S-1041 Multistate Regional Project

The Science and Engineering for a Biobased Industry and Economy

2017 – 2018 Annual Report

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S1041 Vice Chair for 2017-2018

Executive summary

The annual report was compiled from individual station reports submitted by station representatives including outcomes and impacts against the S1041 objects, 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 S1041 project are:

OBJECTIVE A. Reduce costs of harvesting, handling and transporting biomass to increase the competitiveness of biomass as a feedstock for biofuels, biomaterials and biochemicals

- Task 1: Quantify and characterize biological feedstocks.
- Task 2: Develop and evaluate harvest, process and handling methods
- Task 3: Model and analyze integrated feedstock supply and process systems.

OBJECTIVE B. Improve biofuel production processes

B.1. Biochemical conversion processes

- Task 1: Develop pretreatment methods for biological conversion processes
- Task 2: Develop conversion processes
- Task 3: Develop value-added products from hemicellulose and lignin

B.2. Thermochemical conversion processes

- Task 1: Develop pretreatment methods
- Task 2: Develop conversion processes
- Task 3: Improve methods for characterization of intermediate products and process control

B.3. Biodiesel production processes

- Task 1: Characterize new feedstocks
- Task 2: Develop an understanding of fuel quality and performance issues
- Task 3: Develop and characterize innovative processes for biodiesel production
- Task 4: Utilize coproducts

OBJECTIVE C. Identify, develop and evaluate sustainable processes to convert biomass resources into biochemicals, biocatalysts and biomaterials (non-fuel uses)

- Task 1: Discover and characterize biochemicals, biocatalysts, and biomaterials in biomass
- Task 2: Develop separation processes for biochemicals, biocatalysts, and biomaterials
- Task 3: Develop applications for biochemicals and biocatalysts with biological activity
- Task 4: Develop enabling technologies for biochemical production.
- Task 5: Develop and evaluate integrated process systems for commercial feasibility

OBJECTIVE D. Identify and develop needed educational resources, develop distance based delivery methods, and develop a trained work force for the biobased economy

- Task 1: Serve as a knowledge resource base for biobased processing and products
- Task 2: Distribute new knowledge to train the work force and general public in biobased products and processing
- Task 3: Develop and disseminate educational materials in high-priority topic areas.

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Outcomes related to Objective A. [Reduce costs of harvesting, handling, and transporting biomass to increase competitiveness of biomass as a feedstock for biofuels, biomaterials and biochemical]

Alabama
We continue to work on quantifying the properties of softwood and hardwood biomass that are important to the storage, preprocessing and transportation of these biomass feedstocks. For example, we investigated the variation of fuel characteristics within loblolly pine trees.

California
A new method for determining elemental release profiles and kinetics of conversion was developed using simultaneous thermogravimetric (TG) and inductively coupled plasma mass spectrometry (ICPMS) analysis. The method has been applied to a range of biomass feedstocks using dynamic TG between ambient temperature and 1300°C and under reducing, oxidizing and neutral atmospheres. Thermal profiles show that the released elements are principally divided into those dominantly released during feedstock decomposition (200 – 475°C) and those dominantly released at high temperatures (900 – 1300°C) reflecting different roles in the organic matrix. Bulk partitioning was quantified between flue gas and aerosol and residual solid char or ash with demonstration of mass balance. The method appears to provide reliable insight and semi-quantitative modeling for elucidating elemental behavior and roles during thermal treatment of biomass.

Ohio
Feedstock supply systems for corn stover and pennycress (an oilseed) modeled and analyzed.

Washington
Most notably accomplishments in this field include an innovative hydrothermal flowthrough pretreatment in a simple and cost-effective way that enables near theoretical sugar yield with negligible sugar dehydration loss and recovers reactive lignin readily for catalytic and biological upgrading to value-added biochemicals. This is important as an innovative hydrothermal pretreatment that has promising potential to provide low risk and high reward platforms on which to build a major biorefining industry (http://www.separationsnow.com/details/ezine/1518c555cda/Treated-with-care-Analyzing-a-new-pre-treatment-process-for-biofuel-production.html?&tzcheck=1&tzcheck=1&tzcheck=1&tzcheck=1). In addition, our team discovered cellulose surface layer conformation via our invented Total Internal Reflection Sum Frequency Generation Vibrational Spectroscopy (TIR-SFG-VS) first time, which allows transformative advances in understanding of: (1) physical and chemical features of biomass that influence recalcitrance with regard to both changes in biomass structure as a result of reduced recalcitrance phenotypes, and (2) changes of biomass properties during pretreatment and the impact of such changes on plant cell wall microfibril-cellulase interactions during the conversion processes. Ultimately, understanding biomass recalcitrance at the molecular level will be the key to overcoming this fundamental barrier to ensure cellulosic biofuels cost-competitiveness.

Pennsylvania
Prior research has demonstrated enhanced conversion of high moisture biomass crops, including mid-season switchgrass, early fall corn stover, and spring harvested winter rye. The Richard Lab is investigating ensiled storage and complementary logistics strategies for these materials. For corn stover, dry matter loss was shown to be low and the ensilage process enhanced downstream processing. Research continues on switchgrass, miscanthus and willow, assessing nutrient losses and environmental impacts of production and processing these high moisture materials, and developing mathematical models to predict dry matter loss during storage as a function of moisture.

Montana
MT S U continues to evaluate camelina and other oilseed crops as potential feedstock for biodiesel and aviation fuels. The major work includes: 1) camelina and canola cultivar evaluation for higher yield and better oil content/profile; 2) genetic modification for better quality of camelina oil; 3) fertility study to determine optimal nutrient inputs; and 4) development of cropping system for camelina feedstock production. Camelina is a promising oilseed crop that is under intensive development mainly for bioenergy production. However there are several traits that need to be improved. Dr. Chen's research group at MT S U is testing camelina varieties and breeding lines in Montana for adaptation and yield potential. Dr. Lu's lab at MT S U is conducting genetic engineering to improve camelina yield and oil quality. Dr. Chen's group is also conducting studies on cropping systems and fertility for camelina. With

funding support from the DOE, Dr. Lu's lab is conducting genomic studies to improve many agronomic traits such as increasing seed size and oil content. Chen's group has started to work on another feedstock, sugarbeet crop, since 2016.

West Virginia
Activity 1: Application of a thermal treatment on Yellow poplar to promote its outdoor applications (Connor Crowley, Kaushlendra Singh, Benjamin Dawson-Andoh and Gloria S. Oporto). Yellow-Poplar (Liriodendron tulipifera) is a common hardwood species of the Appalachian Forest. It is relatively fast growing, generally produces straight and tall logs, and is easily identified by its "tulip" shaped leaves. However, until this point its wood has been underutilized primarily because of its inferior physical and mechanical properties compared to other hardwoods. This work aims to add commercial value to this hardwood raw material for outdoor applications through the application of a thermal treatment. Using a simple experimental design, several samples of Yellow poplar were exposed to temperatures ranging from 100°C-200°C in a nitrogen atmosphere for two and four hours. Control samples and final specimens were evaluated to compare their density, water absorption, swelling and compression strength according to standard ASTM 1037. In addition, the evaluation of porosity and resistance to fungi was performed. Preliminary data have shown interesting trends in relation to the mechanical properties of the treated materials especially at higher temperatures.

North Dakota
Effect or organic acids for the preservation of sugars in beet juice was studied. Mineral acid preserves sugar in industrial beet juice under non-freezing conditions at pH less than 3.5 and solids content less than 64.5%. Organic acids produced in-situ at the start of storage may also be effective in preserving sugar; however, there is no study that has shown the potential of using organic acid to preserve beet juice. Use of butyric acid at pH 4.25 and acetic acid at pH 3.5 resulted in retention of 85% of sugar after 38 storage days. A life cycle assessment approach was used to compare primary fossil energy use and greenhouse gas emissions from using pelleted and non-pelleted corn stover as a biorefinery feedstock. Operations considered were densification, transportation, and soaking in aqueous ammonia (SAA) pretreatment. SAA-pretreatment of pelleted biomass required lower energy inputs (89%). Higher pretreatment solid loadings possible with pelleted biomass also significantly reduced chemical and water use. This study demonstrated that SAA-pretreatment may be a feasible option when using densified biomass as biorefinery feedstock. Two major studies focused at infield biomass bale aggregation logistics scenarios and the impact of equipment due to field operations. An automatic bale-picker (ABP) capacity of 8 bales/trip produced the least operating time for the field areas (8–259 ha), and was about 5.0 and 2.6 times lesser than the tractor with bale capacity 1 and 2 bales/trip, respectively. Overall, an ABP with a capacity of 8 bales/trip, which can also handle 11 bales/trip, was recommended considering its less soil impact pressure compared to higher capacity ABPs. Equipment impacted area simulation indicated that the infield bale logistics had a significant reduction of track impacted areas with ABP compared to the control method. Results indicated that the harvester followed by baler produced the most impacted area and the ABP the least impacted area.

New Jersey
We are developing a platform to grow duckweed and fish, where the goal is to develop a system that can supply the feedstock in a timely and predictable manner.

Minnesota
University of Minnesota continues to develop technologies for production of algal biomass and other bioproducts using animal manures. We are currently investigating a new thermophilic AD process as pretreatment method to improve the nutrient profiles of animal wastewater for algae cultivation and hydropoinic production. The process uses a low vacuum to help removal of ammonia and hydrogen sulfide from the AD system. We were able to demonstrate improvement in methane production and significant reduction in ammonia nitrogen in the effluent. Cultivation of microalgae on the effluent was 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 growth.

Tennessee
Bulk-format of a field-grown energy crop (switchrass) was extensively evaluated by the University of Tennessee and collaborators for the key logistics steps from harvest with a forage harvester to supply, storage, and densification for delivery to a biorefinery. The goal was to pursue the concept of handling biomass in bulk for a continuous conveyance

stream of milled product. Research data from global position system-monitored equipment operations, stacker and reclaimer bulk handling and pneumatic conveyance, use of a solid waste compactor and ejector transfer system for alternative bulk compaction and hauling, and agricultural equipment evaluation with high-yield switchgrass provided the engineering basis for conducting an extensive techno-economic analysis of bulk-format. Engineering costs depend on several assumptions that need to be stated. This analysis covered logistics costs of harvest, transport, storage, pre-processing, and delivery of 371,870 dMg year-1 of low moisture switchgrass as a milled product to a biorefinery. Switchgrass was harvested from about 22,000 ha located an average travel distance of 72 km from the biorefinery. This analysis assumed five bulk-format storage depots at an average travel distance of 16 km from harvest fields with forage harvest chop hauled un-compacted, whereas the bulk was transported in densified form in ejector trailers the 56 km from the depot to the biorefinery. The harvest-to-storage supply was envisioned separate from and storage-to-biorefinery supply, primarily because of the weather limited nature of harvest versus the reality of the need for a regular industrial supply, respectively. Harvest was conducted from Nov. 1 to Mar. 1 during suitable weather calculated and assumed as 371 h year-1 versus the year-round biorefinery supply of 2000 h year-1. Thus, the switchgrass was harvested after senescence and field drying while standing. In addition to the harvest time that equipment was used each year, additional annual use was assumed so as to not conflict with the harvest window. Total annual use for agricultural equipment, including forage harvesters, was assumed as 600 h year-1, use of tractors was assumed as 1,200 h year-1, and use of over-the-road trucks and trailers was assumed as 2000 h year-1. Except for storage-to-biorefinery equipment, other equipment fixed costs were allocated to additional uses and sharing of those equipment fixed costs. Fixed and variable costs for the bulk-format system were broken down by steps identified for the bulk-format system, such as mow, forage chop, transport, unload at depot, mobile stacker-reclaimer, compactor, hauling with ejector trailer, and off-loading at depot. All costs were conducted at diesel fuel costs of $0.53 L-1, $0.92 L-1, and $1.32 L-1, and this factor was prioritized because of the swing in diesel fuel prices over the project. Total costs were reasonable ($54.63 to 66.21 dMg-1) considering that a milled product was delivered to the biorefinery.

Outcomes related to Objective B. [Investigate and develop sustainable technologies to convert biomass resources into chemicals, energy, materials and other value-added products]

Alabama

We have several completed and ongoing 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) We have also developed various genome engineering tools for engineering the microorganism for biofuel and biochemical production. In one project, we explored the endogenous CRISPR system for the genome engineering of a Clostridium strain for high level butanol production, and enabled the strain to produce up to 26.2 g/L butanol in a batch fermentation, which is the highest number that has ever been reported. 3) In another project, supported by the Southeastern Sun grant, we engineered a Clostridium strain for isopropanol-butanol-ethanol (IBE) production. Naturally, solventogenic clostridia produce acetone, butanol and ethanol (ABE). However, the acetone in the ABE mixture cannot be used as a fuel source due to its corrosiveness to the engine. So, in this project, we engineered the strain to convert acetone to isopropanol. Since isopropanol is an alcohol, and thus the whole IBE mixture can be directly used as a fuel source. 4) Algal-bacterial interaction for advanced wastewater treatment and biofuel production. Algae are very effective at removing nutrients from wastewater and many algae species accumulate lipids (oil) and starch which can be processed into biofuels. Sometimes algal-bacterial interactions are harmful (even pathogenic). However, we have shown that in many cases, bacteria can dramatically enhance algal growth, nutrient uptake, and production of biofuel precursors. 5) Integration of anaerobic digestion with algae cultivation. Anaerobic digesters are effective at stabilizing organic wastes while producing biogas whereas algae can be effective at removing inorganic nutrients from the digester effluent. One of the key bottlenecks to integrating digesters with algae cultivation is the presence of algal inhibitors in digestate. Such inhibitors include excess ammonia, volatile fatty acids, and phenolic compounds. We are investigating chemical (nanomaterial) and biological strategies for overcoming algal inhibition. We have recently had success in using aerobic biological treatment to enhance algae growth on digestate without the need for dilution water.

Illinois

The expression of cell wall degrading enzymes in bioenergy crops has been proposed as a cost-effective method to produce fuel and chemicals. In this study, the thermoregulated xylanases (iXyn GH10 and iXyn GH11) were expressed in switchgrass (Panicum virgatum). Two xylanase-expressing lines (Alamo background genetics) were compared to the wild type (Alamo genetics) to determine their composition, pretreatment, enzymatic hydrolysis, and ethanol fermentation. Three switchgrass samples with similar carbohydrate contents performed differently under four pretreatment conditions. Pretreated iXyn samples had higher glucan and lower xylan concentrations compared to the pretreated Alamo. An increased rate of glucose production and a higher glucan conversion ratio were observed in both iXyn lines. Pretreated iXyn samples required less exogenous enzyme to achieve similar levels of saccharification. Ethanol production increased from the glucan portion of the pretreated iXyn lines (Chen et al 2017). In cellulosic biofuel production, chemical pretreatment performed at laboratory or pilot scale, followed by mechanical refining, has been demonstrated to be effective to increase feedstock enzyme digestibility. To take the combined pretreatment process one step closer to commercialization, disk milling was performed with commercially pretreated corn stover. Dilute acid pretreated samples were obtained from a commercial plant. Effects of pretreatment conditions, milling cycles and enzyme dosages were evaluated. Milling improved glucose yields by 0.7 to 1.2 fold. Higher enzyme dosages enhanced sugar yields. Milling was more effective to improve glucose yields, while enzyme dosage was more effective to improve xylose yields. Dilute acid pretreatment condition was the most important factor to increase final sugar yields compared to milling cycles and enzyme dosages (Kim et al 2017). Recently, sugarcane has been engineered to accumulate lipids. This study performs techno-economic feasibility analysis of jet fuel production from this high yielding feedstock. A process model for a biorefinery producing hydrotreated jet fuel (from lipids) and ethanol (from sugars) was developed. Analysis was performed with lipid-cane containing 5 to 20% lipids. Production costs of jet fuel for different scenarios was estimated $0.73 to $1.79 per liter of jet fuel. In all cases, cost of raw materials accounted for more than 70% of total operational cost. Minimum fuel selling prices with a 10% discount rate for 20% lipid case was estimated $1.40/L, which was lower than most reported prices of renewable jet fuel from other oil crops and algae. Along with lower production costs, lipid-cane could produce as high as 16 times the jet fuel (6307 L per ha) per unit land than that of other oil crops and do this using low-value land unsuited to most other crops, while being highly water and nitrogen use efficient (Kumar et al 2017). A techno-economic analysis of simultaneous ethanol production and anthocyanins extraction from colored corn in a dry grind facility was studied. Ethanol production costs during purple corn processing was 42% less than that of yellow corn ($0.75 vs. $1.30/gal

ethanol) because of high revenue from anthocyanin extract. Annual anthocyanin extract production from blue corn was only 26.5 MT compared to 879 MT for purple corn; the process was not economically viable. Internal rate of return for a plant processing purple corn was 21.2%, compared to only 8.7% for a conventional plant using yellow dent corn. Use of purple corn in dry grind facilities can significantly improve the process economics and provide anthocyanin extract for use in the food industry (Somavat et al 2018). Fouling is unwanted deposition of materials on surfaces of processing equipment, which leads to additional capital investment and lower processing efficiency. During fuel ethanol production, fouling occurs when thin stillage is concentrated into condensed distillers solubles. Investigations of protein impact on fouling are limited despite high protein concentration in thin stillage (17 to 33% db). Protein contributions to fouling have been verified in the dairy industry. Whey proteins and calcium phosphate interact with each other or other proteins and form aggregates on heated surfaces. Due to complex components in thin stillage, it is difficult to study a single effect on fouling without interference from other factors. The objective was to investigate fouling properties of nitrogenous substances (urea and yeast) using model fluids; effects of protease addition on fouling properties of model and commercial thin stillage fluids. Urea addition did not lead to fouling while glucose-yeast model fluids displayed fouling tendencies. Protease from pineapple stem (bromelain) incubation increased fouling in model and commercial fluids, which were indicative that hydrolyzed molecules such as peptides, amino acids or protease can be involved in deposit formation.

Research into catalytic fluidized bed methanation of syngas continued with development of a pressurized and temperature-controlled synthesis reactor supported by FTIR, GC and other analytical instrumentation. Experiments were initiated on surrogate gases to determine conversion yields, product quality, and bed coking. The latter is more generally avoided in the fluidized bed compared to fixed bed reactors employed for this purpose. Gluconate could potentially be directly produced from cellulosic biomass and is an attractive substrate for fuels and chemicals production. While gluconate was used as the substrate for ethanol production, a small fraction of the acetate has to be produced along with ethanol due to the fact that gluconate was a more oxidized substrate than glucose. We explore the co-fermentation of gluconate and glycerol, which is a more reduced substrate than glucose and a biodiesel byproduct for balanced ethanol production. Results shows that co-fermenting with glycerol can greatly improve the ethanol yield. The deletion of the competing pathway further increases the ethanol yield. Ligninolytic enzyme (LE) can be produced by white rot fungi. Fungal co-cultures appear to be an attractive alternative for increasing LE production as compared to the chemical induction of LEs in fungal organisms, as it avoids the potential toxicity caused by some chemical inductors of fungal cells and also reduces the production of chemical residues. A novel fungal co-culture between Pycnoporus sanguineus and Beauveria brongniartii were studied using a statistical design method. The laccase and MnP activities of P. sanguineus increased in a co-culture with B. brongniartii. Anaerobic digestion of organic wastes can produce low carbon renewable energy and nutrient-rich effluent (digestate). However, large volumes and difficulties in handling and applying the digestate are challenges to its use as fertilizer. A pilot-scale integrated digestate processing system that includes solid/liquid separation, ultrafiltration, and drying processes waste developed to produce liquid and solid biofertilizer products that are easy to handle and apply for specialty crop production. The developed system processed 1,000 gallons/day of food waste and dairy manure digestates. The liquid biofertilizer products were successfully applied to tomato plants at 180 lb [N]/acre through drip irrigation lines at the Russell Ranch Sustainable Agriculture Facility in Davis, CA. Filtered food waste digestate was used as nutrient sources for microalgae cultivation. Based on lab-scale microalgae screening, Chlorella sorokiniana was identified as a promising strain for growth on the digestate. Sub-pilot experiments using 10x-diluted digestate were performed outside in Davis, CA during the summer and winter months to determine the effect of reactor heating, covering, and aeration on the yield of C. sorokiniana. The results showed that covering and/or aerating the reactor significantly affect the rates of algae growth and ammonia volatilization, and different combinations of reactor design may be better suited for certain seasons. Soil borne pathogens and pests can lead to devastating food and financial losses. Chemical solutions to this problem, such as fumigation with methyl bromide, can lead to even greater environmental damage including ozone layer depletion. Soil solarization is an effective, non-chemical alternative to chemical fumigation. Research in California has focused on engineering biomass resources and soil amendment strategies to improve the efficacy of soil solarization. Laboratory and field experiments were completed to examine the impact of organic matter amendment on organic acid accumulation during soil solarization. Soil columns that permit sampling of gas and water at different depths have been designed, constructed and implemented in the lab. The column system allows us to reproduce irrigation and similar environmental conditions (anaerobic conditions) that are expected in the field. The system has been used to monitor oxygen and organic acid concentration at different depths under different irrigation regimes and organic amendment application. DNA from samples collected from field and

laboratory experiments has been sequenced and bioinformatic tools used to understand the evolution of the soil microbial community that contributes to the pest inactivation system.

Washington

Discovering Pathways for Biological Conversion of Poplar Wood to Lipids by Co-Fermentation of Rhodococcus Strains: Biological routes for utilizing both carbohydrates and lignin are important to reach the ultimate goal of bioconversion of full carbon in biomass to biofuels and biochemicals. Recent biotechnology advances have shown promises toward facilitating biological transformation of lignin to lipids. In this study, a series of natural and engineered Rhodococcus strains (e.g. R. opacus PD630, R. jostii RHA1, and R. jostii RHA1 VanA-) with lignin degradation and/or lipid biosynthesis capacities were selected to establish a co-fermentation module that enabled a platform for fundamental understanding of bioconversion pathways of glucose and lignin to lipids. Profiles of metabolites produced by Rhodococcus strains following growth on different carbon sources (e.g. alkali lignin, flowthrough pretreated poplar slurry) revealed several unexpected fermentation products, suggesting novel metabolic capacities and unexplored metabolic pathways in these organisms. Although Rhodococci showed preference to glucose over lignin, nearly half of the lignin was quickly depolymerized to monomers by these strains for cell growth and lipid accumulation after glucose was nearly exhausted. Proteomic profiles showed that lignin depolymerization by Rhodococci involved multiple peroxidases with accessory oxidases. Besides the β-ketoadipate pathway, the phenylacetic acid (PAA) pathway played a predominant role in the in vivo ring cleavage activity. Deficiency of reducing power and cellular oxidative stress led to lower lipid production while using lignin as the sole carbon source compared with that of using glucose. This work thus suggests that synthetic reconstruction and balanced modification of key regulators and enzymes in lignin depolymerization, aromatic compound metabolism, lipid biosynthesis, and other relevant processes will enable efficient conversion of both lignin and carbohydrates to lipids by Rhodococci.
New catalyst for lignin based Jet fuel: The synthesis of high-efficiency and low-cost catalysts for hydrodeoxygenation (HDO) of waste lignin into advanced biofuels is crucial for enhancing current biorefinery processes. 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. The improved catalytic performance of Ru-Cu/HY was probably due to the following three factors: (1) high total and strong acid sites, (2) good dispersion of metal species and limited segregation, (3) high adsorption capacity for polar fractions, including hydroxyl groups and ether bonds. Moreover, all the bifunctional catalysts were proven to be superior over the combination catalysts of Ru/Al2O3 and HY zeolite. Bifunctional catalysts Ru/HY and Ru-M/HY (M= Fe, Ni, Cu, Zn) were synthesized and evaluated on HDO conversion of softwood lignin as well as several lignin model compounds. Results obtained from guaiacol HDO conversion indicate that all the bimetallic catalysts, especially Ru-Cu/HY, exhibited better HDO catalytic activities (regarding guaiacol conversion and hydrocarbon yield) as compared with Ru/HY. The combination of a 3d transition metal (Fe, Ni, Cu, Zn) with Ru can modulate the hydrogenolysis activity of Ru and help to prevent the hydrocarbon products from being over-hydrogenolysis to form gaseous products. Results from conversion of other lignin model compounds and softwood lignin also revealed the high HDO catalytic activity of the prepared bimetallic catalysts. The yield of hydrocarbon products over the synthesized bifunctional catalysts was higher than that over the combination mixing catalyst of Ru/Al2O3 and HY zeolite, which could be probably ascribed to the intimacy criterion. These catalysts were characterized by BET, NH3-TPD, XRD, and STEM to study the structure-catalytic activity relationship. Results revealed that Ru-Cu/HY has both higher acid volume and larger ratio of stronger acid sites as compared to other prepared bifunctional catalysts. XRD test indicated that the impregnation of metals in the HY support has little effect on the parent zeolite structure. Moreover, XRD and STEM results suggested that the addition of a second metal to Ru enabled Ru to form smaller size particles. The morphology of the bimetallic clusters was found to be quite different (smaller average size and narrow size distribution) from that of monometallic particles as indicated by STEM. Further study on the alloying effect of ruthenium metal with Fe.

Texas

TAMU Beta Lab has completed the design and development of an advanced photo bioreactor for the production of algae species and other oil crops. The unique design allows for continuous production of algae biomass. In addition, we have developed quick characterization of the lipids, proteins and other compositional parameters via spectrophotometric processes. These procedures are quick and would not require longer analytical procedures.

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 tedious commercialization efforts to bring this research output into the hands of private communities. Monte Cristo Gasifiers will also be selling these commercial units in Europe. The mobile gasification unit developed at TAMU AgriLife Research will be purchased by Creative Mills Solutions for immediate deployment is application sites near Georgia. Texas A&M AgriLife Research has also completed research on developing technologies for new oil seed crops. The current biodiesel work is the development of complete 20 kW power generation system using used 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. In addition, the BETA Lab has completed the testing of state-of-the art photo bioreactor for growing various algae species including spirulina for protein production. The unique photo bioreactor is internally illuminated and production kinetics have been established. A quick spectrophotometer protocol for the evaluation of algae components has also been established.

Louisiana
A new approach for converting lignocelluloses biomass into regenerated cellulose fibers has been taken for improving thermal and mechanical properties of fibers. A major research objective is to examine the effectiveness of nanoparticles as cellulose fillers on improving thermal and mechanical properties of the regenerated cellulose fibers. To this aim pure wood and bagasse cellulose solutions and cellulose/nanoparticle composite solutions were prepared using an amine-N-oxide solvent and spun into filament fibers. The investigations revealed that adding a small amount of nanoparticles to fill in the wood cellulose matrix resulted in an increase of the cellulose fiber tensile strength and a decrease of cellulose glass transition temperature. In separate projects microencapsulated biobased rejuvenators have been used in paving asphalt mixtures to address the cracking performance of pavements at intermediate temperatures. At the same time a series of recycled asphalts and various tire crumb rubbers (with various contents of natural component) have been investigated regarding the impact of their use and/or modifications on asphalt binder and paving mixture properties.

Nebraska
Aryl alcohol oxidase (AAO), an extracellular H_2O_2-providing enzyme that plays an important role in lignin depolymerization, was produced using a genetically modified filamentous fungus (Aspergillus nidulans). Cost-effective production of AAO was investigated and optimized in a submerged culture containing corn steep liquor (CSL), which is a by-product of corn wet-milling. Results demonstrate that the engineered A. nidulans strain was capable of secreting and accumulating AAO with high activity. Moreover, CSL was proven to be an excellent nitrogen source, when compared to other sources of organic and inorganic nitrogen, e.g. yeast extract, peptone, NaNO3, NH4Cl. An AAO activity of more than 800 U/L was obtained with current optimal condition and with veratryl alcohol as substrate. Upstream lignocellulosic feedstocks pretreatment and hydrolysis can produce two streams: sugar streams containing sugar mixtures and lignin-rich streams called alkaline pretreated liquor. During the past year, polyhydroxybutyrate production was conducted using both sugar mixtures and alkaline pretreated liquor. A combined mixture-process model was developed for PHB production from sugar mixture and can be used to manipulate sugar mixture ratio to maximize PHB production. Enzyme-mediator catalytic systems were constructed to improve PHB production from 0.4 to 3.8 g/L.

Pennsylvania
Accomplishments this year included progress on four major areas of research. 1) We continue investigating microbial conversion of biomass into methane and carboxylic acids through various modes of anaerobic mixed culture fermentation, with a strong emphasis on mechanical cotreatment. 2) We also continued experiments to understand the factors that contribute to greenhouse gas and ammonia emissions during high solids manure storage and composting. 3) 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. And 4) We continue our work to quantify carbon offset benefits in forest and cropland bioenergy systems, including opportunities for Biomass Energy Carbon Capture and Storage. A range of papers were published on these topics as indicated later in this report. Title of Project: Production of Value Added Products by Microbial Fermentation (Ali Demirci) Outcomes: Following projects have been studied: 1) Simultaneous saccharification and fermentation of ethanol from industrial potato waste by co-culturing A. niger and S. cerevisiae in

biofilm reactor was completed without needing added hydrolyzing enzymes.3) Continued to work on Vitamin K production by using bioreactors. 4) Continued to work on the project to produce hydrolytic enzymes production from distillers dried grains with solubles (DDGS) for cellulosic biomass hydrolysis for biofuels and other uses.

The Salis lab's research focuses on the development of predictive models and optimization algorithms that enable rational engineering of micro-organisms for metabolic engineering applications. In the past year, we've developed a new algorithm, called the Non-Repetitive Genetic Parts Calculator that designs large toolboxes of highly non-repetitive genetic parts that may all be used simultaneously without introducing any repetitive DNA sequences. We applied this algorithm to design 4300 highly non-repetitive bacterial promoters with a maximum repeat size of 10 base pairs. Promoters are regulatory DNA sequences that control transcription rate, which is the first step of the Central Dogma of Molecular Biology. We constructed and characterized this promoter toolbox, utilizing state-of-the-art oligopool synthesis and next-generation sequencing to measure their transcription rates. We found that this toolbox of promoters varied transcription rate by more than 1,000,000-fold, enabling unprecedented control over transcription rate for broad Synthetic Biology and Metabolic Engineering applications. Separately, we've also developed a biophysical model of translation regulation, mediated by a global bacterial regulator called CsrA,that enables us to predict how CsrA modulates translation rates across a bacteria's transcriptome, improving our understanding of how bacteria respond to environmental stresses, including antibiotic resistance.

Oklahoma

Improving gasification conversion systems in the production of bioenergy, biofuels and bioproducts Scaled-up Gasifier Performance A feasibility study using municipal solid waste (MSW) as a co-gasification feedstock with switchgrass was carried out using OSU's downdraft gasifier (100 kg biomass per hour). MSW was in pellet form and had a higher heating value (HHV) of 19 MJ/kg, while chopped switchgrass had a HHV of 15 MJ/kg. The effect of the feedstock on syngas quality and quantity by varying the content of MSW was studied at 0, 20, and 40% co-gasification ratios (CGR); this ratio is the MSW content in the MSW and switchgrass mixture. At a CGR of 60%, agglomeration of ash was observed during gasification, resulting in the 60% CGR not being included in the study. Results showed that performance of CGR of 20 and 40% are comparable to switchgrass gasification (0% CGR). At CGR of 20 and 40%, CO and H2 generated were 12.6 and 14.1%, and 8.6 and 10.0%, respectively. The calorific value of the syngas varied from 6.5 to 7.0 MJ/Nm3 and hot and cold gas efficiencies varied from 51 to 60% and 55 to 64%, respectively, at an average equivalence ratio of 0.20. Utilization of biochar in syngas fermentation media New fermentation media were formulated for biological conversion of syngas to ethanol and butanol using biochars. The biochars were made by gasification of lignocellulosic biomass and pyrolysis of animal wastes. Biochar contains minerals and metals that can serve as nutrients for bacteria. Biochars from switchgrass (SGBC), forage sorghum (FSBC), redcedar (RCBC) and poultry litter (PLBC) were used. Results showed that 17% and 59% more ethanol was produced by Clostridium ragsdalei in the new media containing RCBC and PLBC, respectively, compared to standard rich yeast extract medium (control). When Clostridium carboxidivorans was used in biochar media, PLBC and SGBC enhanced ethanol and butanol production more than FSBC and RCBC. The PLBC and SGBC media enhanced C. carboxidivorans ethanol production by 90% and 73%, respectively, and butanol production by fourfold compared to standard rich yeast extract medium without biochar (control). Enhanced Biological Ethanol Production from Syngas Using Novel Control Method A novel method to control syngas fermentation in bioreactors was developed in our laboratory. The method is based on regulating the supply of CO, CO2 and H2 to maintain a constant fermentation pH by formation of weak acetate buffer and reduction of nearly all produced acetic acid to ethanol. Syngas flow rate was automatically adjusted by a PID controller using pH as the input parameter. Continuous fermentations were operated for over 2000 h in a 3-L CSTR. Ethanol production up to 25 g/L was achieved. In addition, a ratio of ethanol to acetic acid of greater than 100 moles per mole was demonstrated. The novel feedback control technique allowed stabilized syngas fermentation with sustained high conversion efficiency and selectivity to ethanol. The developed control method can be applied in process design for commercial syngas fermentation. This method is described in a 2018 U.S. Patent No. US 10,017,789. Enhanced Syngas Fermentation for Ethanol Production Using Activated Carbon Syngas fermentations with and without activated carbon were compared. Results showed that the addition of activated carbon in the fermentation medium sustained activity of the bacterium used increasing total CO and H2 uptake six fold compared to no activated carbon. The increased gas uptake with activated carbon produced 19 g/L ethanol with less than 1 g/L total acetic acid. However, only about 1 g/L ethanol and 5 g/L acetic acid were produced without activated carbon. This method is described in a U.S. Patent application Publication US 2016/0215303 A1.

Wisconsin
We developed assessment tools around manure processing and digestion with the goal of minimizing nutrient losses to air and water. We improved geospatial data analysis methodologies to eneable optimization for biomass harvesting to minimize environmental impacts (global warming potential, eutrophication and soil loss). We investigated dairy systems as a whole to minimize nutrient and GHG losses. We investigate several biomass fractionation technologies including ionic liquids and green solvents. We investigated novel AD processes to increase gas yield and reduce S and N emissions.

West Virginia
Activity 1: Adsorption and Physical Characteristics of Activated Carbons Prepared via Two Impregnation Routes from Herbaceous Biomass (Oluwatosin Oginni, Kaushlendra Singh, Louis McDonald, Tugrul Yumak, Edward M. Sabolsky, and Litha Sivanandan) The objective of this study was to investigate the adsorption characteristics of activated carbons (AC) synthesized from herbaceous biomass following two activation methods (1. Biomass+activation agent-> activated carbon and 2. Biomass-> bio-char+activation agent-> activated carbon). The precursors for the activated carbon synthesis were biomass and biochar derived from it. The precursors were impregnated with phosphoric acid and thereafter activated at a temperature of 900 °C in inert condition. The surface morphology, porosity and surface chemistry of the activated carbons were characterized. Also, the activated carbons were used in adsorbing two pharmaceutical active compounds; acetaminophen and caffeine. Activated carbons synthesized directly from the biomass had high surface area (1373 m2/g) while the biochar derived AC had low surface area (698 m2/g). Overall, the biomass-derived activated carbon showed 5-folds more adsorption for caffeine and 2.5-folds more adsorption for acetaminophen than biochar-derived activated carbons. The high adsorption was dues presence of more mesopore volume and associated surface area on Biomass-Derived AC. Raman analysis showed that the biomass-derived activated carbon particles showed more disordered SP2 carbon cluster, which is associated with presence of more amorphous regions. Therefore, the impregnation of the activation agent directly into the biomass precursor produced a better activated carbon than impregnating biochar derived from biomass.

Activity 2: Template-Free Synthesis of Highly Ordered Carbons from Kanlow Switchgrass Biomass/Biochar for Supercapacitor Applications. (Tugrul Yumak, Gunes A. Yakaboylu, Dustin E. Bragg, Oluwatosin Oginni, Kaushlendra Singh and Edward M. Sabolsky) In this study, the main aim was to synthesize biomass-derived (Kanlow switchgrass) and modified activated carbon samples, to fabricate the supercapacitors and to test their electrochemical performance. The chemical activation and metal oxide (MnO2, NiO) addition methods were utilized to improve the pore structure, surface chemistry and electrochemical performance. XPS, SEM, TGA and N2 physisorption techniques were used to investigate influence of the experimental parameters on the surface chemistry, morphology, specific surface area and pore characteristics. The results demonstrated that they displayed the required electrochemical stability and reversibility with up to 142 F/g specific capacitance, which depended on the specific surface area, pore characteristics, microstructure and surface chemistry. Activity 3: Non-isothermal Pyrolysis Kinetics Analysis of Switchgrass and Miscanthus (Oluwatosin Oginni and Kaushlendra Singh) In this study, the pyrolysis kinetics of Public Miscanthus and Kanlow Switchgrass harvested from marginal land were investigated using isoconversional methods. The thermogravimetric analysis was carried out by heating the biomass samples from room temperature to 700 ºC in an inert condition at heating rates of 5, 15 and 25 ºC/min. Three isoconversional methods (Friedman, Ozawa-Flynn-Wall, Kissinger-Akhira-Sunrose) were employed in estimating the activation energies of the biomass samples. The average activation energies from Friedman, OFW and KAS methods for Public Miscanthus were 568.63, 493.11 and 508.87 kJ/mol respectively and 306.28, 308.21 and 314.53 kJ/mol, respectively for Kanlow Switchgrass. The activation energies for Public Miscanthus increased with an increase in the fractional conversion while the activation energy reduced with the fractional conversion for Kanlow Switchgrass.

North Dakota
Soaking in Aqueous Ammonia pretreatment was done at 6 different severities, including a nonpretreated control, using loose corn stover. Severity was varied by increasing pretreatment time, temperature, and ammonia concentration. As expected, results showed increasing delignification (lower residual lignin content) with increasing pretreatment severity. All samples were hydrolyzed under low, moderate, and high cellulase and hemicellulase loadings. The same pretreatment conditions were tested with pelleted stover to test differences in delignification and subsequent impact on hydrolysis yields. Use of pelleted stover allowed reduction in pretreatment conditions, enzyme loadings, and hydrolysis time. At the highest enzyme loadings, hydrolysis time could be reduced from 48 to 24 with

biomass pellets while still achieving 90% glucose yields. Pretreatment time, temperature and ammonia concentration could also be reduced compared to required conditions with loose stover. Using lower enzyme loadings, several pretreatment conditions allowed for 90% hydrolysis yields with pelleted stover while no conditions produced those yields with low enzyme loadings and loose stover.

Iowa
Coproducts soybean hull, and switchgrass fibers were optimized and compared for microbial production process for biosurfactant at 5-L scale. Microbial surfactant was characterized for antibacterial and food-emulsion properties; they were effective against two foodborne pathogens E. coli, and L. monocytogenes when applied in conjunction with essential oil cinnamaldehyde. Starch-based biopolymer films were produced via extrusion process and characterized. Acid-based starch hydrolysis carried out for creating nanocrystals and properties evaluated.

New Jersey
The team am working with is developing a duckweed platform modular, where the duckweed can be used for food, feed, fuel, and other materials (currently, we are focusing on food, feed, and fuel).

Virginia
New fermentation technologies have been developed to converted food waste to value added butanol An integrated process has been developed to convert grape pomace to multiple products: grape oils, polyphenols, and biofuels.

Massachusetts
At UMass, the chelator-mediated Fenton (CMF) system is being used and compared to Fenton chemistry to digest, spruce, pine and maple wood chips. Modified procedures to allow iron to associate with lignin and cellulose at the molecular level are allowing hydroxyl radical generation to be achieved with much greater efficiency. Thus solubilization of the three wood species at room temperature, without harsh or toxic chemical treatments, has been enhanced to the point where a 3-pulse treatment over several hours results in almost complete solubilization of the wood. Further work is now being conducted on single-pulse treatments to assess how effective this is for enzymatic pretreatment. However, complete solubilization without generation of toxic compounds such as furfural and HMF is currently being achieved with multiple CMF pulses.

Missouri
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. Laboratory experiments were conducted to shed light on the relationship between ammonia toxicity and pH in adult Artemia. The results suggest that in spite of exponentially increasing free ammonia at elevated pH levels brine shrimp mortality at low pH (less than 7.0) is radically more severe as opposed to high pH greater than 8.0). Apparently, brine shrimp are capable of employing some form of protective mechanism allowing them to resist free ammonia toxicity at high solution pH. This observation is critical in understanding how brine shrimp are capable of growth in heavy algal bloom conditions where culture pH is often elevated. Furthermore, this characteristic has important implications in management of high density brine shrimp culture for use in harvesting and converting algal or bacterial cultures into brine shrimp biomass During the last year, a series of experimental trials were directed at development of 1) Tunable green solvents for biomass pretreatment into digestible pulp for biofuels and high-quality technical lignin, 2) Biological and chemical reactor systems for converting biomass conversion into platform chemicals, 3) A new technology for nanocellulose extraction and application in active packaging In addition, we explored use of lignin as a feedstock for polyurethane synthesis.

Minnesota
University of Minnesota have been conducting research on microwave assisted pyrolysis (MAP) and gasification (MAG) of biomass and plastic waste. In situ and ex situ catalytic pyrolysis was investigated. Catalysts and process conditions for high yield and quality of bio-oil were determined. The resultant bio-oil contained high percentage of gasoline range hydrocarbons. For gasification, we tested different microwave absorbents and ratios of microwave absorbent to feedstock. Effect of catalysts and processing conditions on syngas yield and coke reduction was evaluated. The syngas is intended mainly for electricity generation. We continued to study and develop processes and systems for production of biochar, high EPA and DHA lipids microalgae biomass for feed. We are also studying

aquaponic systems for the purpose of complete utilization of liquid and solid waste streams from agricultural sources for production of vegetables and fish. We have initiated a new study on converting CO, a major component of syngas to bio-polymers such as PHA.

Tennessee
Lignin was fractionated from pulp grade chips of hybrid poplar, an energy crop harvested from Oak Ridge, TN, using a patented organosolv process that employs a 50:34:16 volumetric mixture of ethanol, water and methyl isobutyl ketone (MIBK) and 0.05 M sulfuric acid as catalyst. Lignin-containing hydrogels were synthesized from this poplar lignin by first esterifying the purified lignin and then by bulk polymerization with 2-hydroxyethylmethacrylate (HEMA) monomers in the presence of a radical initiator. Addition of esterified lignin was shown to induce cross-linking between the linear polymeric chains of HEMA. Lignin-HEMA hydrogels exhibited superior materials properties such as 39% enhanced water retention and three-fold increase in shear storage moduli (G'), which made it an ideal candidate for applications involving high impact forces. Lignins fractionated from other viable candidates for bio-based production, such as switchgrass and loblolly pine, were upgraded to valuable chemicals via catalytic reduction. Catalytic transfer hydrogenolysis (CTH) was employed to depolymerize the ether and ester linkages of lignin to yield phenolic monomers; supercritical ethanol was the hydrogen donor and FeNiB nano-metallic alloy was the catalyst. The use of FeNiB catalyst increased the yield of de-oxygenated phenolic monomers, thereby enhancing lignin's heating value. CTH derived lignin monomers were used in the synthesis of photopolymer resins via methacrylation of their primary and secondary hydroxyl groups. These photopolymer resins when mixed with suitable acrylate oligomers and photo-initiator compounds could be used as 3-D printing inks in stereolithography printers. Incorporating lignin derivatives will provide additional material strength via crosslinking and also eliminate the use of petroleum-derived chemicals in the 3-D printing resins

Bench and pilot scale experiments evaluated the feasibility of extracting and recovering preservatives from treated wood, e.g. used railroad ties and utility poles, through a mild torrefaction. The resulting preservative ties were then evaluated for their suitability for conversion through fast pyrolysis. The technical findings were reported in a series of referred articles previously reported. One of the significant outcome of this activity is that the torrefaction approach was very effective at desorbing creosote (~97 % at most severe conditions), a common preservative used in treated wood and considered problematic in used treated wood due to EPA regulations and restrictions. Furthermore, the recovered preservatives appeared to have a toxicity threshold similar to wood decay fungus using a standard, lab-scale test method based on AWPA standard E10. In addition to creosote, copper naphthenate extraction from used treated wood was investigated. Copper naphthenate is also common preservative found in treated wood and, based on discussion with industry partners, its removal from used treated wood is critically important to the treated wood industry to reduce cost associated with disposal by incineration. A biodegradable chelating agent extraction step was evaluated prior to torrefaction and pyrolysis. The preliminary results showed that near complete removal of copper naphthenate can be achieved.

Outcomes related to Objective C. [Identify, develop and evaluate sustainable processes to convert biomass resources into biochemicals, biocatalysts and biomaterials (non-fuel uses)]

California
Work was completed on the development of an integrated geospatial optimization model to evaluate hybrid poplar feedstock production sustainability across the Pacific Northwest. The model is used to assess sustainability metrics on both a site-specific and system-wide basis and is spatially explicit and flexible to the desired resolution. Included are a poplar growth model, bioenergy crop adoption and statewide agricultural production model to examine crop substitution effects, and a geospatial bioenergy systems model to determine optimal siting for biorefineries and other facilities based on the desired regional outcomes. Environmental lifecycle assessment and socioeconomic impacts are also modeled. A major objective was the development of interactive quantitative tools to support decision processes by landowners and others involved in the development of new biomass resources for biofuels and bioenergy. As a result of the above work, a new project on siting woody-biomass to electricity facilities has now been initiated with the California Energy Commission. The project involves the development of a web-based forest biomass-to-energy plant siting application that allows users to quickly evaluate the economic feasibility and environmental impacts of potential wood-based bioenergy facilities in California with extensions elsewhere. The project particularly addresses biomass resources associated with the extreme tree mortality in the western U.S. that currently constitute a major ecological concern. Optimization models for biomass-integrated renewable energy microgrids including options for combined heat and power and energy storage were developed. The models integrate supply and demand uncertainties by coupling model predictive control and Monte Carlo simulation to optimize system levelized cost of energy or other objective functions as desired.

Ohio
Techno-economic and life cycle analyses were conducted for the cellulosic biomass production, harvest, logistics and conversion to biofuels.

Washington
Lignin to Jet fuel TEA analysis: Sustainable aviation fuels remain the only true alternatives for the commercial aviation industry and the military, both facing ambitious near-term targets of greenhouse gas reduction. A broad range of renewable alternative jet fuel possesses performance characteristics and chemical compositions essentially identical to conventional jet fuel. Although most biojet fuel technologies are still in the early stages of research, development, and certification, biojet fuel is the most promising alternative energy source as both short- and long-term solutions to replace crude oil derived jet fuel for the airline industry. The US jet fuel market represents a market with 20 billion gallons hydrocarbon fuel. All emerging biojet fuel technologies that meet ASTM standards could contribute to this jet market. However, as of this date, no clear winning sustainable jet fuel technology exists, a situation that encourages constant research and development in innovative biojet fuel conversion strategies. For biomass-based biojet fuels, as in the case of biofuels for ground transportation, it is critical to have sustained and low cost feedstocks for commercial feasibility. This presents a challenge because, unlike crude oil, biomass contains a high level of oxygen in its major heteropolymers. A degree of progress has been made for biojet fuel technologies using these diverse biomass substrates, but more effort is still needed to improve the biomass conversion efficiencies as well as to improve economic viability. Currently there are five main developed biojet fuel conversion technologies that have been approved by ASTM as meeting the standard specifications ASTM D7566, certifications in preparation. They are Fischer-Tropsch Synthetic Paraffinic Kerosene (FT-SPK), Fischer-Tropsch Synthetic Kerosene with Aromatics (FT-SKA), Hydrotreated Esters & Fatty Acids (HEFA), Synthesized Iso-Paraffinic (SIP), and Alcohol (isobutanol) to Jet Synthetic Paraffinic kerosene (ATJ-SPK) which can be blended with Jet A or Jet A-1 fuel certified to Specification D1655 and 16 certifications in preparation. There are also five additional biojet fuel technologies are under review such as High Freeze Point Hydrotreated Esters & Fatty Acids (HFP-HEFA), Virent BioForm Synthesized Aromatic Kerosene (SAK) Jet Fuel (SAK), LanzaTech ATJ-SPK (Ethanol to Jet), Applied Research Associates Catalytic Hydrothermolysis Jet (ARA-CHJ), and BioForm® Synthesized Kerosene (SK) Jet Fuel (Virent SK). Data are being collected for three more technologies including ATJ-SKA developed by Byogy (Byogy Renewables, Inc., San Jose, USA), Swed Biofuels (Swedish Biofuels AB, Stockholm, Sweden), and the IH2 demonstration scale by Shell (Royal Dutch Shell, UK) which acquired the technology from the Gas Technology Institute (GTI) (Des Plaines, USA) in 2009. Indeed, there are many more technologies are in exploratory discussions such as Vertimas: one-step catalytic conversion of ethanol to jet, petrol, diesel fuel and chemicals which was originally invented at Oak Ridge National Laboratory(57); SBI Bioenergy: continuous catalytic process that converts fat, oil or grease into renewable gasoline,

diesel and jet fuel with proprietary process intensification and continuous flow through processing technologies (PICFTR)' Joule: CO2-derived fuels 'Sunflow-J' jet fuel from specially engineered photosynthetic bacteria, waste carbon dioxide, sunlight and water); Global Bioenergies: biological production of isobutene and process to jet fuel; Eni: hydrogenated vegetable oil (HVO); Enerkem: municipal waste gasification and catalytic conversion to ethanol followed conversions to biofuels and chemicals; and Washington State University: Lignin to Jet Fuel (LJ-D&HDO) through one-step proprietary catalytic upgrading of lignin waste to jet fuel. 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

Nebraska
A techno-economic simulation model was developed to investigage the impact of fed-batch enzymatric hydrolsysis on biofuel production. The simulation model was used to compare the impact of fed-batch hydrolysis vs batch hydrolysis.Using a fed-batch operation decreased facilities costs by 41%, labor costs by 21% and capital costs by 15%. A service-oriented architecture was used to build a modeling frame-work to link a crop-production model (DSSAT) to a biofuel life cycle assessment model (GREET).Currently, the modeling framework is being used to simulate link crop production in eastern Nebraska region to corn ethanol production. The framework was used to evaluate the effects of agronomic decisions on overall sustainability of the system.

Pennsylvania
Accomplishments this year focused on project: "Investigate and develop sustainable technologies to convert biomass resources into chemicals, energy, materials and other value-added products." Accordingly, we 1) reviewed opportunities and challenges of the U.S. biofuels industry, 2) examined drivers and barriers to the adoption of higher ethanol fuel blends into retail fuel companies' stations, 3) summarized U.S. laws and policies impacting the U.S. biofuels industry, 4) assessed drivers and barriers to the adoption and diffusion of sustainable jet fuel in the U.S. Pacific Northwest (PNW) region, 5) explored lignin valorization from biorefinery waste streams, and 6) deployed a stepwise biogeophysical and social analysis approach to biorefinery site selection.

Oklahoma
Process Simulation of Gasification and Syngas Fermentation: Switchgrass to Ethanol A process model using ASPEN Plus was developed to simulate commercial ethanol production from gasification of 1200 tons of switchgrass per day followed by fermentation of the produced syngas. Results showed that about 37 million gallons of anhydrous ethanol can be produced per year from 1200 tons per day switchgrass. The gasification-syngas fermentation process yielded about 98 gallons ethanol per dry ton of biomass, which is higher than the 70 gallons ethanol per dry ton of biomass typically achieved using the biochemical platform. The process model can be used as a basis for a detailed techno-economic analysis and help designing an efficient commercial gasification-syngas fermentation biorefinery.

Wisconsin
We investigated production of biochar from biomass as adsorbent. We investigated novel nanomaterial and aerogels produced form biomass using ionic liquids. We investigated producing nanomaterials from green solvent sytems. We developed several techno-economic analyses on chemical products produce from biomass feedstocks.
North Dakota. Cellulase enzymes were conjugated on a PGMA-PEG polymer for development of an engineered cellulosome. Initial testing showed that conjugated enzymes performed better than free enzymes at low enzyme loadings. At more typical enzymes loadings, free and conjugated enzymes performed similarly. Preliminary results showed that the effects of enzyme product inhibition from glucose release were negligible for the polymer-enzyme conjugate while the same system resulted in a 50% activity reduction for the free enzymes.

Iowa
Several rules of thumb have been identified governing combined fermentative catalytic processing systems for biomass converion. Simplified cost analysis of biorenewable carbon use for industrial chemical production was proposed which will enhance the accuracy of estimations. Cost-benefit analysis of 5-L scale and a simulated 20,000-L biosurfactant process facility based on switchgrass as feedstock.

New Jersey
Coupled duckweed with red-belly pacu fish. The developed system resulted not only eco-friendlier but yield added economic and environmental value than the existing systems. Develop a computable general equilibrium model to access the sustainability and viability of direct nitrogen reduction technologies.

Outcomes related to Objective D. [Identify and develop needed educational resources, develop distance based delivery methods, and develop a trained work force for the biobased economy]

West Virginia
Activity 1: Graduate and Undergraduate Education (Singh) The course WDSC 444: Biobased Energy Systems is being offered since Fall 2017 semester. In addition, Dr. Singh also teaches WDSC 100: Forest Resources in U.S. History (in class as well as web-based), which is a freshmen course.

Activity 2: Extension of Technology to Small Businesses (Singh and Sivanandan) Drs. Singh and Sivanandan are engaging small food business owners to motivate them for transforming their waste for value added products through extension presentations and workshops.

Washington
The notable outcomes from our team won several top places in business competitions in Washington State. For example, we won the third place among 21 teams at the Alaska Airlines Environmental Innovation Challenge finals in April of 2017. For the challenge, interdisciplinary student teams define an environmental problem, develop a solution, design and build a prototype, create a business plan that proves their solution has market potential and pitch their idea to 170 judges from throughout the Northwest. Our team also won the Wells Fargo "CleanTech" Big Picture prize during the University of Washington's Business Plan Competition in May of 2017. The team was accepted into the Cascadia CleanTech accelerator program, which is a 14-week program that delivers mentorship, curriculum, connections and funding opportunities designed specifically for early-stage cleantech startups. Publications and News Produced as Result of This Research 1. Grant funds test of market potential for jet fuel research (https://news.wsu.edu/2016/12/01/grant-funds-test-market-potential-jet-fuel-research/) 2. Alaska Airlines Environmental Innovation Challenge (https://news.wsu.edu/2017/04/03/tri-cities-clean-tech-business/#more-155806) 3. WSU Tri-Cities team in UW business competition 'sweet 16' (https://news.wsu.edu/2017/04/28/wsu-in-sweet-16-uw-business-competition/) 4. WSU Tri-Cities team won the CleanTech Big Picture prize at the UW business competition (https://bsyse.wsu.edu/2017/05/30/wsu-tri-cities-team-earns-cleantech-big-picture-prize-at-uw-business-competition/) 5. Libing Zhang, Terri L. Butler, and B. Yang*, Recent Trends, Opportunities and Challenges of Sustainable Jet Fuel," Green Energy to Sustainability: Strategies for Global Industries, John Wiley & Sons, Ltd, 2017. In Press.

Pennsylvania
Enhancement of the bioenergy online courses, which have been developed for "Master of Professional Studies in Renewable Energy and Sustainability Systems (MPS-RESS)" and "Online Graduate Certificate Program in Bioenergy" at Pennsylvania State University. The project aimed to create innovative tools for the hands-on practical/laboratory educational experiences associated with distance learning of technical subjects.

New Jersey
We are interacting with Rutgers aquaculture outreach and am hoping to introduce the technology to local aquaculture farmers.

Minnesota
Biobased economy is a relatively new field, and therefore has high demand for human resources. Our project has trained many students and junior researchers who either took on industry or academic jobs that require knowledge of renewable energy technology. Many of our findings have found their way in classroom teaching. Our thermochemical conversion, scum biodiesel, and algae research activities have resulted in pilot scale facilities for demonstration to stakeholders.

Illinois
In January 2018, two short courses were taught: one on corn wet milling and one on fuel ethanol production technology. Each short course was taught by eight experts: four faculty, two USDA-ARS scientists and two speakers from industry. Eighty participants from wet milling, dry grind ethanol and allied industries participated in the courses. An additional wet milling course was offered in May 2018, due to popular demand. Forty participants attended this workshop. These workshops were designed as an outreach activity to members of the starch and biofuels industries. Graduate students presented their research posters to the participants during the workshops. In

August 2018, as part of the S-1041 annual meeting, a mini-symposium was held at the Forest Products laboratory in Madison, Wisconsin. Papers and posters were presented and compiled into printed proceedings (edited by Illinois representatives) that were distributed at the symposium and posted on line. Proceedings will also be distributed to state and federal agencies.

Alabama

We have developed a 'Metabolic Engineering for Bioprocess' class for both undergraduate students and graduate students. An Applied Biotechnology undergraduate major has been started in the College of Agriculture at Auburn University from Fall 2017. This class has been included in the Applied Biotechnology curriculum as a core class. We have also developed a 'Life-Cycle Assessment for Biological Systems' class for both undergraduate students and graduate students. The Biosystems Engineering Department at Auburn University will start a new Bioprocess Engineering Option for the undergraduate curriculum from Fall 2018. Auburn University is also a participant of the Consortium for Advanced Bioeconomy Leadership Education (CABLE) Program, started from Fall 2017. CABLE is an undergraduate training project leading by Ohio State University in partnership with 19 other institutions (including Auburn University) sponsored by USDA-NIFA. The purpose of the project is to train the future workforce in the bioeconomy industry, especially to prepare the next-generation bioeconomy industry leaders.

Impacts

Alabama
1) Developed new engineered strains and bioprocesses for biofuel and biochemical production; 2) Secured federal grants for further biomass and bioenergy research, education and outreach; 3) Developed new courses in the biomass and bioenergy area, which will help train the next generation of workforce for the future bioeconomy.

Illinois
1. Information on low cost methods of pretreating energy crops using enzymes have been studied and results disseminated, bringing the cellulosic ethanol from energy crops closer to commercial reality. 2. Dilute acid pretreatment conditions were identified that will make this low impact method more commercially viable. Pretreatment conditions were found to have large effect on sugar yield and ethanol production. 3. Techno-economic analysis revealed that lipid cane to be a cost effective, renewable source for jet fuel production. 4. Techno-economic analysis found that processing corn with high pigment contents would have high economic impact on biofuel processors and improve economic sustainability of the biofuel plants. 5. Improved understanding of effects of protein on fouling rates will increase efficiency of more than 200 biorefineries that use evaporators.

California
The research findings and decision support tools resulting from the research can be used by extension and other academic investigators and private developers to disseminate knowledge about possible environmental impacts and economic implications for biofuel systems and to assist in specific investment decisions. In addition, researchers in the field can use insights of the work to further advance the methods and approaches for enhanced decision support and sustainability assessment. The research results will also lead to new technologies and methods for converting biomass into bioenergy, biochemicals and soil amendment to support the development of bioeconomy.

Ohio
3 PhD students, 1 MS student, 1 postdoctoral research associate, and 2 visiting PhD students were trained in feedstock logistics and systems analyses research.

Washington
The postdoctoral researcher supported by this project was involved in all aspects of the proposed studies, and had cross-training opportunities in multi-disciplinary research areas as different subfields, including interviews with potential customers, competitors and investors, building our business model, jet fuel distribution logistics, market test, and cost-saving scale-up. The EL has been encouraged to participate Aviation Alternative Fuels Initiative (CAAFI) conference to help us build networks with main stakeholders in aviation fuel industry and gain attention of main business players on our technology and business. EL registered a company named LIGNIN BIOJET LLC.

Texas
The gasification research at Texas A&M University has generated additional 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 also entered into a contract with TAMU Sponsored Research Services at TAMU for the implementation of Sponsored Research for the commercialization work.

Louisiana
Impacts on value added and improvements of regenerated cellulose fibers from annual plants. On using bioderived rejuvenators and recycled materials in asphalt pavements.

Pennsylvania
Use of increased renewable resources will require deliberate development of technologies for efficient use of resources due to three converging issues: (1) decrease in productive agricultural land areas under urbanization pressures; (2) clearing of land areas using unsustainable methods; and (3) increasing world population with an increased standard of living including a clean environment. One billion hectares of land will be cleared by 2050, resulting in the release of three Gt/year of greenhouse gases. Global population will reach nine billion by 2050, resulting in increases in global food demand from 2005 to 2050. Breadth of these intersecting problems are so vast

that constructive solutions can be designed and implemented only through collaborations crossing traditional disciplinary boundaries.

Oklahoma
OK Station research efforts will impact conversion efficiency, cost of production, reactor design, and process development of the hybrid gasification-syngas fermentation technology for implementation in sustainable biorefineries in the nation, and the world. There are opportunities to apply the hybrid gasification-syngas fermentation technology in different regions of the country to meet our increasing energy needs. Upon its full development, this hybrid technology can provide 35% more ethanol from the same amount of biomass as compared to the biochemical conversion technology. If fuel producers adopt this hybrid technology to produce 25% of the mandated 16 billion GPY renewable transportation fuels such as ethanol (i.e., 4 billion GPY), OK research suggests a projected annual savings of over $650 million due to the use of 13.1 million tons less biomass with the hybrid technology.

Wisconsin
Improved small-scale AD technologies for rural communities; Developed lifecycle assessment tools; developed novel biomass fractionation using ionic liquids and green solvent technologies; developed novel biobased aerogel and nanomaterials

Montana
Since wheat is the major cash and food crop in the Northern Great Plains, it is not feasible to replace wheat acres with camelina for biodiesel or aviation fuel feedstock production. We use camelina as a rotational crop for wheat. In order to make camelina a profitable crop, variety development and genetic improvement is needed, along with the cropping systems optimization. The development of a simple and effective transformation procedure in the Lu lab promoted camelina as a widely adopted plant species for translational biology research. Recently, Dr. Lu's group has developed an efficient tool using CRISPR-Cas9 for gene editing in camelina. This tool will be useful to investigate gene functions in camelina and relieve other bottlenecks of HFA accumulation, such as replacing endogenous genes with those homologous from HFA-accumulators to avoid competitions.

West Virginia
During past year, one research articles are published and two research articles are under revision. Additionally, 15 technical presentations were made to technical and non-technical audience.

Iowa
Knowledge of coproduct properties, and optimized processes and technologies will lead towards sustainable biochemicals/biobased products. Cost-benefit information on biochemical of interest provides information on process economics and helps manufacturers understand types and magnitudes of costs involved.

New Jersey
The involvement with S1041 introduced me to agricultural engineering, and led to interactions with its members that helped me better understand the questions am working on and how to find plausible solutions. It also led to joint work with some of its members.

Virginia
Conversion of food waste and food processing byproducts to value-added chemicals could greatly enhance the sustainability of the U.S. agriculture system.

Massachusetts
A method to deconstruct woody biomass and wood residues for biorefinery applications that does not require expensive high-temperature treatment, nor does it require harsh or toxic chemicals, is being developed. The CMF treatment is conducted at room temperature, it is a quick process to solubilize wood, it is low cost, low energy, and does not generate or use harsh or toxic chemicals.

Missouri
The observation of an inverse ammonia toxicity relationship is critical in understanding how brine shrimp are capable of growth in heavy algal bloom conditions where culture pH is often elevated. Furthermore, this characteristic has

important implications in management of high density brine shrimp culture for use in harvesting and converting algal or bacterial cultures into brine shrimp biomass

Minnesota
Production of current major biofuels, i.e., biodiesel and ethanol, is competing with food and feed demands, prompting the need to use non-food biomass feedstock for biofuel production. Our work on pretreating animal manures to produce effluent suitable for microalgae and vegetables 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 and stability of the products. Our work on microwave assisted catalytic conversion of biomass and plastic wastes has improved the yield and quality of bio-oil and syngas. These outcomes have positive impacts on the overall technical and economic performance of thermochemical conversion technologies. Our wastewater based algae technology also provides significant environmental benefits in addition to biofuels and bioproducts.

Tennessee
The complexities to supply a commercially-consistent feedstock of biomass at predictable specifications involves not only the target specifications for conversion, but also required specifications of biomass feedstock for efficient handling, conveyance, and reduced plugging, in addition to increased bulk density and reduced moisture retention for quality under aerobic conditions.

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.

Target Audience

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

Illinois
Our target audience covers a spectrum of interested parties, including: crop producers, biomass processors and corn refiners. On a regular basis, we meet with and disseminate information to crop producers, crop genetics industry, agricultural chemical companies, commodity production groups (e.g., Illinois Corn Marketing Board, National Corn Growers Association), grain industry groups (e.g., North American Millers Association, Corn Refiners Association), corn processor representatives, and government regulatory agencies.

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.

Ohio
biobased industries, farmers, researchers, academicians

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

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

Louisiana
Academic media and industrial research on regenerated cellulose fibers. Development departments on paving materials, asphalt producers, the highway paving contractors, Federal and State Highway Administration.

Nebraska
Researchers and industry professionals interested in biofuels, bioproducts, and agricultural sustainability.

Pennsylvania
The target audience for this research includes science discovery and biomass processing companies ranging from small start-ups. Agricultural stakeholders include state and national organizations, state and federal agencies. Communities are interested in these technologies from economic and community development perspectives. 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), scientific journal articles and extension publications. Academic research labs within the Metabolic Engineering & Synthetic Biology fields. Industrial biotech researchers in Biopharmaceutical companies, Metabolic Engineering companies, and Enzyme companies, spanning from start-ups to large businesses.

Oklahoma
Scientists, engineers, graduate students, postdoctoral associates, product developers, and the general public.

Wisconsin
Industry, Engineers, Scientists, Policymakers and Students

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

Iowa
surfactant industry, bioprocessors, academia, scientific, general public

New Jersey
Practitioners, local farmers, and academia

Virginia
Food processing industries, biochemical companies, local farmers

Massachusetts
Biorefineries, Sustainable Biomaterial Experts

Missouri
1) Aquaculture stakeholders and algal biomass culturists 2) Researchers and stakeholders interested in conversion of lignin and cellulose into specialty products.

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.

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. In other words, the target considers the potential new cellulosic biofuels industry for farm-to-biorefinery. Farm producers, biomass supply logistics firms, truckers, and biorefineries are targeted for the impact of supply logistics on conversion processes. Farmers are an important target for creating economically-viable biomass feedstock supplies since they make important decisions regarding the production and harvest of biomass crops to meet specifications acceptable to downstream conversion processes. Supply logistics firms can affect the quality of biomass since exposure to climatic elements affects biomass degradation and introduction of inhibitors. Truckers move biomass from farms to depots and/or biorefineries and possibly other points along the supply chain. Their understanding of moving biomass with seasonal harvest constraints and specification quality are paramount in the successful deployment of a supply chain. Biorefineries need of understand the importance of defining target biomass specifications that affect their processes, and the acceptable range of tolerances as it affects the cost of supply and conversion. At the moment the target audience is the biorefinery/lignin scientific community. The targeted audience of the aforementioned activities includes 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. Technical findings were presented at technical meetings or in refereed articles.

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Alabama

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Related Presentations

Alabama

1. Vivek Patil and Sushil Adhikari. Using paper industry waste in a biorefinery. Auburn University Graduate Engineering Research Showcase. Auburn, AL. November 09, 2017.
2. Sanjeev K.C., Sushil Adhikari and Robert Jackson. Bio-derived oil for automotive and industrial lubrication. Auburn University Graduate Engineering Research Showcase. Auburn, AL. November 09, 2017.
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5. Nikhil Jain and Sushil Adhikari. Microemulsion route to upgrade algal biocrude. Auburn University College of Agriculture Graduate Student Research Poster Showcase. Auburn, AL. October 26, 2017.
6. Sushil Adhikari, Saravanan R Shanmugam and Rajdeep Shakya. Nutrient removal and energy production from aqueous phase of bio-oil generated during thermochemical liquefaction of algae. TC Biomass 2017. Chicago, IL. September 19-21, 2017.
7. Sourov Kar Sajib, Sushil Adhikari and James Radich. Fast pyrolysis of canola meal derived n-doped mico/mesoporous activated biochars for Li-S battery. American Society of Agricultural and Biological Engineers (ASABE) annual meeting. Spokane, WA. July 17-18, 2017.
8. Saravanan R Shanmugam, Sushil Adhikari, and Rajdeep Shakya. Nutrient and energy recovery from aqueous phase of bio-oil generated via hydrothermal liquefaction of algae. American Society of Agricultural and Biological Engineers (ASABE) annual meeting. Spokane, WA. July 17-18, 2017.
9. Khalida Binte Harun* and Sushil Adhikari. A comparative study of Ru-doped ZSM-5 activated carbon and biochar catalysts for hydrogen production by thermocatalytic decomposition of methane. American Society of Agricultural and Biological Engineers (ASABE) annual meeting. Spokane, WA. July 17-18, 2017.
10. Saravanan R Shanmugam, Sushil Adhikari, Hyungseok Nam and Sourov Kar Sajib. Effect of adsorbents on methane generation via anaerobic digestion of glucose using mixed anaerobic cultures: evaluation of microbial community dynamics. American Society of Agricultural and Biological Engineers (ASABE) annual meeting. Spokane, WA. July 17-18, 2017.
11. Vivek Patil and Sushil Adhikari. Hydrothermal liquefaction of lignin for production of biofuels and chemicals. American Society of Agricultural and Biological Engineers (ASABE) annual meeting. Spokane, WA. July 17-18, 2017. (Poster)
12. Rajdeep Shakya, Sushil Adhikari, Zhouhong Wang, Ravishankar Mahadevan*, Nikhil Jain* and sanjeev KC*. Effects of residence time and CO2 partial pressure on catalytic upgrading of bio-oil produced from hydrothermal liquefaction of algae. American Society of Agricultural and Biological Engineers (ASABE) annual meeting. Spokane, WA. July 17-18, 2017.
13. Sanjeev KC and Sushil Adhikari. Understanding the effect of catalytic pyrolysis bio-oil produced using CaO during hydrotreatment. American Society of Agricultural and Biological Engineers (ASABE) annual meeting. Spokane, WA. July 17-18, 2017.
14. J. Zhang, Y. Wang. Exploiting endogenous CRISPR-Cas system for multiplex genome editing in Clostridium and engineering Clostridium for enhanced biobutanol production. ASABE 2018 Annual International Meeting. Detroit, MI, July 29-August 1, 2018.
15. J. Zhang, W. Hong, Y. Wang. Exploiting endogenous CRISPR-Cas system for multiplex genome editing in Clostridium. ASM Microbe 2018, American Society for Microbiology. Atlanta, GA, June 7-11, 2018.
16. J. Feng, Y. Gu, C. Song, Y. Wang. Recruiting energy-conserving sucrose utilization pathways for enhanced biochemical production in Bacillus. ASM Microbe 2018, American Society for Microbiology. Atlanta, GA, June 7-11, 2018.
17. J. Yoon, D. Lee, E. Lee, S.P. Woo, Y.S. Yoon, Y. Wang, D.J. Kim. Sputtering of nickel-palladium bimetallic anode catalysts for direct urea/urine fuel cell (DUFC) application. The 233rd Electrochemical Society (ECS) Meeting. Seattle, WA, May 13-17, 2018.
18. P. Wang, S. Taylor, Y. Wang. Engineering Clostridium saccharoperbutylacetonicum for enhanced isopropanol-butanol-ethanol (IBE) production from lignocellulosic biomass through acetic acid pretreatment. 40th Symposium on Biotechnology for Fuels and Chemicals, Society of Industrial Microbiology and Biotechnology. Clearwater Beach, FL, April 29-May 2, 2018.

19. J. Zhang, S. Wang, H.P. Blaschek, Y. Wang. Develop CRISPR-Cas genome engineering tools and engineer solventogenic clostridia for enhanced biofuel and biochemical production. 40th Symposium on Biotechnology for Fuels and Chemicals, Society of Industrial Microbiology and Biotechnology. Clearwater Beach, FL, April 29-May 2, 2018.
20. Y. Wang. Bioenergy and Biofuel: for the Sustainable Future of U.S. International Workshop and Conference on Renewable, Conventional Power and Green Technology, Auburn University-Montgomery, Montgomery, AL. December 4, 2017.
21. E. Lee, J. Yoon, D. Lee, S. Woo, Y. Yoon, Y. Wang, B.C. Prorok, D.J. Kim. Direct conversion fuel cell of urine in animal wastes and its condition monitoring sensors for efficient water usage in agriculture. The 232nd Electrochemical Society (ECS) Meeting. National Harbor, MD, October 1-6, 2017.
22. Y. Wang, Z.T. Zhang, S. Wang, J. Zhang, P. Wang, H.P. Blaschek. Develop CRISPR-Cas genome engineering tools and engineer solventogenic clostridia for enhanced biofuel and biochemical production. ASABE 2017 Annual International Meeting. Spokane, WA, July 16-19, 2017.
23. S. Dong, S. Wang, Y. Wang. Metabolic engineering of Clostridium pasteurianum for enhanced biobutanol production. ASABE 2017 Annual International Meeting. Spokane, WA, July 16-19, 2017.
24. Wang, Q., B.T. Higgins. 2018. Improved microalgae biomass production and wastewater treatment: Pre-treating municipal anaerobic digestate for algae cultivation. Presented at the Annual International Meeting of American Society of Agricultural and Biological Engineers. July 29-Aug 1, Detroit, MI
25. Higgins, B.T., M.B. Paddock*, S. Staley*, S.J. Ceballos, J.S. VanderGheynst. 2017. Modeling of photosynthetic aeration for energy-efficient wastewater treatment and reduced greenhouse gas emissions. Presented at the Annual International Meeting of American Society of Agricultural and Biological Engineers. July 16-19, Spokane, WA
26. Higgins, B.T., I. Gennity, S. Samra, T. Kind, O. Fiehn, J.S. VanderGheynst. 2018. Synergy of algae and bacteria for treatment of winery wastewater (oral). Algal Biomass, Bioenergy, and Bioproducts Conference, June 11-13, Seattle, WA
27. Higgins, B.T., Q. Wang, S. Du, M. Hennebelle, A. Taha, O. Fiehn, J.S. VanderGheynst. 2018. Metabolomics reveals the impact of thiamine deficiency and alleviation on Auxenochlorella protothecoides (poster). Algal Biomass, Bioenergy, and Bioproducts Conference, June 11-13, Seattle, WA
28. Higgins, B.T., I. Gennity, S. Samra, T. Kind, O. Fiehn, J.S. VanderGheynst. 2018. Combined digester and algal treatment of agricultural wastewaters for re-use in irrigation (oral). Water Research Foundation Conference. May 6-8, Atlanta, GA
29. Wang, Q., B.T. Higgins. 2018. The study of algae growth inhibitors in Anaerobic Digestate effluent (oral). AL Chapter of ASABE Meeting, Auburn University, Auburn, AL
30. Preisser, M., B.T. Higgins. 2018. Anaerobic digestion of poultry litter and food waste for biogas production (oral), National Undergraduate Research Conference. April 4-7, University of Central Oklahoma, Edmond, OK
31. Chaump, K., B.T. Higgins. 2018. Effects of leaching on anaerobic digestion of poultry litter (poster). This is Research Symposium, Auburn University, Auburn, AL
32. Wang, Q., B.T. Higgins. 2018. The study of algae growth inhibitors in Anaerobic Digestate effluent (oral). This is Research Symposium, Auburn University, Auburn, AL
33. Bankston, E., B.T. Higgins. 2018. Using anaerobic digesters to treat poultry litter waste & grow microalgae (poster). This is Research Symposium, Auburn University, Auburn, AL
34. Preisser, M., B.T. Higgins. 2018. Anaerobic digestion of poultry litter and food waste for biogas production (poster), This is Research Symposium, Auburn University, Auburn, AL

California

1. Tao, W., Lin H. Huang. H., Fan, Z Conversion of gluconate and glycerol to ethanol using the recombinant klebsiella oxytoca strains presented in 2017 AICHE annual meeting in Minneapolis, MN
2. Jabusch, L.K., VanderGheynst, J.S. Techno-economic analysis of algae and algae grazer in co-culture. The 8th International Conference on Algal Biomass, Biofuels and Bioproducts. June 11-13, 2018. Seattle, WA.
3. VanderGheynst, J.S., Simmons, C.W. Integrating organic waste recycling with agriculture in a resource-limited environment. Presented at the winter meeting of the UC Davis Arab Region Consortium. February 7, 2018. Davis, CA.
4. Fernández-Bayo, J.D., Parr, A.E., Achmon, Y., Shea, E.A., Lopez, E.A., Stapleton, J.J., VanderGheynst, J.S., Hodson, A.K., Simmons, C.W. Nematicidal Activity of Biosolarization Using Almond Waste Amendments. Methyl Bromide Alternatives Outreach Symposium, November 2017. San Diego, California.

5. Higgins, B.T., Paddock, M.B., Staley S., Ceballos, S.J., VanderGheynst, J.S. Modeling of photosynthetic aeration for energy-efficient wastewater treatment and reduced greenhouse gas emissions. Presented at the American Society of Agricultural and Biological Engineers 2017 Annual International Meeting. July 17, 2017. Spokane, WA.
6. Fernandez-Bayo, J.D., Randall, T.E., Achmon, Y., Hestmark, K., Harrold, D.R., Su, J., Dahlquist-Willard, R., Gordon, T., Stapleton, J., VanderGheynst, J.S., Simmons, C.W. 2017. Effect of Partially Stabilized Organic Amendments on Volatile Acids Production and Pest Inactivation using Soil Biosolarization. Presented at the American Society of Agricultural and Biological Engineers 2017 Annual International Meeting. July 19, 2017. Spokane, WA.
7. Jabusch, L. K., J. S. VanderGheynst. Integrating Growth Kinetics into a Techno-economic Analysis for Algae Biomass Production. Presented at the American Society of Agricultural and Biological Engineers 2017 Annual International Meeting. July 17, 2017. Spokane, WA.
8. Stapleton, J.J., J.S. VanderGheynst, and C.W. Simmons. Optimizing solarization-based technologies as alternatives to soil fumigation. CA Department of Pesticide Regulation. Sacramento, CA. March 21, 2017.
9. Fernández-Bayo, JD., T.E. Randall, Y. Achmon, K. Hestmark, D. Harrold, J. Su, R.M. Dahlquist-Willard, T. Gordon, J.J. Stapleton, J.S. VanderGheynst, C.W. Simmons. Application of Partially Stabilized Organic Amendments to Inactivate Brassica nigra (a weed) and Fusarium oxysporum f.sp.lactucae (a fungus) using Soil Biosolarization. CA Weed Science Society. January 18, 2017.
10. Barzee, T., R. Zhang, H. El Mashad. 2017. Fungal assisted harvesting of algae and bacteria. Paper presentation at ASABE International Meeting, Spokane, WA, July 17.
11. Barzee, T., A. Edalati, H. El Mashad, J. Rapport, K. Scow, R. Zhang. 2017. Liquid fertilizer production from anaerobic digestate for growing tomatoes. Paper presentation at ASABE International Meeting. Spokane, WA, July 17
12. Edalati, A., T. Barzee, H. El Mashad, J. Rapport, K. Scow, R. Zhang. 2017. Solid pelletized biofertilizer production from anaerobic digestate for growing corn. Paper presentation at ASABE International Meeting, Spokane, WA, July 17.
13. Zhang, R. Powerful Microbes and Biodigesters for Turning Waste into Energy. Halloween Symposium on Microbiomes. UC Davis Genome Center. October 27, 2017
14. Zhang,R. Digestate Alone and With Compost-Designing for Specific End Uses. California Bioresource Alliance 2017 Symposium. Sacramento, CA. November 1-2, 2017.

Ohio

1. A. Khanal, A. Manandhar, A. Shah. 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.
2. A. Khanal, S. Khanal, S. H. Mousavi Avval, A. Shah. Life Cycle Assessment of corn stover collection for cellulosic biofuel production. ASABE Annual International Meeting 2018, July 29-Aug 1, Detroit, MI.
3. 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. (Oral)
4. 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. (Oral)
5. Z. Cui, A. Shah. 2018. Upgrading effluent from anaerobic digestion through hydrothermal carbonization. ASABE Annual International Meeting 2018, July 29-Aug 1, Detroit, MI.
6. J. Vasco-Correa, R. Capouya, A. Shah, Y. Li, T. Mitchell. 2018. Changes in composition, enzymatic digestibility and microbial communities during sequential solid-state fungal pretreatment of non-sterile Miscanthus. ASABE Annual International Meeting 2018, July 29-Aug 1, Detroit, MI.
7. J. Vasco-Correa, A. Shah. 2018. Identification of bottlenecks of fungal pretreatment of lignocellulosic biomass: process development and techno-economic analysis. ASABE Annual International Meeting 2018, July 29-Aug 1, Detroit, MI.
8. 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. (Oral)
9. 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.
10. J. Wang, A. Shah. 2018. Techno-economic analysis of levoglucosan utilization via different conversion systems. ASABE Annual International Meeting 2018, July 29-Aug 1, Detroit, MI.

11. 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.
12. A. Khanal, A. Manandhar, A. Shah. Evaluating biomass composition and nutrients in non-grain fractions of the corn plant for sustainable cellulosic biofuel production. 2018 NABEC conference, Morgantown, West Virginia, 2018-Poster
13. A. Manandhar and A. Shah. 2018. Techno-economic analysis of lactic acid production using corn stover and switchgrass. Poster presentation. S-1041 Annual Meeting, Madison, WI.

Washington

1. 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.
2. Bin Yang, "Lignin Based Jet Fuel", ACS NORM 2018, Richland, WA. June 26, 2018.
3. 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.
4. 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.
5. 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.
6. Xiaolu Li, Zhangyang Xu, and Bin Yang, "Enabling Bioconversion of Biorefinery Wastes to Lipids with Oleaginous Rhodococci", AIChE annual meeting, Minneapolis, MN November 1, 2017.
7. Libing Zhang, Yucai He, and Bin Yang, "Hot Water-Only and Alkali Flowthrough Pretreatment of Softwood", AIChE annual meeting, Minneapolis, MN November 2, 2017.
8. Zhangyang Xu, Xiaolu Li, Seema Verma, John H. Miller, Bin Yang "Paving bacterial pathways: from lignin to polyhydroxyalkanoates", 2017 ASABE Annual International Meeting, Spokane, WA, July 17, 2017.
9. Bin Yang "Aqueous Processing of Lignocellulosic Biomass to Advanced Biofuels", 2017 ASABE Annual International Meeting, Spokane, WA, July 18, 2017.
10. Fitria, Libing Zhang, Zheming Wang, Steven C. Fransen, and Bin Yang "Understanding the effects of mineral salts on biomass pretreatment – a case for switchgrass", 2017 ASABE Annual International Meeting, Spokane, WA, July 19, 2017.
11. Rongchun Shen and Bin Yang, "Techno-Economic Assessment of Jet Fuel Production from Biorefinery Waste Lignin", 39th Symposium on Biotechnology for Fuels and Chemicals, San Francisco, CA. May 2, 2017.
12. Libing Zhang, Lishi Yan, and Bin Yang, "Physiochemical Characterization of Lignocellulosic Biomass Dissolution by Flowthrough Pretreatment", AIChE annual meeting, San Francisco, CA November 17, 2016.

Texas

1. Capareda, S.C. and Amado Maglinao. 2017. Demonstration of water purification/treatment/recycling and power generation in a commercial dairy. 2017 ASABE International Meeting, Spokane, Washington, July 16-19, 2017. Technical Paper No. 1701682, ASABE, St. Joseph, MI.
2. Baticados, El Jerie, Sergio Capareda, Calvin Parnell Jr., and Russell McGee. 2017. Solid aerosol formation from the reaction of ammonia with greenhouse gases (GHG). 2017 ASABE International Meeting, Spokane, Washington, July 16-19, 2017. Technical Paper No. 1700699, ASABE, St. Joseph, MI.
3. Capareda, S.C. and Amado Maglinao. 2017. Demonstration of water purification/treatment/recycling and power generation in a commercial dairy. 2017 S1041 Multistate Committee Annual Meeting and Symposium, July 10-11, 2017 at USDA/NIFA National Institute of Food and Agriculture, Washington, DC.
4. Capareda, S.C. and Amado Maglinao. 2017. Demonstration of water purification/treatment/recycling and power generation in a commercial dairy. Soil and Water Conservation Society (SWCS) 72nd International Annual Conference: Conservation Connections: Creating Pathways to Sustainability, Juy 30-August 2, 2017, Monona Terrace Convention Center, Madison, Wisconsin.

5. Capareda, S.C. and Amado Maglinao. 2017. Demonstration of water purification/treatment/recycling and power generation in a commercial dairy. Waste –to-Worth Conference organized by the Livestock & Poultry Environmental Learning Center, Cary, North Carolina, April 17-21, 2017.
6. Choi, Julius and Sergio C. Capareda. 2017. Tuning the Physicochemical Properties of Biochar Derived from Ashe Juniper By Vacuum Pressure and Temperature, AIChE Annual Meeting, October 30, 2017, Minneapolis, MN.
7. Choi, Julius and Sergio C. Capareda. 2017. Selective Conversion of Ashe Juniper Waste into Levoglucosenone and Acetol, AIChE Annual Meeting, November 1, 2017, Minneapolis, MN.
8. Choi, Julius and Sergio C. Capareda. 2017. Selective Conversion of Ashe Juniper Waste into Levoglucosenone and Acetol, The 2nd Annual Texas A&M Conference on Energy, College station, TX, 09/28/2017 (Best poster award)
9. Choi, Julius, H. K. Jeong and S. C. Capareda. 2017. Fabrication of Graphene Oxide-Supported Metal-Organic Framework Films, MRS spring meeting, Arizona, Pheonix, 04/18/2017 (MRS Best poster award nominee).
10. Camelo, Alessandra, Sergio C. Capareda, Juliana L. Paes, Amado L. Maglinao and Jinjuta Kongkasawan. 2017. CARACTERIZAÇÃO DO BIOPRODUTO LIQUIDO ORIUNDO DA PIRÓLISE LENTA PRESSURIZADA DO HÍBRIDO PMN10TX15. Apresentado no XLVI Congresso Brasileiro de Engenharia Agrícola - CONBEA 2017, 30 de julho a 03 de agosto de 2017 - Maceió - AL, Brasil.

Louisiana

1. Negulescu, Ioan I. Rheological, Chemical, Mechanical Properties of Re-refined Engine Oil Bottoms (REOB) Modified Binder, FHWA Asphalt Binder Expert Task Group Meeting, Bozeman, Montana, September 19-20, 2017.
2. Negulescu, Ioan I., with Taesun You, Sreelatha Balamurugan, Munir Nazal, Louay N.Mohammad and William H. Daly. Rheological, Chemical, Micro-Mechanical, and Mechanical Properties of Re-refine Engine Oil Bottoms (REOB) Modified Binders. 97th Transportation Research Board Annual Meeting. January 14-18, 2018, Washington, D.C.
3. Negulescu, Ioan I., with Max Aguirre; Marwa Hassan, PhD; Sharareh Shirzad; Samuel Cooper, and Louay Mohammad, Evaluation of Hollow-Fibers Encapsulating a Rejuvenator in Asphalt Binder with Recycled Asphalt Shingles. 97th Transportation Research Board Annual Meeting. January 14-18, 2018, Washington, D.C.
4. Negulescu, Ioan I. with Sreelatha Balamurugan, Louay N. Mohammad, William H. Daly, Samuel B. Cooper, III, Samuel B. Cooper, Jr., and Gaylon L. Baumgardner. Impact of Various Crumb Rubber Modifications on Asphalt Binder and Mixture Properties. 93rd AAPT Annual Meeting, March 18-21, 2018, Jacksonville, Florida.
5. Negulescu, Ioan I., with Sharareh Shirzad, Marwa M. Hassan, Max A. Aguirre, Samuel Cooper, Jr., and Louay N. Mohammad. Enhancing the Durability and the Service Life of Asphalt Pavements through Innovative Light-Induced Self-Healing Material. TranSET Annual Conference April 3-4, 2018, New Orleans, LA.

Nebraska

1. Ramchandran, D., M. R. Wilkins, M. Li. 2018. Liquid hot water pretreatment and enzymatic digestion of corn fiber to produce fermentable sugars. 2018 S-1041 Science and Engineering for a Biobased Industry and Economy Symposium, July 9-10, 2018. Poster Li, M., K.M. Eskridge and M.R. Wilkins. 2018.
2. Optimization of polyhydroxybutyrate production by response surface modeling of combined ternary sugar mixture (glucose, xylose and arabinose) and process variables. 2018 S-1041 Science and Engineering for a Biobased Industry and Economy Symposium, July 9-10, 2018. Poster.
3. Wilkins, M.R., O. Pardo-Planas, R.A. Prade, H.K. Atiyeh, M. Mueller. 2017. Production of aryl alcohol oxidase by an Aspergillus nidulans mutant in a trickle bed reactor. 14th Convention of The Biotech Research Society, India, and International Conference on Emerging Trends in Biotechnology for Waste Conversion (ICETBWC – 2017), Nagpur, India, October 8-10, 2017.
4. Wilkins, M.R., O. Pardo-Planas, R.A. Prade, H.K. Atiyeh, M. Mueller. 2017. Production of aryl alcohol oxidase by an Aspergillus nidulans mutant in a trickle bed reactor. 2017 ASABE Annual Meeting, Spokane, Washington, USA, July 26-29, 2017. Oral.
5. Emanuel, E., Keshwani D.R. Techno-economic implications of fed-batch enzymatic hydrolysis for cellulosic ethanol production. 2017 ASABE Annual Meeting, Spokane, Washington, USA, July 26-29, 2017. Oral.
6. Anderson, R., Guru, A., Keshwani, D.R., Subbiah J. Developing an integrated model for the Corn-Water-Ethanol-Beef Nexus System. 2017 ASABE Annual Meeting, Spokane, Washington, USA, July 26-29, 2017. Oral.

Pennsylvania

1. Liang, X., X. Shao, E. Holwerda, D.G. Olson, S. Murphy, L. Tian, T.L. Richard, J.M. Whitham, D.M. Klingeman, J.G. Elkins, S.D. Brown and L.R. Lynd. 2017. Switchgrass fermentation by thermophilic microbiomes: Community characterization and comparison to pure cultures of Clostridium thermocellum. Presented at the 39th Symposium on Biotechnology for Fuels and Chemicals. May 1-4, 2017. San Francisco, CA.
2. Bharadwaj, A. K. DiMarco, M. Campbell, S.D. Brown, X. Shao, L.R. Lynd and T.L. Richard. 2017. Effect of cotreatment (mechanical disruption) on microbial consortia involved in anaerobic digestion of lignocellulosic biomass. Presented at the 39th Symposium on Biotechnology for Fuels and Chemicals. May 1-4, 2017. San Francisco, CA.
3. Izmirlioglu, G., and A. Demirci. 2017. Comparison of pure and co-culture ethanol fermentations in biofilm reactors. Agricultural and Biological Engineering Conference. July 30-Aug 2.
4. Groton, CT. Germec, M., K. Tarhan, E. Yatmaz, N. Tetik, M. Karhan, A. Demirci, and I. Turhan. 2017. Optimization of ultrasound-assisted dilute acid hydrolysis conditions of tea processing wastes. Agricultural and Biological Engineering Conference. July 30-Aug 2.
5. Groton, CT. Germec, M., I. Turhan, M. Karhan, and A. Demirci. 2017. Ethanol production from carob extract by using Saccharomyces cerevisiae in biofilm reactor. Agricultural and Biological Engineering Conference. July 30-Aug 2. Groton, CT.
6. Mahdinia, E., A. Demirci, and A. Berenjian. 2017. Optimization of growth parameters and media for vitamin K (MK-7) production by Bacillus subtilis. Agricultural and Biological Engineering Conference. July 30-Aug 2. Groton, CT.
7. Mahdinia, E., A. Demirci, and A. Berenjian. 2017. Strain and plastic composite support (pcs) selection for Vitamin K (MK-7) production in biofilm reactors. Agricultural and Biological Engineering Conference. July 30-Aug 2. Groton, CT.
8. Cekmecelioglu, D., and A. Demirci. 2017. Feasibility of DDGS for production of cellulase and xylanase enzymes cocktail. Agricultural and Biological Engineering Conference. July 30-Aug 2 Groton, CT. Ciolkosz, D. and A. Demirci. 2017. The impact of hands-on activities on effective online learning of bioenergy. Northeast Agricultural and Biological Engineering Conference. July 30-Aug 2.
9. Groton, CT. Izmirlioglu, G. and A. Demirci. 2017. Inactivation of Salmonella Enteritidis on walnuts by using pulsed UV light. Northeast Agricultural and Biological Engineering Conference. July 30-Aug 2.
10. Groton, CT. Salis, H. M. June 22, 2018. "Building a Synthetic Biology Discipline: Automated Design of Cellular Sensors, Circuits, and Pathways," DuPont Seminar, DuPont, Wilmington, DE. Salis, H. M. May 11, 2018. "Simultaneous Regulation of Many Genes using Highly Non-repetitive Extra Long sgRNA Arrays," Synthetic Biology Congress, Oxford Global, Boston, MA.
11. Salis, H. M. April 20, 2018. "Toolboxes of Highly Non-repetitive CRISPR Parts for Highly Multiplexed Applications," DARPA Safe Genes Program Review, DARPA, Tuscon, AZ.
12. Hossain, A. Reis, A. Cetnar, D., Salis, H. M. March 23, 2018. "The Non-Repetitive Parts Calculator: Thousands of Highly Non-repetitive Promoters for Synthetic Biology Applications," Engineering Biology Research Center Retreat, EBRC, Seattle, WA.
13. Salis, H. M. January 29, 2018 - February 2, 2018. "System-wide Predictions using Biophysical Models and Machine Learning," SD2 Quartertly Hackathon (5-day workshop), DARPA, Austin, TX.
14. Salis, H. M. December 2017. "Building a Synthetic Biology Discipline: Automated Design of Cellular Sensors, Circuits, and Pathways," Division Seminar, Pacific Northwest National Laboratory, Richland, WA.
15. Salis, H. M. November 30 2017. "Model-guided Sensor Engineering," ONR MURI Review Meeting, Office of Naval Research, Boston, MA.
16. Salis, H. M. October 22, 2017 - October 27, 2017. "Genetic Circuit Modeling, Predictions, and Design," SD2 Quartertly Hackathon (5-day workshop), DARPA, Arlington, VA.
17. Hoard, S., C. Sanders, M. Gaffney, P. Smith. 2017. Social Assets and Stakeholder Assessments: Strategic Applications for Sustainable Alternative Jet Fuel Systems. Presented at the Federal Aviation Administration-Aviation Sustainability Center (FAA-ASCENT) Spg. Meeting, Alexandria, VA. Apr. 18.
18. Mueller, D., S. Hoard, P. Smith, C. Sanders, and M. Gaffney. 2017. Airport Management Perceptions of Aviation Biofuels in the Pacific Northwest. Poster presentation at the Federal Aviation Administration-Aviation Sustainability CENTer (FAA-ASCENT) Spring Meeting, Alexandria, VA. Apr. 26-27.
19. Gaffney, M., P. Smith, S. Hoard, C. Sanders, S. Rijkhoff and D. Mueller. 2017. “Social Elements of Sustainable Alternative Jet Fuel Systems: Assessment and Applications.” Presented to the Seminars on Alternatives to Petroleum (SOAP) - Jet Commercial Aviation Alternative Fuels Initiative (CAAFI) WebEx/Teleconference

Webinar in conjunction with the Federal Aviation Administration (FAA) and Airlines for America (A4A), Feb. 27.

20. Vazhnik, V., J.K. Hansen and T.L. Richard. 2017. Multiattribute optimization of farm plans to improve economic, environmental and social conditions on the example of a farm in the Chesapeake Bay. ASABE Paper No. 1700562. ASABE, St. Joseph, MI.

Oklahoma

1. Atiyeh, H. K., P. Munasinghe, K. Liu, R. S. Tanner and T. Ezeji, "Enhanced Alcohols, Ketones and Organic Acids Production via Co-Fermentation of Sugars and Gases", 2017 AIChE Annual International Meeting, Minneapolis, MN, October 29 - November 3, 2017. Oral.
2. Dang, J., N. Wang and H. K. Atiyeh, "Development CO Sensor for Syngas Fermentation for Production of Fuels and Chemicals", 2017 AIChE Annual International Meeting, Minneapolis, MN, October 29 - November 3, 2017. Oral.
3. Wilkins, M.R., O. Pardo-Planas, R.A. Prade, H.K. Atiyeh, M. Mueller. 2017. Production of aryl alcohol oxidase by an Aspergillus nidulans mutant in a trickle bed reactor. 14th Convention of The Biotech Research Society, India, and International Conference on Emerging Trends in Biotechnology for Waste Conversion (ICETBWC – 2017), Nagpur, India, October 8-10, 2017. Oral.
4. Sun, X. and H. K. Atiyeh, "Enhanced Bioethanol Production from Syngas Using Medium with Biochar", 2017 ASEE Midwest Section Conference, Stillwater, Oklahoma, September 24-26, 2017. Poster.
5. Dang, J., N. Wang and H. K. Atiyeh, "Development of a Mid-Infrared Carbon Monoxide Sensor", 2017 ASEE Midwest Section Conference, Stillwater, Oklahoma, September 24-26, 2017. Poster.
6. Sun, X. and H. K. Atiyeh, "Enhanced Ethanol Production from Syngas with Various Medium Formulations", 2017 ASABE Annual International Meeting, Spokane, Washington, July 16-19, 2017. Oral.
7. Atiyeh, H. K., J.R. Phillips, R.L. Huhnke and R.S. Lewis "Enhanced Syngas Fermentation for Ethanol Production Using Activated Carbon", 2017 ASABE Annual International Meeting, Spokane, Washington, July 16-19, 2017. Oral.
8. Wilkins, M., O. Pardo-Planas, R. Prade and H. K. Atiyeh, "Reduction of melanin formation during aryl alcohol oxidase production by an Aspergillus nidulans cell orverproducing mutant", 2017 ASABE Annual International Meeting, Spokane, Washington, July 16-19, 2017. Oral.
9. Atiyeh, H. K., "Development of the Hybrid Conversion Technology for Sustainable Production of Fuels and Chemicals", 2017 Oklahoma Engineering Conference. Moore Norman Technology Center, OKC, June 15-16, 2017. Oral.
10. Sun, X. and H. K. Atiyeh, "Continuous Production of Ethanol with Limited Accumulation of Acetate via Syngas Fermentation", 2017 Annual Meeting Oklahoma Section ASABE, Stillwater, OK, February 24, 2017. Poster.
11. Kumar, A., N. Indrawan, R. L. Huhnke. Small-scale Co-gasification of Municipal Solid Waste (MSW) and Biomass for Power Generation. International Conference on Emerging Trends in Biotechnology for Waste Conversion (ETBWC- 2017), Nagpur, India, Oct 8-10, 2017.
12. Indrawan N., S. Thapa, P. R. Bhoi, A. Kumar, and R. L. Huhnke. Distributed power generation via co-gasification of municipal solid waste and biomass. Poster presentation. 2017 Gasification and Syngas Technology Council (GSTC) Annual Meeting, Colorado Springs, CO.
13. Indrawan N., S. Thapa, P. Bhoi, A. Kumar, and R.L. Huhnke. 2017. Mobile power generation unit from co-gasification of municipal solid wastes and biomass. ASABE 1700917. Presented at the Annual International Meeting of ASABE, Spokane, WA.
14. Thapa, S., P. R. Bhoi, A. Kumar, and R. L. Huhnke. 2017. Development of a low-cost syngas cleaning technology using heat exchanger and vegetable oil bubbler. ASABE 1700564. Presented at the Annual International Meeting of ASABE, Spokane, WA.

Wisconsin

1. Aguirre-Villegas H.A. and R.A. Larson. 2017. Greenhouse gas emissions from dairy manure management. 2017 ASABE Annual International Meeting, July 16-19, 2017, Spokane, WA.
2. Larson, R.A., M.A. Holly, and H.A. Aguirre-Villegas. 2017. Assessment of Anaerobic Digesters and Solid Liquid Separators in Wisconsin: tracking nutrients and assessing emissions (POSTER). 2017 ASABE Annual International Meeting, July 16-19, 2017, Spokane, WA.
3. Larson, R.A., A. McCord, V. Tumwesige, D. Lsoto, J. Musinguzi, S. Stefanos, and D. Nampamya. 2017. Integrating Anaerobic Digesters in Uganda: Assessment of Performance, Impact of Digestate Application to Crop

Yields, and an Evaluation of Air Quality with Conversion to Biogas Stoves. 2017 ASABE Annual International Meeting, July 16-19, 2017, Spokane, WA.

4. Aguirre-Villegas H.A. and R.A. Larson. 2017. Anaerobic Digestion in Developing Regions for Household Applications. 2017 ASABE Annual International Meeting, July 16-19, 2017, Spokane, WA.
5. Sharara, M., T. Runge, R.A. Larson, and J.G. Primm. 2017. Techno-economic optimization of community-based manure processing. 2017 ASABE Annual International Meeting, July 16-19, 2017, Spokane, WA.
6. Larson, R.A., A. McCord, V. Tumwesige, and H. Aguirre-Villegas. 2017. Integrating Small Scale Digestion Systems in Developing Regions. LPELC Waste to Worth 2017: International Conference on Livestock and Poultry Environmental Quality, April 18-21, 2017, Cary, NC.
7. Larson, R.A., M. Holly, M. Powell, and H. Aguirre-Villegas. 2017. Reducing GHG and ammonia emissions from manure systems. LPELC Waste to Worth 2017: International Conference on Livestock and Poultry Environmental Quality, April 18-21, 2017, Cary, NC.
8. Aguirre-Villegas, H. and R.A. Larson. 2017. Estimating GHG Emissions from Manure Management Practices in Dairy Systems. LPELC Waste to Worth 2017: International Conference on Livestock and Poultry Environmental Quality, April 18-21, 2017, Cary, NC.
9. Larson, R.A. and B.J. Holmes. DFI Environmental Management Course. Nestle, June 5-9, 2017, Harbin, China.
10. Larson, R.A. 2017. Workshop: Whole Farm Nutrient Management. VSIGERA International Symposium on Agricultural Residues, May 9-11, 2017, Foz du Iguacu, Brazil.
11. Larson, R.A. 2017. Workshop: Manure Systems and Processing. VSIGERA International Symposium on Agricultural Residues, May 9-11, 2017, Foz du Iguacu, Brazil.
12. Larson, R.A. 2017. Workshop: Nutrient Management: Manure Storage and Land Application. VSIGERA International Symposium on Agricultural Residues, May 9-11, 2017, Foz du Iguacu, Brazil.
13. Ning Li, Xiaohui Yang, Xuliang Lin, and Xuejun Pan. Cleavage of β-O-4 ether bonds in acidic lithium bromide trihydrate for lignin depolymerization. 2017 AIChE Annual Meeting, October 29-November 3, 2017, Minneapolis, MN.
14. Ning Li, Zening Wang, TIanjiao Qu, Joseph Kraft, and Xuejun Pan. Synthesis of water-soluble oligosaccharides as potential prebiotics via non-enzymatic sugar glycosylation. 2017 AIChE Annual Meeting, October 29-November 3, 2017, Minneapolis, MN.
15. Yang Liao and Xuejun Pan. Fabrication of functionalized aerogels from cellulose and whole biomass for absorbing formaldehyde from indoor air. 2017 AIChE Annual Meeting, October 29-November 3, 2017, Minneapolis, MN.
16. Mahmoud A. Sharara, Troy M. Runge, and Rebecca Larson. Assessment of Coordinated Anaerobic Digestion of Dairy Manure. Livestock and Poultry Environmental Learning Center (LPELC) Webinar Series (August 14, 2017).
17. Mahmoud A. Sharara, Troy M. Runge, Rebecca Larson, and John Primm. Techno-economic optimization of community-based manure processing. Annual International meeting of the American Society of Agricultural and Biological Engineering (ASABE), Spokane, WA (July 19, 2017).
18. Mahmoud A. Sharara, Troy M. Runge, Rebecca Larson. Economic Assessment of Coordinated Anaerobic Digestion of Dairy Manure. Assessment of coordinated anaerobic digestion of dairy manure. Waste to Worth 2017. Cary, NC (April 19, 2017).
19. Troy Runge. Manure Processing Technologies. Wisconsin Manure Summit Program, Green Bay, WI (February 22, 2017).

Montana

1. Chen, C. 2017. Potential bioenergy feedstock production, cropping systems, and energy balance in Northern Great Plains of USA. The 7th International Conference on New Energy and Sustainalbe Development, December 1-3, 2017, Sanya, China.
2. Chen, C., R. Keshavarz Afshar, W. Stevens, W. Iversen, and T. Fine. 2017. Sugarbeet response to tillage and nitrogen management. MonDak Ag Research Summit. November 15, 2017. Sidney, MT.
3. Chen, C., R. Keshavarz Afshar, W. Stevens, and W. Iversen. 2017. Response of sugarbeet to nitrogen rate while shifting from conventional tillage to conservation tillage. ASA, CSSA, and SSSA Annual International Meeting, October 22-25, Tampa, FL.
4. Keshavarz Afshar, R., C. Chen, W. Stevens, and W. Iversen. 2017. Sugarbeet yield and quality response to irrigation management. ASA, CSSA, and SSSA Annual International Meeting, October 22-25, Tampa, FL.

5. Chen, C. and R. Keshavarz Afsha. 2017. Conservation tillage and nitrogen management for sugarbeet production. 7th International Conference on Environmental Pollution (ICEPR'17), June 6-8, Rome, Italy.

West Virginia

1. Oginni, O., K. Singh, L. McDonald, T. Yumak, E. Sabolsky, and L. Sivanandan. 2018. Adsorption of Pharmaceutical Active Compounds using Activated Carbons synthesized from Herbaceous Biomass. Paper ID# 2851258, Presented at the 255th ACS National Meeting, New Orleans, LA (March 17-22, 2018).
2. Yumak, T., G. A. Yakaboylu, D. Bragg, O. Oginni, K. Singh, and E. M. Sabolsky. 2018. Nano-Oxide Enhancement of Biomass-Derived Activated Carbons for Supercapacitor Applications. Paper ID# A01-0158, Presented at the 233rd Electrochemical Society Meeting, Seattle, WA (May 13-17, 2018).
3. Yumak, T., G. A. Yakaboylu, O. Oginni, K. Singh, and E. M. Sabolsky. 2018. Metal Oxide Modification of Waste Biomass for Supercapacitor Applications. Paper ID# 18-078, Presented at the 2018 Northeast Agricultural and Biological Engineering Conference, Morgantown, WV (July 15-18, 2018).
4. Oginni, O., K. Singh, L. McDonald, T. Yumak, E. Sabolsky, and L. Sivanandan. 2018. Effect of Activation Agent Impregnation Route on Activated Carbon Properties. Paper ID# 18-002, Presented at the 2018 Northeast Agricultural and Biological Engineering Conference, Morgantown, WV (July 15-18, 2018).
5. Akharume, F., L. Sivanandan, and K. Singh. 2018. Polycyclic Aromatic Hydrocarbons (PAHs) in Smoked Food. 2018. Paper ID# 18-026, Presented at the 2018 Northeast Agricultural and Biological Engineering Conference, Morgantown, WV (July 15-18, 2018).
6. Oginni, O., K. Singh, L. McDonald, T. Yumak, E. Sabolsky, and L. Sivanandan. 2018. Effect of Activation Agent Impregnation Route on Activated Carbon Properties. Paper ID# 18-002, Presented at the 2018 Northeast Agricultural and Biological Engineering Conference, Morgantown, WV (July 15-18, 2018).
7. Oginni, O., C. Crowley, K. Singh, L. McDonald, T. Yumak, E. Sabolsky, and L. Sivanandan. 2018. Pyrolysis Characteristics of White Pine and Norway Spruce Needles. Paper ID# 18-035, Presented at the 2018 Northeast Agricultural and Biological Engineering Conference, Morgantown, WV (July 15-18, 2018).
8. Oginni, O., K. Singh, L. McDonald, G. S. Oporto, E. Sabolsky, and L. Sivanandan. 2018. Effect of Pyrolysis Temperature on the Thermal Stability and Agronomic Characteristics of Biochars Produced from Herbaceous Biomass. Paper ID# 18-036, Presented at the 2018 Northeast Agricultural and Biological Engineering Conference, Morgantown, WV (July 15-18, 2018).
9. Oginni, O., C. Crowley, and K. Singh. 2018. Pyrolysis and Thermal Decomposition Kinetics of White pine and Norway spruce needles. Paper ID# 1800069, Presented at the 2018 American Society of Agricultural and Biological Engineers, Detroit, MI. (July 28- August 2, 2018).
10. Akharume, F., L. Sivanandan, and K. Singh. 2018. Polycyclic Aromatic Hydrocarbons (PAHs) in Smoked Food. 2018. Paper ID# 1801822, Presented at the 2018 American Society of Agricultural and Biological Engineers, Detroit, MI. (July 28- August 2, 2018).
11. Yumak, T., G. A. Yakaboylu, D. Bragg, O. Oginni, K. Singh, and E. M. Sabolsky. 2018. Surface Enhancement of Biomass-derived Activated Carbons for Supercapacitor Applications. Paper ID# 1800054, Presented at the 2018 American Society of Agricultural and Biological Engineers, Detroit, MI. (July 28- August 2, 2018).
12. Oginni, O., K. Singh, L. McDonald, T. Yumak, E. Sabolsky, and L. Sivanandan. 2018. Effect of Impregnation Route on Activated Carbon Properties from Herbaceous Biomass. Paper ID# 1800035, Presented at the 2018 American Society of Agricultural and Biological Engineers, Detroit, MI. (July 28- August 2, 2018).
13. Oginni, O., K. Singh, L. McDonald, T. Yumak, E. Sabolsky, and L. Sivanandan. 2018. Effect of Impregnation Route on Activated Carbon Properties from Herbaceous Biomass. Paper ID# 1800035, Presented at the 2018 American Society of Agricultural and Biological Engineers, Detroit, MI. (July 28- August 2, 2018).
14. Oginni, O., C. Crowley, and K. Singh. 2018. Pyrolysis Characteristics of White Pine and Norway Spruce Needles and Properties of Resulting Bio-Chars. Presentation I.D. 2.4.3 #5, USBI Biochar 2018, Wilmington, Delaware (August 20-23, 2018).
15. Oginni, O., K. Singh, L. McDonald, T. Yumak, E. Sabolsky, and L. Sivanandan. 2018. Effect of Activation Agent's Impregnation Route on Activated Carbon Properties. Presentation I.D. 3.1.3 #4, USBI Biochar 2018, Wilmington, Delaware (August 20-23, 2018).

North Dakota

1. Monono, E., and D. Wiesenborn. 2018. Design and Testing of a Prototype Distillation Unit: A student Class Project. Paper No. 11800968 ASABE International Meeting Detroit, MI July 29-Aug 1, 2018.

2. Pandey, R., Nahar, N., and S.W. Pryor. 2018. Quantifying Reduction in Soaking in Aqueous Ammonia Pretreatment Severity and Enzyme Loadings for Corn Stover Pellets, ASABE Annual International Meeting. Paper No. 1800286 Detroit, MI. July 29-Aug 1, 2018.
3. Zholobko, O., Hammed, A., Zakharchenko, A., Borodinov, N., Urbanowicz, B., Luzinov, I., Minko, S., Pryor, S.W., and A. Voronov, 2017. Polymeric Cellulosomes for Cellulose Bioconversion, 2nd International Symposium on Materials from Renewables, Athens, GA, Nov 8-10, 2017.
4. Subhashree, S.N., and Igathinathane, C. 2017. Infield Equipment Impacted Area during Harvesting, Baling, and Bale Aggregation. 2017 SNRS Research Symposium, Memorial Union, NDSU, Fargo, ND, December 4, 2017. (Poster presentation)
5. Subhashree, S.N., and Igathinathane, C. 2017. Efficient Biomass Bale Aggregation Logistics using an Automatic Bale Picker. 2017 Bio Industry Summit, Delta by Marriot, Fargo, ND, November 2, 2017. (Poster presentation)
6. Subhashree, S.N., and Igathinathane, C. 2017. Track Impacted Field Areas during Harvesting, Baling, and Infield Bale Logistics Simulation. 2017 Friends and Neighbors Day, NGPRL USDA-ARS, Bismarck, ND, July 27, 2017. (Poster presentation)
7. Subhashree, S.N., and Igathinathane, C. 2017. Infield Bale Logistics Scenario using Automatic Bale Picker (ABP). 2017 Friends and Neighbors Day, NGPRL USDA-ARS, Bismarck, ND, July 27, 2017. (Poster presentation)
8. Subhashree, S.N., and Igathinathane, C. 2017. Biomass Bale Infield Logistics Scenario using Automatic Bale Picker. ASABE Paper No. 1700598, 2017 ASABE Annual International Meeting held in Spokane, WA July 16th - 19th, 2017 (Oral presentation).
9. Subhashree, S.N., and Igathinathane, C. 2017. Equipment Track Impacted Field Areas during Harvesting, Baling, and Infield Bale Logistics. ASABE Paper No. 1700599, 2017 ASABE Annual International Meeting held in Spokane, WA July 16th - 19th, 2017 (Oral presentation).

Iowa

1. K. Ren, B. P. Lamsal*. 2018. The stability of nanoemulsions and emulsions containing cinnamaldehyde and biosurfactants, and their antimicrobial performance against Escherichia.coli O157:H7 and Listeria monocytogenes, Oral presentation at AOCS 2018 annual meeting, May 4-6, 2018, Minneapolis, MN.
2. K. Ren, B. P. Lamsal*. 2017. The antibacterial property of fatty acyl glutamic acid and proposed mechanism, Oral presentation at AOCS 2017 annual meeting, April 30- May 3, 2017, Orlando, FL.

Virginia

1. Q. Jin†, A. P. Neilson, A.C. Stewart, S. O'Keefe, Y.T. Kim, H. Huang*. Integrated Approach for the Valorization of Red Grape Pomace: Production of Oils, Polyphenols, and Biofuels. Poster Presentation, 2018 IFT Annual Meeting, Chicago, IL, July 2018. (Abstract accepted, will present it in July 2018).
2. N. Poe†, Q. Jin†, M. Ponder, A. Stewart, J. Ogejo, H. Huang. Conversion of Fruit Based Food Wastes to Acetone, Butanol, and Ethanol (ABE) via Anaerobic Fermentation using Clostridium beijerinckii. Poster Presentation, 2018 IFT Annual Meeting, Chicago, IL, July 2018. (Abstract accepted, will present it in July 2018).
3. D. Yu†, A. Neilson, S. O'Keefe, H. Huang. Ultrasound-assisted Enzymatic Separation of Proteins from Brewer's Spent Grain. Poster Presentation, 2018 IFT Annual Meeting, Chicago, IL, July 2018. (Abstract accepted, will present it in July 2018).
4. Y. He†, D.D. Kuhn, J. Ogejo, S. O'Keefe, C. Fernández-Fraguas, H, Huang. Wet milling process to separate proteins from brewer's spent grain. Poster Presentation, 2018 IFT Annual Meeting, Chicago, IL, July 2018.
5. Q. Jin†, H. Huang. Acetone-butanol- ethanol (ABE) production from apple pomace by anaerobic fermentation. Poster Presentation, 2017 ASABE Annual International Meeting, Spokane, WA. July, 2017.

Massachusetts

1. B. Goodell. "Non-enzymatic Redox Mechanisms in Fungal Degradation and Pathogenesis". Invited by and presented to: The Five College Biophysics Network Colloquium. November 16, 2017
2. Barry Goodell. Fungal Extracellular Biodegradation Mechanisms and Changes in Lignin and Cellulose Nanostructure During Fungal Attack. Sveriges lantbruksuniversitet - Swedish University of Agricultural Sciences. 12-12-2017.
3. Tabor, S. and B. Goodell. 2018. A new catalytic mechanism for ROS generation during fungal infection by Cryptococcus. Pioneer Valley Microbiology Symposium. UMass. Jan 19, 2018.

4. B. Goodell. Microbial non-enzymatic catalysis in substrate deconstruction -- and pathogenesis. UMass "Models to Medicine-Plant & Microbial Innovations" Theme Meeting. Feb. 15, 2018.
5. Tabor, S. and B. Goodell 2018. Enhancing biomass deconstruction by mimicking the action of low molecular weight fungal metabolites to overcome lignin recalcitrance. Massachusetts Climate Leadership Summit. UMass. April, 18, 2018
6. Tabor, S., L. Orjuela, D. Contreras, G. Alfredsen, J. Jellison, S. Renneckar, B. Goodell. Enhancing Our Understanding of Brown Rot Mechanisms through Catalytic Pretreatment and Cellulase Cocktail Treatments. Presented also as a Plenary Session Paper. International Research Grp Wood Protection - IRG/WP 18-10828. IRG49 Scientific Conference. April 29 - May3, 2018. Section I Biology. Johannesburg, South Africa. 8pp. B.
7. Goodell. Biomimicry of brown rot non-enzymatic fungal catalysis using low molecular weight fungal metabolites to overcome lignin recalcitrance. The Science and Engineering for a Biobased Industry and Economy. NIFA-Hatch. USDA meetings. Madison, WI. July 8-10.

Missouri

1. Brune, D. E., Observations of an Inverse Ammonia Toxicity Relationship in the Brine Shrimp, Artemia, Presentation at the 2018 Aquaculture America Symposium, Las Vegas NV.

Minnesota

1. Roger Ruan, Erik Anderson, Min Addy, Renchuan Zhang, Yanling Cheng, Lu Wang, Peng Peng, Yiwei Ma, Xiaochen Ma, Liangliang Fan, Kuan Ding, Aoxi He, Yaning Zhang, Chunhua Xin, Richard Griffith, Shiyu Liu, Nan Zhou, Xiangyuan Deng, Hunwen Zhou, Wenguang Zhou, Muhammad Omar, Richard Griffith, Faryal Kabir, Hanwu Lei, Yunpu Wang, Yuhuan Liu, Paul Chen. 2018. Innovative biorefining processes and systems for complete liquid and solid waste utilization and treatment. Keynote Forum, BioEnergy 2018, Berlin.
2. Roger Ruan and Paul Chen. 2018. Bioenergy: A great promise for our economy, environment, and society. Opening Ceremory, BioEnergy 2018, Berlin.
3. Roger Ruan, Paul Chen, Juer Liu, Li Huang, Yanling Cheng, Yiwei Ma, Chi Chen, Guangwei Huang. 2018. Non-thermal Processes for Making Clean Label Food and Nutraceutical Ingredients from Almond Hull. 20th Annual Almond Quality & Food Safety Symposium. Modesto, CA.
4. Roger Ruan, Erik Anderson, Min Addy, Renchuan Zhang, Yanling Cheng, Lu Wang, Peng Peng, Yiwei Ma, Xiaochen Ma, Liangliang Fan, Kuan Ding, Aoxi He, Yaning Zhang, Richard Griffith, Shiyu Liu, Nan Zhou, Xiangyuan Deng, Hunwen Zhou, Chunhua Xin, Wenguang Zhou, Muhammad Omar, Richard Griffith, Faryal Kabir, Paul Chen, Hanwu Lei, Yunpu Wang, Yuhuan Liu. 2018. Innovative processes and systems for solid waste utilization and treatment: model, technology and economic analysis. Beijing University of Mining, Beijing.
5. Roger Ruan, Erik Anderson, Min Addy, Renchuan Zhang, Yanling Cheng, Lu Wang, Peng Peng, Yiwei Ma, Xiaochen Ma, Liangliang Fan, Kuan Ding, Aoxi He, Yaning Zhang, Chunhua Xin, Richard Griffith, Shiyu Liu, Nan Zhou, Xiangyuan Deng, Hunwen Zhou, Wenguang Zhou, Muhammad Omar, Richard Griffith, Faryal Kabir, Paul Chen, Hanwu Lei, Yunpu Wang, Yuhuan Liu. 2018. Innovative processes and systems for liquid waste utilization and treatment: model, technology and economic analysis. Beijing University of Mining, Beijing.
6. Roger Ruan, Paul Chen, Erik Anderson, Min Addy, Renchuan Zhang, Yanling Cheng, Lu Wang, Peng Peng, Yiwei Ma, Xiaochen Ma, Liangliang Fan, Kuan Ding, Aoxi He, Yaning Zhang, Richard Griffith, Shiyu Liu, Nan Zhou, Xiangyuan Deng, Hunwen Zhou, Wenguang Zhou, Muhammad Omar, Richard Griffith, Faryal Kabir, Hanwu Lei, Yunpu Wang, Yuhuan Liu. 2018. Innovative Biorefining Processes and Systems for Complete Waste Utilization and Treatment. The 1st Forum on the Test Area Construction (Jiangxi) of National Ecological Civilization & Promotion Conference on Ecological Civilization Construction Technologies. Nanchang, Jiangxi.
7. Roger Ruan. 2018. Microwave assisted catalytic conversion of waste plastics for fuels and energy production. Resynergi Industrial Waste Plastics Utilization Meeting. Twin Cities.
8. Roger Ruan. 2017. Innovative biorefining technologies for complete waste utilization and treatment. First International Industry, Research and Education Open Innovation Cooperation Forum. Beijing Union University. Beijing.
9. Roger Ruan. 2017. Conference of Food Engineering (CoFE) 2018. NC-1023 Committee Meeting, Washington State University. Pullman, WA.
10. Roger Ruan. 2017. Intensive pulsed light technology for non-thermal pasteurization of powdered foods. NC-1023 Committee Meeting, Washington State University. Pullman, WA.
11. Roger Ruan. 2017. Sustainable and complete chicken waste utilization and treatment. Forsman Farms (one of the largest egg producers in the world). Howard Lake, Minnesota.

12. Roger Ruan. Shiyu Liu, Yaning Zhang, Liangliang Fan, Nan Zhou, Erik Anderson, Peng Peng, Yanling Cheng, Min Addy, Kuan Ding, Hanwu Lei, Yunpu Wang, Yuhuan Liu, Paul Chen. 2017. Microwave Assisted Fast Catalytic Pyrolysis and Gasification for Solid Wastes Conversion and Utilization. AICHE Annual Meeting, Minneapolis, Minnesota.
13. Roger Ruan, Paul Chen, Erik Anderson, Min Addy, Renchuan Zhang, Yanling Cheng, Peng Peng, Yiwei Ma, Liangliang Fan, Yaning Zhang, Qian Lu, Shiyu Liu, Nan Zhou, Xiangyuan Deng, Wenguang Zhou, Muhammad Omar, Richard Griffith, Faryal Kabir, Hanwu Lei, Yunpu Wang, Yuhuan Liu. 2017. A biorefining approach to treatment and utilization of solid and liquid wastes. CAE International High-level Conference on Green Industrial Process. Jieshou, Anhui.
14. Ruan R., Paul Chen, Erik Anderson, Min Addy, Renchuan Zhang, Yanling Cheng, Peng Peng, Yiwei Ma, Liangliang Fan, Yaning Zhang, Qian Lu, Shiyu Liu, Nan Zhou, Xiangyuan Deng, Wenguang Zhou, Muhammad Omar, Richard Griffith, Faryal Kabir, Hanwu Lei, Yunpu Wang, Yuhuan Liu. 2017. Innovative Biorefining Processes and Systems for Complete Waste Utilization and Treatment.
15. Ruan, R., S. Liu, Y. Zhang, L. Fan, N. Zhou, P. Peng, Y. Cheng, M. Omar, E. Anderson, P. Chen, Y. Wang, Y. Liu. 2017. Innovative Fast Microwave Assisted Catalytic Pyrolysis of Biomass for Energy, Fuels, Chemicals and Materials Profudction. HIT Summer School on Energy 2017. Harbin, Heilongjiang.
16. Ruan, R. 2017. Thermochimical Conversion of Biomass for Energy, Fuels, Chemicals and Materials Profudction. HIT Summer School on Energy 2017. Harbin, Heilongjiang.
17. Ruan, R., Peng Peng, Yanling Cheng, Nan Zhou, Charles Schiappacasse, Yiwei Ma, and Paul Chen. 2017. Nonthermal Plasma Technology Application and Industrial Implementation. IAFP 2017 Symposium on Non-Thermal Plasma Technology for Improving Food Safety and Quality. Tampa, FL.
18. Ruan, R., D. Baumler, C. Chen, P. Chen, Z. Vickers, J. Feirtag, L. Lee, Y. Cheng, P. Peng, Q. Mao, Y. Ma, J. Wiertzema, D. Chen, J. Liu, N. Zhou, C. Schiappacasse, C. Borchardt. 2017. CAP [2015- 08046] Development of continuous intense pulsed light technology for non-thermal pasteurization of powdered foods. USDA NIFA 2017 Project Directors Meeting For Enhancing Food Safety Through Improved Processing Technologies, Tampa Convention Center, July 8, 2017, Tampa, FL.
19. Ruan, R. 2017. Fast Microwave Assisted Catalytic Conversion of Biomass for Biofuels and Biochemicals Production. British Petroleum (BP) Executives R&D Visit Meeting. Minneapolis, MN.
20. Ruan, R., Min Addy, Renchuan Zhang, Qian Lu, Yanling Cheng, Shanshan Luo, Wenkui Li, Hongyan Ren, Erik Anderson, Wenguang Zhou, Yiwei Ma, Richard Griifith, Yuhuan Liu, Hanwu Lei, Dean Current, Petrona Lee, Paul Chen. 2017. Innovative Processes and Systems for Complete Waste Utilization and Treatment. Keynote Address. International Conference on Biological Waste as Resource. The Hong Kong Polytechnic University. Hung Hom, Kowloon, Hong Kong.
21. Ruan, R., P. Chen, S. Liu, N. Zhou, Y. Zhang, L. Fan, E. Anderson, P. Peng, Y. Cheng, M. Addy, Y. Wang, Y. Liu. 2017. Fast Microwave Assisted Catalytic Conversion of Biomass for Biofuels and Biochemicals Production. International Biomass Conference & Expo. Minneapolis Convention Center, Minneapolis, Minnesota, USA

Tennessee

1. Rajan, K., D.P. Harper, D.J. Carrier, N. Labbé and S.C. Chmely. 2018. Development and characterization of depolymerized lignin & acrylate-based renewable photopolymers. 255th ACS National Meeting, New Orleans, LA.
2. Rajan, K., D.P. Harper, D.J. Carrier, T.G. Rials, N. Labbé and S.C. Chmely. 2018. Developing renewable and high strength hydrogels by incorporating lignin. 255th ACS National Meeting, New Orleans, LA.
3. Holly L. Haber, Pyoungchung Kim, Stephen C. Chmely, Jeff Lloyd, Yagya N. Regmi, Nourredine Abdoulmoumine, Nicole Labbé. A Two-Step Process for Recovery of Copper Naphthenate from End-of-Life Railroad Ties. March 18, 2018 - Mar 22, 2018, New Orleans, LA.

Theses and Dissertations

Alabama

1. Zhong-tian Zhang. Simultaneous fermentation and esterification for butyl butyrate production in biphasic medium with clostridium tyrobutyricum. Master thesis. August, 2017. Department of Biosystems Engineering, Auburn University, Auburn, AL.
2. Pixiang Wang. Engineering Clostridium saccharoperbutylacetonicum for enhanced isopropanol-butanol-ethanol (IBE) production from lignocellulosic biomass through acetic acid pretreatment. PhD dissertation. August, 2018. Department of Biosystems Engineering, Auburn University, Auburn, AL.
3. Phillip J. Cross. Gasification and pyrolysis of eucalyptus, prickly pear, gumweed, and lignin for biofuels and chemical intermediates. PhD dissertation. August, 2018. Department of Biosystems Engineering, Auburn University, Auburn, AL.

California

1. Zheng, Y.Y. 2018. Optimization under uncertainty of a biomass-integrated renewable energy microgrid with energy storage. PhD dissertation, University of California, Davis.

Ohio

1. Vasco-Correa, J. 2017. Investigation of solid-state fungal pretreatment of Miscanthus for biofuels production. Ph.D. Dissertation. Department of Food, Agricultural and Biological Engineering, Ohio State University, Wooster, OH.
2. Khanal, A. 2018. Evaluating the environmental impact of corn stover collection for biofuels production. M.S. Thesis. Department of Food, Agricultural and Biological Engineering, Ohio State University, Wooster, OH.

Washington

1. Hao Ruan. 2017. "Aqueous Catalytic Processing of Lignin and Aromatics and Jet Fuel Hydrocarbons" MS Thesis, Washington State University, Richland, Washington, July.

Texas

1. Tyler Kimbriel, ME, BAEN, Geothermal Energy Project in Tennessee, (Fall 2017)
2. Divine Angela D. Genuino, PhD, in Environmental Engineering, UP Diliman, Philippines, Synthesis and Application of Activated Biochar from the Slow Pyrolysis of Municipal Solid Wastes for the Removal of Organic Contaminants from Aqueous Solutions (Fall 2017)
3. Julius Choi, PhD, BAEN, TAMU, Valorization of Ashe Juniper Waste into High Value-Added Products: Functionalized Biochar and High value Chemical, (Fall 2017)
4. John Kennady Vincent George, MS in Energy, Theoretical and Experimental Study of Biobased Succinic Acid Production, Energy Institute, (August 2017)

Nebraska

1. Emanuel, Ellen. 2017. Techno-economic Implications of Fed-batch Enzymatic Hydrolysis. M.S. Thesis, University of Nebraska-Lincoln Anderson, Ryan. 2018. Developing an integrated model for the corn, ethanol, and beef systems using a loosely coupled web framework. M.S. Thesis, University of Nebraska-Lincoln

Pennsylvania

1. Mahdinia, Ehsan. 2017. Vitamin K2 (Menaquinone-7) production by Bacillus subtilis natto in a biofilm reactor. Ph.D. Dissertation. Pennsylvania State University. University Park, PA.
2. Ramcharan, A. M. 2017. Multidisciplinary Applications of U.S. Soils Datasets: Machine Learning Models, Data Mining, and Land Use Analyses. Ph.D. Thesis. The Pennsylvania State University, University Park, PA.
3. Boden, J.L. 2018. U.S. retail fuel companys' perceptions regarding the adoption-diffusion of higher ethanol fuel blends. M.Sc. Thesis. The Pennsylvania State University, University Park, PA.
4. Sciaudone, K.T. 2018. Impacts of Vegetative Buffers and Winter Crops on Water Quality and Profitability of Small to Midsize Farms in Pennsylvania. M.Sc. Thesis. The Pennsylvania State University, University Park, PA.

Oklahoma

1. Xiao Sun, Ph.D. Biosystems Engineering, Oklahoma State University, 2014 – 2018. Dissertation: Enhanced Alcohol Production During Syngas Fermentation Using Biochar. Completed July 2018. Advisor: Hasan Atiyeh

Wisconsin

1. Evan Price, 2018 MS Continuous processing of high solids lignocellulosic biomass
2. Shu-Ching Yang 2018 MS Fabrication and application of cellulose-based hydrogels using lithium bromide molten salt hydrate as solvent

West Virginia

1. Akharume, F. 2017. Improving Osmo-convective Dehydration as a Processing Technique to Food Preservation, Quality Enhancement, and New Product Development. M.S. Thesis, Division of Forestry and Natural Resources, West Virginia University.
2. Rahimi, S. 2017. Physical Properties and Drying Behavior of Hydrothermally Treated Yellow-Poplar. M.S. Thesis, Division of Forestry and Natural Resources, West Virginia University.

North Dakota

1. Nahar, N., 2017. Processing Trade-Offs in a Cellulosic Biorefinery, Ph.D. Dissertation, North Dakota State University; Major: Environmental and Conservation Science; Advisor: Dr. Scott Pryor.
2. Subhashree Navaneetha Srinivasagan. 2017. Infield Biomass Bales Aggregation Logistics and Equipment Track Impacted Area Evaluation. MS Thesis. Major Advisor: Igathinathane Cannayen

Iowa

1. Synthesis of some biobased surfactants, and their functionalities as emulsifiers and antimicrobial agents; PhD Dissertation by Kangzi Ren Life Cycle Assessment (LCA) and Techno-Economic Analysis (TEA) of Biobased Adhesive Derived from Glycerol, by Minliang Yang

Missouri

1. Wu, Ying, Nanocellulose extraction and surface modification toward active packaging applications, University of Missouri, November, 2017 Ameri, Maryam Al, Deep eutectic solvent pretreatment for enhancing biochemical conversion of switchgrass, University of Missouri, July 2017

Minnesota

1. Erik Anderson. Ph.D. Biosystems and Agricultural Engineering. December, 2017. Thesis: New Technologies for the Complete Rendering and Economic Conversion of Waste Oils to Biofuels.
2. Qian Lu. Ph.D. Food Science and Nutrition. January, 2018. Thesis: Strategies to Cultivate Microalgae on Eutrophic Wastewater for Nutrients Recycling and Biomass Production.

Tennessee

1. Holly Haber (2018). Sustainable Method for Recovery of Copper Naphthenate from Used Railroad Ties. MS thesis. Knoxville, TN: University of Tennessee, Institute of Agriculture, Biosystems Engineering and Soil Science Department.

Synergistic activities

Alabama
1) Investigators serve on panel review of several grant agencies in United States. 2) Auburn University is also a participant of the Consortium for Advanced Bioeconomy Leadership Education (CABLE) Program, started from Fall 2017. CABLE is an undergraduate training project leading by Ohio State University in partnership with 19 other institutions (including Auburn University) sponsored by USDA-NIFA. The purpose of the project is to train the future workforce in the bioeconomy industry, especially to prepare the next-generation bioeconomy industry leaders. 3) Dr. Yi Wang collaborates with the Virginia station for proposals, and also provide the engineered strains for the PI at the Virginia station. 4) Auburn University is going to host 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 will participate this conference.

California
Research results contribute to the development of knowledge and human resource skills. We are training graduate students and post doctoral scholars on this project. Their training is unique in that it has a focus in both engineering and biology with application to sustainable agriculture and energy production. Graduate students are also trained in the mentoring of undergraduates offering multiple opportunities for human resource development. Partner organizations include government agencies and private companies, such as US Department of Energy, US Department of Agriculture, National Science Foundation, California Energy Commission, and California Department of Food and Agriculture.

Ohio
Auburn University University of Hawaii University of Nebraska-Lincoln Oklahoma State University

Texas
Hosting of the following Post Docs from China a. Bai Xuewei, Shenyang Agricultural University, China b. Junming Hou, Shanyang Agricultural University, China

Louisiana
Interdepartmental teamwork at LSU. Collaboration with Departments of Civil Engineering from University of Minnesota, Minneapolis, MN, and Ohio University, Athens, Ohio.

Pennsylvania
Most of our research is coordinated with other research and extension teams; including teams from University of Texas at Austin, MIT, the Northwest Advanced Renewables Alliance (NARA) included over a dozen universities, private companies and national labs and includes regions and states of Oregon, Washington, Idaho and Montana, Michigan, West Virginia. We were also participating in the FAA ASCENT Center of Excellence for alternative aviation fuels with the following collaborators: Washington State University, Purdue, the University of Illinois, and the University of Tennessee.

West Virginia
1. A multi-university collaborative proposal is funded by the Northeast Sungrant Center. Collaborators are from the Ohio State University, University of Hawaii, and University of Delaware Singh, K., S. Khanal, D. Jaisi, and A. Shah. 2018-2020. Novel Bio-Chars Production from Northeastern Forestry Feedstocks and Their Land Application to Enhance Environmental Sustainability of Agricultural Production Systems. USDA-NE Sungrant Initiative 2. A multi-disciplinary proposal is funded through USDA-AFRI Program. Sivanandan, L., K. Singh, and L. Towers. 2018-2020. Improving Manufacturing Method for Production of a New Smoky Dried Apple (SDA) Snack and Promoting Small-Scale Fruit Drying Businesses to Process Unsold Apples in West Virginia. USDA- NIFA AFRI Foundational Program. 3. A multi-disciplinary proposal is funded through USDA-AFRI Program. Sivanandan, L., K. Singh, and L. Towers. 2017-2018. Lab-to-community system approach on food safety and preservation programs to offer hands-on training. Northeast Extension Risk Management Education- University of Vermont.
Massachusetts
Collaboration with Nicole Labbe University of Tennessee.

Missouri
Cooperative research with aquaculture scientists at Mississippi State University, and the Mississippi Warm water Aquaculture Center.

Minnesota
We collaborated with investigators at South Dakota State University, Washington State University, Mississippi State University, Stanford University, and Berkeley Lab — Lawrence Berkeley National Laboratory in research and grant writing activities. We established external partnerships with agencies and companies including Minnesota Metropolitan Council Environment Services, Minesga.