudone, V. Vazhnik, D. Muth, F. Montes, A.R. Kemanian, J. Duncan, and T.L. Richard. 2018. Planting native perennial grasses in multifunctional riparian buffers for water quality and farm profitability. Presented at Institute of Biological Engineering annual meeting, April 5 " April 7, 2018, Norfolk, VA.
6. Herbstritt, S., K. Sciaudone, V. Vazhnik, D. Muth, F. Montes, A.R. Kemanian, J. Duncan, and T.L. Richard. 2018. Planting native perennial grasses in multifunctional riparian buffers for water quality and farm profitability. Presented at Energy Days May 30 " 31, 2018, State College, PA.
7. Amador-Diaz et al. 2018. Cotreatment enhanced mixed culture fermentation of switchgrass. Presented at Energy Days May 30 " 31, 2018, State College, PA.
8. Bharadwaj A., Whitham J., Brown S., Holwerda E., Lynd L.R., and T.L. Richard. 2018. Anaerobic digestion of lignocellulose using mixed microbial populations. Energy Days, May 30 - 31. State College, PA.
9. Bharadwaj A., Whitham J., Brown S., Holwerda E., Lynd L.R., and T.L. Richard. 2018. Anaerobic digestion of lignocellulose using mixed microbial populations. Symposium for Biotechnology in Fuels and Chemicals, April 29 - May 2, Clearwater, FL.
10. Bharadwaj A., Whitham J., Brown S., Holwerda E., Lynd L.R., and T.L. Richard. 2018. Anaerobic digestion of lignocellulose using mixed microbial populations. Center for Bioenergy Innovation Annual Meeting. June 4 - 6. Asheville, NC.
11. Amador-Diaz et al. 2018. Fundamentals of Cotreatment: Engineering a ruminating reactor. Presented at Center for Bioenergy Innovation annual meeting, June 4 " June 7, 2018, Asheville, NC.
12. Cekmecelioglu, D. and A. Demirci. 2018. Evaluating fungal co-production of cellulase and xylanase enzymes at shake-flask scale using distillers dried grain with solubles (DDGS) and its validation in benchtop fermenters. ASABE Paper No. 1800332. American Society of Agricultural Engineers. St. Joseph, MI. 12 pp.
13. Cekmecelioglu, D. and A. Demirci. 2018. Evaluating fungal co-production of cellulase and xylanase enzymes at shake-flask scale using distillers dried grain with solubles (DDGS) and its validation in benchtop fermenters. 14th Conference of Food Engineering. Minneapolis, MN. Abstract # 102.

14. Iram, A., A. Demirci, and D. Cekmecelioglu. 2018. The evaluation of acid pretreatment of DDGS as a carbon source for microbial fermentation. Allegheny Branch of the American Society for Microbiology Meeting. Gettysburg, PA. Abstract # EnvGP2.
15. Iram, A., A. Demirci, and D. Cekmecelioglu. 2019. Screening of bacterial and fungal strains for cellulase and xylanase production using distillers™ dried grains with solubles as the feedstock. Northeast Agricultural and Biological Engineering Conference, Lac Beauport, QC, Canada. Abstract # 19-047.
16. Salis, H. M. 2019. Highly Scalable Multiplexed CRISPR Technologies for Medical, Industrial, and Agricultural Applications. DARPA Safe Genes Annual Meeting Meeting, DARPA, Bethesda, MD.
17. Salis, H. M. 2019. Highly Scalable Multiplexed CRISPR Technologies for Medical, Industrial, and Agricultural Applications. DARPA PREPARE Program Kick-off Meeting, DARPA, New York, NY.
18. Salis, H. M. 2019. Rapid Development of Acetogenic Clostridia using Highly Multiplexed Genome Engineering for Control of C1 Bioconversion. Genomic Sciences Program Annual Meeting, DOE, Tyson's Corner, VA.
19. Hossain, A., and Salis, H. 2019. Automated Design of Non-Repetitive Genetic Parts: 4350 highly non-repetitive bacterial promoters, DARPA SD2 Q5 Workshop, DARPA, Austin, TX.
20. Reis, A., and Salis, H. M. 2018. Simultaneous regulation of many genes using highly non-repetitive extra-long sgRNA arrays. AIChE Annual Meeting, AIChE, Pittsburgh, PA.
21. Cetnar, D., Salis, and H. M. 2018. Systematic quantification of the sequence determinants controlling mRNA stability in bacterial operons, AIChE Annual Meeting, AIChE, Pittsburgh, PA.
22. Salis, H. M. 2018. Engineering RDX Riboswitches for Explosives-sensing Bacteria, DARPA SD2 Q4 Hackathon, DARPA, Boston, MA.
23. Reis, A., Salis, H. M. 2018. Simultaneous regulation of many genes using highly non-repetitive extra-long sgRNA arrays. Engineering Biology Research Center Retreat, EBRC, Ft. Collins, Colorado.
24. Salis, H. M. 2018. Engineering Autonomous Sensors for Explosives. DARPA SD2 Q3 Hackathon, DARPA, Seattle, WA. National.
25. Salis, H. M. 2018. Simultaneous Regulation of Many Genes using Highly Non-repetitive Extra Long sgRNA Arrays. Synthetic Biology Congress, Oxford Global, Boston, MA.
26. Salis, H. M. 2018. Toolboxes of Highly Non-repetitive CRISPR Parts for Highly Multiplexed Applications. DARPA Safe Genes Program Review, DARPA, Tuscon, AZ.
27. Hossain, A. Reis, A., Cetnar, D., Salis, H. M. 2018. The Non-Repetitive Parts Calculator: Thousands of Highly Non-repetitive Promoters for Synthetic Biology Applications. Engineering Biology Research Center Retreat, EBRC, Seattle, WA.
28. Koirala, A., and Liu, J., 2018. Biomass Harvesting Systems for Energy Crops in the US: A Review on research trends. ASABE Annual International Meeting, July 29 - August 1, 2018. Cobo Center, Detroit, Michigan USA.
29. Liu, J., and Fasick, G. 2018. Miscanthus Mechanical Conditioning, ASABE Annual International Meeting, July 29 - August 1, 2018. Cobo Center, Detroit, Michigan USA.
30. Liu, J. 2018. Mechanical Properties of Miscanthus & Switchgrass. Northeast Agricultural and Biological Engineering Conference, July 15 " July 18, Lakeview Golf Resort and Spa, Morgantown, West Virginia.

South Dakota

1) Abdus Sobhan, Kasiviswanathan Muthukumarappan, Lin Wei*. 2019. Characterization of bionanocomposite films based on nanocellulose and activated carbon, Paper #: 1900618.ASABE Annual International Meeting, July 7-10, 2019, Boston, MA.
2) Zhisheng Cen, Lin Wei*, Yajun Wu. 2019. Developing a control-release nitrogenous fertilizer by combination of biochar and sodium alginate, Paper #: 1900423.ASABE Annual International Meeting, July 7-10, 2019, Boston, MA.
3) Lin Wei*, Zeyad Ali Albahr, Madison Best, Zhisheng Cen, 2018. Develop food packaging nanocomposites from lignocellulosic biomass, Paper Number: 1800100. ASABE Annual International Meeting, July 29 " August 1, 2018 - Detroit, Michigan,
4) Lin Wei*, Zeyad Albahr. Nanocellulose extraction from corn stover using acid hydrolysis and following by homogenization, Paper Number: 1800101 ASABE Annual International Meeting, July 29 " August 1, 2018 - Detroit, Michigan,

5) Lin Wei*, Yajun Wu. Develop cellulose-based root targeted controlled-release fertilizers for soybean production, Paper Number: 1800109 ASABE Annual International Meeting, July 29 " August 1, 2018 - Detroit, Michigan,
6) Lin Wei* and Kasiviswanathan Muthukumarappan, 2018. Effects of cold press operation conditions on fatty acid profiles of non-food vegetable oils. July 9 " 10th, 2018. USDA Forest Service Forest Products Laboratory, Madison, WI.

Tennessee

1. Kalavathy Rajan, Stephen C. Chmely, Nicole LabbÃ©, David P. Harper and Danielle Julie Carrier. ""Development and characterization of depolymerized lignin & acrylate-based renewable photopolymers, in the 40th Symposium on Biotechnology for Fuels and Chemicals, San Fransisco, CA, May 1, 2018
2. Kalavathy Rajan, Stephen C. Chmely, Jeffrey K. Mann, Yagya N. Regmi, Nicole LabbÃ© and Danielle Julie Carrier. Depolymerized lignin & acrylate-based renewable photopolymers, in the 255th ACS National Symposium and Exposition, New Orleans, LA, March 21, 2018.
3. Kalavathy Rajan, Stephen C. Chmely, Nicole LabbÃ©, Danielle Julie Carrier and David P. Harper. Development of photocurable resins based on lignin-mimics, in the Frontiers in Bio-refining conference, St. Simmons Island, GA, November 7, 2018.
4. Kalavathy Rajan, Stephen C. Chmely, Nicole LabbÃ©, Danielle Julie Carrier and David P. Harper. Photopolymerization of acrylated lignin monomers: Implications for lignin utilization in additive manufacturing by stereolithography, in the Spring 2019 ACS National Meeting, Orlando, FL, April 3, 2019.
5. Ross Houston, Oluwafemi Oyedeji and Nourredine Abdoulmoumine. Computational Fluid Dynamic Modeling of Catalytic Hydrous Pyrolysis in a Fluidized Bed Reactor to Produce Refinery-Ready Bio-crude Oil. ASABE Annual International Meeting, July 29th-August 1st, 2018, Detroit, MI.

Texas

1. Capareda, Sergio C. 2019. Developing the Bio-economy in an Era of Low Crude Oil Prices: Lessons Learned from the Biofuels Industry in the United States of America. Invited Speaker presentation held on June 11, 2019 at the University College Dublin Ireland for the Annual Bio-economy Conference.
2. Capareda, S. C. and Amado L. Maglinao Jr. 2019. Advances in Biomass Power Generation Using Fluidized Bed Gasification Techniques: Update of Current State of the Art and Report of Challenges and Opportunities. Paper presented at the 2019 Annual International Meeting of the American Society of Biological and Agricultural Engineering (ASABE), held in Boston, Massachusetts, on July 8-11, 2019, ASABE Paper No. 1901932, ASABE, St Joseph, MI. An ASABE Meeting Presentation, DOI: https://doi.org/10.13031/aim.201901932.
3. Magomnang, Antonio-Abdu Sami and Sergio C. Capareda. 2019. Improvement of biogas production by sequential pretreatment of rice straw and coconut shell for power generation applications. Paper presented at the International Conference on Chemical Engineering, ICCE UNPAR 2019, held in Bandung, West Java, Indonesia on 28-29 November 2019.
4. Capareda, S. C., Ali M. 2019. Capareda, S. C., Ali M., M. Salah Hassan, A. H. elSayed, Mohamed Mahmoud, R. Mohtar and M. Akbulut. 2019. Advanced solar energy-assisted water desalination system in high salinity and brackish water areas with controlled greenhouse for sustainable agriculture: A Water-Energy Food (WEF) Nexus project. Presented at the 2019 NAS-STDF Symposium held in Cairo, Egypt from November 5-9, 2019.

Virginia

1. Y. He, D. Kuhn, J. Ogejo, C. Fernandez-Fraguas, H. Huang. Wet fractionation process to separate high protein product from brewer's spent grain. 2019 IFT Annual Meeting, New Orleans, Louisiana, June, 2019
2. Q. Jin, A. Damle, N. Poe, H. Wang, J. Wu, H. Huang. Butanol production from food waste by immobilized cell fermentation and advanced membrane separation system. 2019 IFT Annual Meeting, New Orleans, Louisiana, June, 2019

Washington

1. Fu, X., S, Chen. 2018. Fungal Pretreatment of Lignocellulosic Biomass with Manganese supply to enhance lignin degradation and sugar yield. 2018 ASABE Annual International Meeting, Cobo Center, Detroit, Michigan USA.

2. Xiaochao Xiong, Rishikesh Ghogare and Shulin Chen. 2018. Synthetic Biology Tools Development and Metabolic Engineering of Yarrowia Lipolytica for Producing Lipid-Based Chemicals, 2018 American Institute of Chemical Engineers (AIChE) Annual Meeting, Pittsburgh, PA, November 1, 2018.
3. Xiaochao Xiong, Yanfang Zhang, Baoming Zhao and Shulin Chen, 2018. Improvement of Lipid-Based Chemicals Production by Overcoming Metabolism Overflow in Oleaginous Yeast Yarrowia lipolytica, 41st Symposium on Biotechnology for Fuels and Chemicals (SBFC), Seattle, WA, April 29, 2019.
4. Martinez J, and S. Chen, 2019. Recovering Valuable Bioactive compounds from Potato Peels via Sequential Hydrothermal Extraction 41st Symposium on Biotechnology for Fuels and Chemicals, Seattle, WA, Sunday April 28th - Wednesday May 31st, 2019.
5. Martinez J, and S. Chen, 2019. Recovering Valuable Bioactive compounds from Potato Peels via Sequential Hydrothermal ExtractionASABE Annual International Meeting, Boston, MA, Sunday July 7th - Wednesday July 10th, 2019.
6. Zhangyang Xu, Libing Zhang, , Zheming Wang, Hongfei Wang, and Bin Yang, Understandings of Thermal Transformation of Cellulose Surface and Crystalline Core by in-situ Nonlinear Vibrational Spectroscopy, 41st Symposium on Biotechnology for Fuels and Chemicals, Seattle, WA. May 1st, 2019.
7. Xiaoyu Wu, Bin Yang, Songmei Li, Chongmin Wang. Rational-designed graphene-like 2D carbonaceous materials from chitin and lignin for energy-related applications. 41st Symposium on Biotechnology for Fuels and Chemicals, Seattle, WA. April 28th, 2019
8. Zhangyang Xu, Xiaolu Li, Naijia Hao, Chunmei Pan, Luis de la torre, Aftab Ahamed, John H. Miller, Arthur J. Ragauskas, Joshua Yuan, Bin Yang, Kinetic understanding of nitrogen supply condition on biosynthesis of polyhydroxyalkanoate (PHA) from benzoate by Pseudomonas putida KT2440, AIChE annual meeting, Pittsburgh, PA Oct. 29, 2018.
9. Maoqi Feng, and Bin Yang, High Energy Density Fuels Produced from Lignin-derived Intermediates and Refinery Waste Gas Streams, AIChE annual meeting , Pittsburgh, PA Oct. 29, 2018.
10. Hao Ruan and Bin Yang, Depolymerization of Lignin to Mono-aromatic Compounds over Solid Acid Catalysts with Hydrogen, AIChE annual meeting , Pittsburgh, PA Oct. 29, 2018.
11. Xiaolu Li, Yucai He, Libing Zhang, Haoxi Ben, Zhangyang Xu, Matthew J. Gaffrey, Yongfu Yang, Wei-jun Qian, Shihui Yang, Joshua Yuan, Scott E. Baker, Bin Yang, Exploiting of Sugars and Lignin to Lipids by Co-Fermentation of Rhodococci Strains 2018 S-1041 Science and Engineering for a Biobased Industry and Economy Symposium, Madison, WI, July 10, 2018.
12. Xiaolu Li, Yucai He, Libing Zhang, Haoxi Ben, Zhangyang Xu, Matthew J. Gaffrey, Yongfu Yang, Shihui Yang, Joshua Yuan, Wei-Jun Qian, Bin Yang*, Exploiting of sugars and lignin to lipids by co-fermentation of Rhodococcus strains ACS NORM 2018, Richland, WA. June 26, 2018.
13. Bin Yang, Lignin Based Jet Fuel, ACS NORM 2018, Richland, WA. June 26, 2018.
14. Qiang Li, Shangxian Xie, Zhihua Liu, Yunqiao Pu, Bin Yang, Arthur Ragauskas and Joshua S. Yuan, Multi-stream Integrated BioRefinery (MIBR) for Sustainable and Cost-effective Biofuels and Bioproducts, 40th Symposium on Biotechnology for Fuels and Chemicals, Clearwater, FL. April 30, 2018.
15. Fnu Fitria, Hao Ruan, Steven Fransen, Haiying Tao, and Bin Yang,, Selecting best winter wheat variety for cellulosic ethanol production in Pacific Northwest, 40th Symposium on Biotechnology for Fuels and Chemicals, Clearwater, FL. April 29, 2018.
16. Zhangyang Xu, Xiaolu Li, Naijia Hao, Chunmei Pan, Luis de la torre, Aftab Ahamed, John H. Miller, Arthur J. Ragauskas, and Bin Yang, Understanding and modeling effects of nitrogen source on biosynthesis of polyhydroxyalkanoates (PHAs) from benzoate by Pseudomonas putida KT2440, 40th Symposium on Biotechnology for Fuels and Chemicals, Clearwater, FL. April 29, 2018.

Wisconsin

1. Larson, R.A. and H. Wang. 2018. Anaerobic Digestion: Incorporating Biochar to Manage Hydrogen Sulfide. Biocycle 18th Annual Conference REFOR18, October 15-18, 2018, Raleigh, NC.
2. Xuejun Pan. Fractionation, Conversion, and Valorization of Lignocellulosic Biomass in Inorganic Ionic Liquid (molten salt hydrate). 2018 AIChE Annual Meeting, October 28-November 2, 2018, Pittsburgh, PA.
3. Ning Li, Yanding Li, Chang Geun Yoo, Xiaohui Yang, Xuliang Lin, John Ralph, and Xuejun Pan. Solid-state depolymerization and isolation of lignin from lignocellulosic biomass. 2018 AIChE Annual Meeting, October 28-November 2, 2018, Pittsburgh, PA.
4. Xuejun Pan. Solid-state depolymerization: an innovative approach to isolate good lignin from lignocellulose for valorization. Xiamen Forum on Biomass Frontiers 2018, October 19-22, 2018, Xiamen, China.

5. Yang Liao and Xuejun Pan. Fabrication of cellulose and whole biomass aerogels directly from ground Douglas fir using a molten salt hydrate as solvent. 2018 International Conference on Nanotechnology for Renewable Materials. June 11-14, 2018, Madison, WI.
6. Xuejun Pan. Applications of molten salt hydrates in fractionation, conversion, and valorization of lignocellulosic biomass. 255st ACS National Meeting & Exposition, March 18-22, 2018, New Orleans, LA.
7. Ning Li, Li Shuai, Chang Geun Yoo, Yanding Li, Xiaohui Yang, Shuting Zhang, Xuliang Lin, John Ralph, and Xuejun Pan. Solid-state depolymerization and fractionation to produce uncondensed lignin from lignocellulosic biomass for valorization. Lignin Gordon Research Conference. August 5-10, 2018, Easton, MA.
8. Yang Liao, Shu-Ching Yang, Ning Li, KG Karthikeyan, and Xuejun Pan. Fabrication and functionalization of 1D and 3D cellulose-based nano-materials. 2018 Nanoscale Science and Engineering for Agriculture and Food Systems, Gordon Research Conference. June 3-8, 2018, South Hadley, MA

Theses and Dissertations

Alabama

1. Elizabeth Bankston, MS Thesis: Enhancement of Nutrient and Organic Removal from Poultry Litter Using Anaerobic Digestion and Subsequent Algal Growth. Graduated 7/2019.
2. Nikhil Jain, MS Thesis: Characterization of Biofuels Produced from Hydrothermal Liquefaction of Algae, Its Subsequent Upgrading and Fractional Distillation. Graduated 12/2018.

Iowa

1. Oliviera, M. C. T. B. 2019. Analyzing and advancing maize and sugarcane biorefinery systems. Ph.D. Dissertation, Iowa State University.
2. Muhammad, N. I. S. 2019. Comparative assessment of the economic and environmental impacts of food waste fermentation on value-added products. Ph.D. Dissertation, Iowa State University.
3. Mahmud, N. 2019. Low moisture anhydrous ammonia (LMAA) pretreatment of lignocellulosic biomass and assessments for biobutanol production. Ph.D. Dissertation, Iowa State University.

Michigan

1. Aseel Mohamed Ahmed Bala Ahmed, PhD Summer 2018 Fundamental Studies and Engineering Modeling of Hydrogen Bonding
2. Yuan Zhong, Ph.D. Summer 2018, ""Anaerobic digestion of agricultural residues and energy crops to generate cellulosic material for advanced biofuel production""
3. Mahlet Garedew, Ph.D. ""Towards lignin valorization : pyrolytic and electrochemical upgrading of lignins extracted from pretreated biomass to valuable intermediates"""

Minnesota

1. Richard Griffith, Chlorella Harvest by Flotation - Electro-Flotation Process. M.S. Bioproducts and Biosystems Engineering, April, 2018
2. Qian Lu, Strategies to Cultivate Microalgae on Eutrophic Wastewater for Nutrients Recycling and Biomass Production. Ph.D. Food Science and Nutrition, January, 2018
3. Peng Peng, Sustainable atmospheric ammonia synthesis and nitrogen fixation using non-thermal plasma (NTP). Ph.D. Bioproducts and Biosystems Engineering, June, 2018

North Dakota

1. Pandey, R., 2019. Process Benefits of Using Biomass Pellets in a Biorefinery, M.S. Thesis, North Dakota State University; Major: Agricultural and Biosystems Engineering; Advisor: Dr. Scott Pryor.

Ohio

1. A. Khanal. 2018. Evaluating the Environmental Impact of Corn Stover Collection for Biofuels Production. The Ohio State University
2. A. Manandhar. 2019. Techno-economic and life cycle analyses of lactic acid production from starch and lignocellulosic biofeedstocks. The Ohio State University.

Pennsylvania

1. Amador-Diaz, I. 2019. Anaerobic digestion of lignocellulosic biomass via cotreatment: A technoeconomic analysis. M.S. Thesis. Pennsylvania State University. University Park, PA.

Tennessee

1. Ross Houston (2018). Catalytic hydrous pyrolysis of loblolly pine to produce refinery-ready biocrude oil. MS thesis. Knoxville, TN: University of Tennessee, Institute of Agriculture, Biosystems Engineering and Soil Science Department.
2. Ekramul Ehite. Examination of lignocellulosic biomass particle mechanics and its implications for conveyance. Ph.D. dissertation (In progress)

Virginia

M.S. Thesis

1. Dajun Yu. Ultrasound-assisted Enzymatic Extraction of Protein Hydrolysates from Brewer™s Spent Grain
2. Nick Poe. Acetone, Butanol, and Ethanol (ABE) Production from Food Waste via Clostridium beijerinckii"

Washington

1. Andre David Bergeron, 2019. Moving towards sustainable & economical bioproducts: bioremeditation of waste streams and improving product titers. Master™s thesis. Washington State University.
2. Na Pang, 2019. synergistic effect of photosynthesis and carbon metabolism on microalgal growth and biosynthesis under mixotrophic conditions, PhD Dissertation. Washington State University.
3. Maryam Davaritouchaee, 2019. Comprehensive study on lignocellulosic biomass degradation with radical systems, PhD Dissertation. Washington State University.

Wisconsin

1) Evan Price, M.S. Biological Systems Engineering. Continuous processing of high solids lignocellulosic biomass
2) Zening Wang, M.S. Bioconversion of lignocellulosic biomass to microbial lipids
3) Hui Wang, PhD. Anaerobic digestion of dairy manure: effect of mixing, tannins, and biochar additives

Synergistic activities

Alabama
1) Investigators serve on panel review of several grant agencies in United States.
2) Dr. Yi Wang started to serve as the associate editor for the ASABE Journals [the Plant, Animal, & Facility Systems (PAFS) technical community] since 10/2018.
3) Dr. Yi Wang collaborates with the Virginia station for proposals, and obtained a DOE grant. Wang also provided the engineered strains for their project for the PI at the Virginia station.
4) Auburn University hosted the 2018 Thermal & Catalytic Sciences Symposium (TCS) from Oct. 8-10 on Auburn Campus. Researchers in the relevant research area from all over the US participated this conference.

Calfornia
Collaboration with the investigators at University of Minnesota and Kansas State University.

Michigan
Dr. Chris Saffron (MSU), Dr. Mark Wilkins (U. Nebraska) and Dr. Scott Pryor (NDSU), wrote a funded NSF proposal to provide graduate student travel awards to attend the S1075 meeting and its accompanying symposium with NREL.

Missouri
Participated in planning sessions at the University of Florida Shrimp Initiative, The Institute of Sustainable Food Systems, University of Florida, Gainesville Fl. Sept 17-19, 2018

Brune, D. E., Session organizer and moderator, œExtending Partitioned Aquaculture World Aquaculture International Symposium, News Orleans, La., March 2019.

Minnesota
A number of joint research activities with other university faculty resulted in synergistic development in TiO2 application in catalytic treatment and utilization of wastewater, and catalytic microwave conversion and utilization of biomass and waste plastics, among others.

Montana
Dr. Chengci Chen at Montana State University has collaborated with Dr. Haibo Huang at Virginia Tech. We submitted two proposals together to study pea proteins.

Mississippi
We are collaborating with Argon national lab (ANL) and Idaho national lab (INL) in the bioenergy project for biogas conversion into liquid hydrocarbon.
We are still working on the project of Research Experience for Undergraduates- Food, Energy and Water Security"" sponsored by National Science Foundation. Several departments (such as Department of Chemistry, Department of Sustainable Bioproducts, Department of Civil Engineering, Department of Agricutural and Biological Engineering) within Mississippi were involved in this project."

Ohio
Collaborated with Dr. Samir Khanal (University of Hawaii at Manoa) and Dr. Kaushlendra Singh (West Virginia University) on a project to evaluate biochar quality from forest biomass, and associated life cycle environmental impacts.

Collaborated with Dr. Sushil Adhikari (Auburn University) on novolac resin production by substituting petroleum derived phenol with biooil.

Oklahoma
We worked with other disciplines including soil scientists and chemists on these projects.

Oregon
1. Initiated collaborations with Prof. Vijay Singh, UIUC and Dr. Brude Dien, ARS, USDA for the use of the high solid hydrolysis reactor designs in CABBI Projects.

Pennsylvania
Co-PI directs the Northeast Sun Grant Center of Excellence for USDA; serves as Deputy Technical Director of the DOEs National Risk Assessment Partnership for geologic carbon storage (consortium of five DOE National Labs (2011-present) as well as aerves 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.

Texas
Hosting of the following Post Docs from China conducting bio-based research
a. Dr. Dongyu Chen
b. Dr. Guixia Ma

Virginia
Collaborates with Dr. Donghai Wang in Kansas on the project of biomass pretreatment using metal oxide
Collaborates with Dr. Yi Wang in at the Auburn University on the project of Butyl Acetate production from corn stover

Washington
The bio-economy for the production of fuels, chemicals and materials from underutilized resources has emerged as an important USDA priority because of its tremendous potential for economic growth and its many other societal benefits. The overall goal of the research effort at Washington State University is to advance the science and technology required to implement a novel biomass economy, for the production of alternative jet fuels and bio-products from the underutilized agricultural and forest biomass resources of Washington State. This project has developed the scientific approach to improve biomass pretreatment, bioconverstion, and thermochemical conversion of biomass available in Washington State to fuels and chemicals. The development of new co-products and their incorporation within the context of integrated biorefineries processing were explored. Techno-economic and environmental evaluations of bio-refinery alternatives that use the targeted technologies and take advantage of existing infrastructure were evaluated. The results of this project were disseminated in workshops, conferences and outreach activities with our agricultural, forest and municipal waste stakeholders in the Pacific Northwest and peer reviewed journals.