THE DEPARTMENT OF

Agricultural & Biological ENGINEERING

AT
PURDUE UNIVERSITY
PRESENTS:

THE 4th ANNUAL ABE-GSA GRADUATE INDUSTRIAL RESEARCH SYMPOSIUM

Thursday February 16, 2017

#ABESymp2017

PROCEEDINGS OF THE 4TH ANNUAL ABE-GSA GRADUATE INDUSTRIAL RESEARCH SYMPOSIUM

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The symposium organizers would like to thank the Purdue Graduate Student Government & the College of Agriculture for their generous support of this event.

We are grateful to the following companies and government entities for their participation in the event:

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We would like to thank the following local businesses for donating gift cards for poster competition prizes:

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S Y M P O S I U M S C H E D U L E

9:00 – 9:30 am	**Registration and presentation set-up – *KRCH Atrium***	
9:30 – 10:40 am	**Machine Systems/Agricultural Systems Management Session – *KRCH 260***	**Bio-Energy Session – *KRCH 270***
	M. Olasubulumi: Design and implementation of a flywheel test rig for accelerated endurance testing of positive displacement machines. **M. Pellegri:** Numerical modelling of gerotor units **P. Banerjee:** Hydraulic hybrid transmissions for on-highway vehicles **D. Seidel:** Investigation into the effects of temperature probe erientation on the Purdue swine cooling pad	**L. Zhang:** Rapid evaluation of adsorption characteristics of proteins to biomass by liquid chromatography **A. Santos:** Temperature dependent cellulase adsorption on lignin from sugarcane bagasse **I. Beheshti:** Production of cellulose nanofibers using phenol oxidized reactions **R. Caulkins:** Sequential aldol condensation and hydrodeoxygenation of cellulose fast-hydropyrolysis vapors for the formation of fuel-range hydrocarbons
10:40 – 10:50 am	***Break***	
10:50 – 12:00 pm	**Environmental & Natural Resources Engineering Session – *KRCH 270***	**Biological Engineering & Food Processing Session – *KRCH 260***
	S. Mehan: Extent of uncertainty in the statistically downscaled climate data **C. Zhang:** CSVI: A new hyperspectral index for characterizing the stress degree on vegetation by copper **L. Sekaluvu:** Constraints to response of water quality conservation measures within Western Lake Erie basin **G. Pignotti:** Sensitivity and skill of ecohydrologic model soil water dynamics	**J. Li:** Prediction of swelling kinetics of maize and rice starch **F. Fang:** Shear-thickening behavior of gelatinized waxy starch dispersions **Y. Lyu:** Free energy of pore formation by aggregates of melittin in DOPC/DOPG mixed lipid bilayer by molecular dynamics simulation **J. Zuponcic:** Osteomimetic and osteoinductive polymer/bioactive glass composite scaffolds for bone regenerative engineering
12:00 – 12:10 pm	***Break***	
12:10 – 1:20 pm	**Plenary Speaker and Lunch – *CoRec Feature Gym*** **Dr. Linda S. Prokopy, Professor of Natural Resources Social Science**	
1:20 – 1:30 pm	***Break***	
1:30 – 2:45 pm	**Networking Session – *CoRec Feature Gym***	
2:45 – 3:00 pm	***Break & Poster Session Setup***	
3:00 – 5:30 pm	**Poster Session – *KRCH Atrium***	
5:30 – 6:00 pm	***Break***	
6:00 – 8:00 pm	**Keynote Speaker and Dinner – *The Anvil*** **Dr. Alison Goss Eng, U.S. Department of Energy**	

KRCH – Krach Leadership Center, 1198 Third Street
CoRec – France A. Córdova Recreational Sports Center, 355 N. Martin Jischke Dr.
The Anvil – 320 North St., West Lafayette, IN 47906

SYMPOSIUM GUEST SPEAKERS

Plenary Speaker:

Dr. Linda Prokopy is a Professor in the Department of Forestry and Natural Resources at Purdue University and the Director of the Indiana Water Resources Research Center. Dr. Prokopy is an interdisciplinary social scientist who is recognized nationally and internationally for her work incorporating social science into the fields of agricultural conservation, agricultural adaptation to climate change, and watershed management. She has developed a highly successful integrated program focused on the role of human decision making in water resources management. Dr. Prokopy has published over 80 peer-reviewed articles in consistently high-tier journals, she has generated over $12 million in competitive research funds, and she has graduated and mentored numerous graduate students and postdocs.

Keynote Speaker:

Alison Goss Eng is the Program Manager for Advanced Algal Systems and Feedstock Supply and Logistics for the Bioenergy Technologies Office (BETO) at the U.S. Department of Energy. In that role, she guides a diverse research portfolio developing technologies to provide a reliable, affordable and sustainable biomass supply to the growing advanced bioenergy industry. Primary areas of focus are terrestrial and algal feedstock resource assessment, feedstock logistics (i.e. harvesting/dewatering, handling, collection, storage, preprocessing, and transportation), algae biology and cultivation, feedstock-conversion interface, and techno-economic/life cycle analyses. She is the liaison between the Biomass Research and Development (BRD) Board and the BRD Operations Committee, an interagency collaborative composed of senior decision-makers from federal agencies and the White House and co-chairs the Biomass Research and Development Initiative Interagency Working Group on Feedstock Logistics.

She joined the office as a Presidential Management Fellow, and previously served as the lead for sustainability research and development programming. Alison was responsible for establishing a portfolio of research within BETO focused on the environmental impacts of bioenergy production. A graduate of Purdue University, Dr. Goss Eng earned her Ph.D. in Earth and Atmospheric Sciences, where her dissertation focused on assessing the historical impacts of landscape transformation on water fluxes in Muskegon River watershed for environmental monitoring and assessment.

Alison is the National Team Lead for Task 38 of IEA-Bioenergy which is focused on Climate Change Effects of Biomass and Bioenergy Systems. Alison also represented the U.S. as a lead author on the bioenergy chapter of the International Panel on Climate Change (IPCC) Special Report on renewable energy and climate change mitigation (SRREN).

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* giving a presentation during the category sessions.

Research Area Key

ASH = Agricultural Safety and Health
BIOE = Bioenergy
BE = Biological Engineering
ENR = Environmental and Natural Resources
FP = Fluid Power
FOOD = Food Process Engineering and/or Food Safety
MACH = Machine Systems

1 Maleic Acid and $AlCl_3$ Co-Catalyst System for Improved Poplar Hemicellulose Conversion

Amanda Kreger, BIOE
Advisor: N. Mosier

Maleic acid has been shown to achieve high yields and selectivity for the hydrolysis of biomass cellulose and hemicellulose. Subsequent conversion of the xylose from hemicellulose to furfural, a high value platform chemical, has been shown as moderately effective with maleic acid. However, in conversion of the glucose from cellulose to hydroxymethylfurfural, maleic acid alone is not a sufficient catalyst to achieve feasible product yields. Instead, a maleic acid $AlCl_3$ co-catalyst system has been shown to significantly improve product yields from glucose. In this study, we test the same maleic acid $AlCl_3$ co-catalyst system for improving poplar hemicellulose conversion to furfural as compared to a maleic acid only catalyst system. In a maleic acid only catalyst system, we show products of xylose and furfural created from the hemicellulose's xylan. We report that with the addition of $AlCl_3$ the co-catalyst system causes a shift in reaction pathways and creation of a xylulose intermediate product in addition to xylose and furfural products. This co-catalyst system results in lower combined yields of xylose, xylulose, and furfural compared to the maleic acid only catalyst system. However, there is a 530% increase in maximum furfural yields by using the co-catalyst system, achieved after a 30% shorter reaction time than the maleic acid only system's maximum yields. This demonstrates that the maleic acid $AlCl_3$ co-catalyst system is a more economical, improved system for hemicellulose conversion due to reduced reaction time and significant increase in furfural yields and concentration.

2 Investigating factors leading to char formation during fast hydropyrolysis of biomass feedstocks

Abhijit Talpade, BIOE
Advisor: F. Ribeiro, N. Delgass

H2Bioil proves to be a carbon and energy efficient process for transforming highly oxygenated fast hydropyrolysis vapors resulting from biomass into liquid fuels through catalytic upgradation. The current process, however, yields high selectivity towards products which are unsuitable for use in fuels and loses a significant amount of carbon to char; with pyrolysis of poplar at 5000C and 25 bar hydrogen pressure in the cyclone reactor giving 28.5% carbon selectivity to char. In this work, we aim to study cellulose, hemicellulose and lignin model compounds to gain an insight into the factors leading to the formation of char and thus drive these carbons into more valuable products.

Preliminary experiments on the cyclone reactor using cellulose have indicated that cellulosic components in biomass do not contribute majorly to char formation. Through studies on various lignin model compounds, lignin fraction is found to be major char contributor. Recent results on hemicellulose model compounds have led us to hypothesize that hemicellulose may also be a major char contributor along with lignin. However, these model compounds were found to contain inorganic elements (Na, Mg, K, Ca) in elevated concentrations. Investigating whether hemicellulose components contribute to char or the high inorganics content in these model compounds are responsible for char is, therefore, critical. Future work includes synthesizing hemicellulose model compounds free of inorganics which could prove vital in testing our hypothesis. Future work also includes modeling the role of inorganics in speciation of reactions that lead to formation of char.

3 Cellulose ethanol production from corn pericarp

Daehwan Kim, BIOE
Advisor: M. Ladisch

The corn kernel, abundant in starch, is utilized to produce fuel ethanol through a dry grind process. In addition to generate starch, other components such as germ, pericarp and oil, which are mixed together during the milling, cooking, hydrolysis and fermentation processes, can be separated and used prior to processing and fermentation. These components have potential to generate other value-added molecules. This could expand the use of corn and add revenue to the corn industries through diversified products and chemicals. One of these uses is production of cellulose ethanol from components that are identifiable as clearly being cellulose. To investigate an alternative source of cellulosic ethanol, we are studying conversion of pericarp, utilizing an enzyme-based process to fractionate kernels into starch, germ, fiber, and soluble proteins. In this work, the pericarp recovered from kernel fractionation was liquefied into simple sugars. These in turn were fermented to ethanol. We tested different sizes of pericarp and demonstrated the effect of particle size, mixing, and enzyme loadings for generation of sugars for the ethanol fermentation using Saccharomyces cerevisiae. Commercial hemicellulase/ cellulase enzymes were used to hydrolyze the pericarp. Mixing was found to be an important factor with an enhanced agitation giving up to 30% higher cellulose conversion in 48 h. Ethanol fermentation of pericarp hydrolysates without solids was completed in 15 h with close to metabolic yields. Experiments leading to optimal conditions are reported, and processes for production of cellulosic ethanol from pericarp are proposed.

4 INCREASING CORN UTILIZATION THROUGH FRACTIONATION OF CORN KERNELS

David Orrego, BIOE
Advisor: M. Ladisch

Diversification of corn products through alternative processes remain as a major challenge in a well stablished corn industry. Previously, we enabled close to 90% recovery of the starch found in a corn kernel in a particulate form after 36 hours of incubation with a commercial protease and cellulase enzymes in a cone-bottom reactor. This resulted in fractionation of corn kernels into identifiable components: starch, pericarp and germ (oil), by scaling the process to 1 L agitated laboratory bioreactors. Enzyme activities, mixing effects, and enzyme and solids loading were optimized in these reactors. Visual observation of mixing patterns showed that rotation and translation of the kernels, as they moved through the bioreactor, enhanced the action of the enzymes which separated starch from the pericarp. The resulting starch recovery was 85% when a mixture of cellulase and protease was incubated with 35% (w/v)

corn kernel solids in 50 mM citrate buffer, pH 5, 50°C and 100 rpm for 48 hours. Enzyme loading was reduced 10x by optimization of reaction conditions. The starch obtained through this process was analyzed, and a material balance around the bioreactor was used to generate an Aspen model of the separation process. We report process analysis of conditions that may be used to scale-up an enzyme-based fractionation process, and discuss how the resulting model indicates optimal conditions.

5 Mechanical fragmentation of corncob at different plant scales: Impact and mechanism on microstructure features and enzymatic hydrolysis

Guanya Ji, BIOE
Advisor: G. Ji, C. Gao, W. Xiao, L. Han

In this work, corncob samples at different scales, i.e., plant scale (> 1 mm), tissue scale (500–100 μm) and cellular scale (50–30 μm), were produced to investigate the impact and mechanisms of different mechanical fragmentations on microstructure features and enzymatic hydrolysis. The results showed that the microstructure features and enzymatic hydrolysis of corncob samples, either at a plant scale or tissue scale, did not change significantly. Conversely, corncob samples at a cellular scale exhibited some special properties, i.e., an increase in the special surface area with the inner mesopores and macropores exposed to the surface; breakage of crystalline cellulose and linkages in polysaccharides; and a higher proportion of polysaccharides on the surface, which significantly enhanced enzymatic digestibility resulting in a 98.3% conversion yield of cellulose to glucose which is the highest conversion ever reported. In conclusion, mechanical fragmentation at the cellular scale is an effective pretreatment for corncob.

6 Production of cellulose nanofibers using phenol oxidized reactions

**Iman Beheshti Tabar, BIOE*
Advisor: N. Mosier

In this study we demonstrate that lignin monomers formed as byproducts of pulping or bioprocessing of lignocellulosic biomass is an effective enhancer to oxidizing cellulose surfaces with ozone for the production of cellulose nanofibers (CNF). Never dried softwood pulp with minimum mercerization was enzymatically treated leading to a homogeneous pulp slurry with a higher reactivity. The slurry was oxidized by ozone gas in the presence of syringic acid, a lignin degradation model compound, as oxidation enhancer at room temperature and pH 11. Transmission electron microscopy (TEM) observations showed stable CNF bundles with 3-10 nm widths and lengths >100 nm were obtained after ultrasonication of the oxidized product in water. Extensive characterization of the new CNF films revealed the nanofibers had carboxylate content similar to conventional carboxylated cellulose prepared by TEMPO-mediated oxidation. Based on NMR spectra, chemical conversion of the syringic acid during oxidation is proposed.

7 Rapid Evaluation of Adsorption Characteristics of Proteins to Biomass by Liquid Chromatography

**Leyu Zhang, BIOE*
Advisor: M. Ladisch

Our previous work showed that Bovine Serum Albumin (BSA) is effective in blocking exposed lignin surface, thus promoting enzymatic hydrolysis. However, its price is too high to be applied in ethanol plants. Other lignin-blocking compounds of low cost have to be found and therefore an efficient screening method of lignin-blocking compounds become crucial. An inverse liquid chromatography (ILC) method was developed for rapid determination of the adsorption characteristics of proteins to lignocellulose. Sugarcane bagasse segments were wet–packed into a column, which was then inserted to an ILC system assembled in our laboratory. BSA (2% w/v) and vanillin (0.05% w/v) dissolved in 50mM citrate buffer (pH 4.6 – 5.0) were used as probe compounds. In this study, the performance of columns, packed by two packing procedures was compared: for vanillin, a lower plat height (12 mm) was observed on the column packed at constant pressure than at constant flow rate (27 mm) at 50°C. Also, both columns showed weaker retention as column temperature increased, which confirmed the Arrhenius definition of adsorption kinetics. However, for BSA, the total peak area at 50°C was only 65% of the area at 20°C (pH 4.6), probably due to lower thermal stability of this protein at higher temperature. Furthermore, this difference became more pronounced at pH 4.2 and less at pH 5.0. These results demonstrated the importance of packing procedure, suggested that the stability of protein affects adsorption, and more importantly, the potential of using ILC for screening process of lignin-blocking agents.

8 Acidification of Food Waste During Storage After Grinding with Insinkerator® Technology

Sarah Daly, BIOE
Advisor: J. Ni

Food waste in the United States is a considerable problem due to the large volume generated yearly. Most food waste is sent to a landfill where it can emit methane, which is a potential greenhouse gas. The following system for handling food waste is one proposed solution to this problem. First, food scraps are ground and diluted in a grinder that has been installed on-site at the food waste source (e.g., a restaurant kitchen). Then, the slurry from the grinder is collected in a large storage tank. After two weeks, the slurry is trucked to a centralized anaerobic digester to produce biogas. This biogas can then be used to generate electricity or fuel for the plant, thereby decreasing operating costs and reducing greenhouse gas emissions. Our objective was to study the effects of different storage conditions on the quality of food waste. We used a mixed-level fractional factorial design to determine the influence of temperature, feeding regimen, inoculum, and food waste composition on the acidification process. Three different temperatures (15°C, 25°C, and 35°), three different substrates (carbohydrate, lipid, and protein), three different feeding regimens (no feeding, feeding, feeding with oxygen removal), and two different inoculum conditions (yes and no) were tested. Ultimately, 12 different conditions were performed in triplicate as determined by the mixed-level fractional factorial design. We found that food waste composition, temperature, and time had the most significant influence on acidification. These results suggest that storage conditions are important considerations

when designing a food waste collection system.

9 Biogas Technology Application in Farming Systems of Western Kenya: A Field Investigation in Nandi & Bomet Counties

Taisha Venort, BIOE
Advisor: J. Ni

The integration of biogas technology into rural farming systems of Kenya is becoming more common. A comprehensive assessment on the role of biogas technology in Integrated Food–Energy Systems (type II IFES) is undertaken in Nandi and Bomet, towards understanding factors affecting applications for energy and agronomic use. Data on farming systems and application were collected using a checklist questionnaire. Descriptive statistics was used to translate users' experiences and understand trends in energy and fertilizer use. A Binary Linear Regression model was developed to find out factors most influential to plants retention. Higher operational rate in Bomet (77%) than Nandi (59%), reveal that plants' viability are significantly associated with the subsidies'liability schemes. Records of partial substitution to biogas and bio-slurry are contributing to the reinforcement of local agro-forestry traditions through the rise of zero-grazing practices, tree lots retention, and more efficient agricultural land attribution, all having a positive impact on household food security. Key recommendations to stakeholders suggest that local subsidy schemes take better account of liability towards local technicians, Quality Control responsibilities shift to local enterprises, and R&D focuses on agricultural applications and relevant value chains, for better experiences of application by farmers.

10 Anaerobic fungal enzymes efficiently degrade diverse agricultural and food wastes for bioenergy

Casey Hooker, BE
Advisor: K. Solomon

Identifying inexpensive and reliable methods for lignocellulosic hydrolysis are key to developing this abundant and renewable substrate as a useable feedstock for the bioeconomy. Diverse enzymes produced by anaerobic gut fungi efficiently break down and ferment cellulosic substrates into simple sugars and hydrogen gas, both having high value for bioenergy. Here, we demonstrate that a new anaerobic fungal isolate, Piromyces indianae, degrades and grows on woody forestry products such as poplar, and an array of agricultural and food wastes. Importantly, fungal growth is robust to lignin composition. Unlike the industry standard Trichoderma reesei, whose enzymes are inhibited up to 50% by increases in select lignin constituents, our isolate exhibits no more than a 20% decrease in growth. This resiliency to lignin composition makes anaerobic fungi particularly attractive as microbial platforms for enzymes that overcome lignocellulosic recalcitrance. Isolation of these enzymes may allow for economical, more efficient methods of biofuel production.

11 Characterization of Collagen Type I and II Blended Hydrogels for Articular Cartilage Tissue Engineering

Claire Kilmer, BE
Advisor: J. Liu

Osteoarthritis (OA) is a debilitating condition that affects over 27 million people in the United States alone and is defined by degradation in articular cartilage extracellular matrix (ECM). Although there is no cure for OA, there are many treatment options including osteochondral grafting and autologous chondrocyte implantation. However, these options usually promote the growth of fibrocartilage, which is inferior to the mechanical properties of native cartilage. Collagen type II makes up 90-95% of the collagen produced by chondrocytes in the ECM and is a promising scaffold material. It has been shown that collagen type II hydrogels promote the differentiation of embedded mesenchymal stem cells to chondrocytes more efficiently than collagen type I gels. However, when compared to collagen type I, collagen type II forms fibrils of smaller diameter and exhibits poor mechanical properties when forming a hydrogel without crosslinking. It was hypothesized that hydrogels made with a blend of collagen type I and II will have superior mechanical properties compared to gels made with collagen type II alone. In addition, GAGs attach to proteoglycans within the extracellular matrix and allow articular cartilage to withstand compressive forces. We are interested in the interactions between a blend of collagen type I, collagen type II, and GAGs. From the different blends that were investigated, the 3:1 blend was able to form more consistent gels with superior mechanical properties as compared to the other blends. Thus, the 3:1 blend has the potential to be implemented as a scaffold for articular cartilage tissue engineering.

12 Molecular modeling of high-oleic soybean oil as a universal solvent for extraction of hydrogen sulfide from natural gas

Emma Brace, BE
Advisor: A. Engelberth

The rise of hydraulic fracturing (fracking) in the United States has increased interest in utilizing natural gas in transportation fuels, since combustion of natural gas releases less carbon dioxide into the atmosphere than conventional gasoline. However, natural gas extracted by fracking has high concentrations of hydrogen sulfide, a corrosive compound that can damage processing equipment, and is harmful for human health. The purpose of this research is to evaluate the feasibility of using high oleic soybean oil to remove hydrogen sulfide from natural gas. The high degree of saturation in high-oleic soybean oil offers several binding sites for sulfur, and a molecular modeling approach was used to determine the conditions under which high-oleic soybean oil can be used as an extraction solvent. The Conductor-like Screening Model for Real Solvents (COSMO-RS) was used to calculate the partition coefficient of hydrogen sulfide between methane and soybean oil phases. This statistical thermodynamics approach simulates the partitioning of the target molecule (hydrogen sulfide) between the liquid (soybean oil) and gas (methane) phases. The molecular modeling approach to predict the partition coefficient allowed for more rapid determination and reduction of experimental effort (time, resources) when choosing the right concentrations of solvents and co-solvents (such as oxidizing agents) which aided the ability of the high oleic soybean

oil to extract the hydrogen sulfide. This work demonstrates a novel use of high-oleic soybean oil as a bio-based solvent for cleaning natural gas, and will potentially improve the viability and economics of the natural gas industry.

13 Anaerobic fungi: Regulating microbial environments in ruminant guts without antibiotics

Ethan Hillman, BE
Advisor: K. Solomon

Emerging antibiotic resistance threatens to rendered common medicines to routine conditions useless. However, unexplored microbial environments are a potential untapped pool of naturally produced antibiotics and other drugs. Because of this, we explore the competitive communities of microbes in the guts of large herbivores. Similar to other fungi, we have observed natural product-rich genomes among anaerobic fungi from the four fully sequenced isolates. Recently, we have isolated a novel anaerobic fungus, Piromyces indianae, from the gut of a donkey. We have begun characterizing the genome of this fungus and have optimized a colony PCR method using degenerate primers to isolate natural product clusters that will lead to new drugs. As we develop the ability to manipulate their genomes, these organisms are prime candidate for probiotic and feed additive applications that are engineered to cultivate a natural healthy community in their native hosts, thus reducing the dependency on antibiotics.

14 Osteomimetic and Osteoinductive Polymer/Bioactive Glass Composite Scaffolds for Bone Regenerative Engineering

**Jessica Zuponcic, BE*
Advisor: M. Deng

Directing osteogenic differentiation of mesenchymal stem cells (MSCs) represents a promising strategy for bone repair. Current paradigms in directing MSC osteogenic differentiation using growth factors are plagued by safety and efficacy concerns. For example, the application of exogenous bone morphogenetic proteins (BMPs) has been hindered by concerns over supraphysiological dosage requirements and undesirable immunological reactions. Our previous studies have demonstrated the osteoinductive potential of calcium and phosphate ions to trigger endogenous MSC-based BMP-2 production. Thus, bioactive glass offers an attractive approach for inducing osteogenic differentiation leading to bone formation due to its ion release capacity. The long-term goal of this work is to develop osteomimetic and osteoinductive composite scaffolds to promote bone regeneration. In this study, a novel 3D osteomimetic composite porous scaffold was developed by sintering of composite microspheres comprised of poly(lactide-co-glycolide) (PLGA) and a novel bioactive silicate glass (BSG). This combination synergistically merged the benefits of mechanical properties of PLGA with the bioactivity of the BSG. Composite scaffolds were optimized to obtain bone-mimicking structural and mechanical properties by controlling fabrication parameters including BSG weight percentage and sintering conditions. The optimized composite scaffold exhibited compressive properties in the mid-range of trabecular bone. Furthermore, the composite scaffolds supported adhesion and growth of human MSCs during a 3-week cell culture. Interestingly, the composite scaffolds significantly increased the alkaline phosphatase activity of the cells leading to enhanced mineralization as compared to control PLGA scaffolds. These experiments supported the promise of developing next generation osteoinductive composite scaffolds for healing large bone defects.

15 Enzymatic Process for Making Plasticizers from High Oleic Soybean Oil

Julia Burchell, BE
Advisor: N. Mosier

Epoxidized soybean oil (ESBO) is a chemically modified soybean oil derivative that is used to make plastics pliable as well as for making bio-based polyurethanes for coatings, epoxide-based resins, and high temperature lubricants. While traditional conversion methods use peroxyacetic acid to catalyze the reaction, lipases can also catalyze epoxidation reactions. In this paper we show conversion of soybean oil and high-oleic content soybean oil using immobilized lipase derived from Candida antarctica without the need for additional solvents, such as toluene, or added free fatty acids. At 35°C, soybean oil can be epoxidized with >90% yield within 15 hours, while using peroxyacetic acid only obtains 70% yield at 50°C after 10 hours of reaction time as side reactions reduced the selectivity of the epoxidation. Reaction kinetics for individual unsaturated fatty acids will be presented, as well as characterization of the enzymatic ESBO compared to the peroxyacetic acid conversion with both soybean oil and high-oleic content soybean oil. Recyclability of the immobilized enzyme is discussed in the context of potential commercial applications as a continuous process.

16 NgAgo inducibly represses gene expression at sites programmed with P-ssDNA

Kok Zhi Lee, BE
Advisor: K. Solomon

Popular genome editing tools such as CRISPR enable modification of genomes at programmable target sites adjacent to sequence-specific motifs. This restriction, however, limits target site choices and may be problematic in genomes with biased GC-content. In contrast, Argonaute from Natronobacterium gregoryi (NgAgo) is reported to be free of such restrictions and is proposed as a controversial alternative to modify genomes. Here, we implement NgAgo in E.coli. While we have yet to demonstrate direct DNA modification, targeting NgAgo to the coding (sense) or antisense strand of essential genes reduced cell viability suggesting targeted reduction of gene expression via some uncharacterized DNA interaction. Similarly, we observe that targeting any plasmid gene with NgAgo inhibits plasmid replication. Our results suggest an unrecognized mode of action for NgAgo and highlights the potential of NgAgo as a novel orthogonal regulator system for programmable control of gene expression.

17 Development of Novel ELP-Based Transcriptional Regulators for Improved Biomanufacturing

Logan Readnour, BE
Advisor: K. Solomon

Microbial chemical factories that sustainably produce commodity chemicals and biofuels are not yet fully realized due to low yields. Production may be enhanced by genetic circuits capable of redirecting resources toward desired products. However, this redirection of flux towards product must be balanced with resources for cellular health to sustain optimal performance. Therefore, we propose novel ELP-sigma factor constructs as synthetic regulators that recognize cues of cellular health and autoregulate expression of bioproduction pathways for improved health and production. Elastin-like polypeptides (ELPs) make ideal sensors since they exhibit a sharp, inverse phase transition to indicators of cellular health such as pH and ionic strength, and external stimuli such as temperature. Initial designs successfully alter gene expression by 15-30% in response to temperature. We anticipate refinement of this design and combinatorial construct libraries will generate various regulators with diverse outputs that may be integrated in bioproduction pathways for improved performance.

18 Improved Optical Purity of Lactic Acid from Mixed Microbial Fermentation

Raymond RedCorn, BE
Advisor: A. Engelberth

Lactic acid is a commodity chemical useful for the production of polylactic acid (PLA) biopolymers. The optical purity of the lactic acid used impacts the characteristics of the resultant polymer; typically <90% L(+)-lactic acid is desired. Previous work has demonstrated that mixed microbial codigestion of foodwaste and primary sludge can achieve 97% of theoretical lactic acid yield at 1.9 g L-1 h-1, however the resultant optical purity was low at 57% L(+)-lactic acid. Meanwhile, separate experiments have shown that at pH 5, high optical purity can be achieved with food waste only (>90% L-lactate), however at low production rate (>45 g L-1 h-1). The present work was performed to determine if high optical purity can be achieved alongside high production rate by co-digesting at pH 5. The results indicate that high production rate can be achieved at pH 5 but the high optical purity achieved in other work at pH 5 could not be replicated, with or without co-digesting sludge. To determine why the results could not be replicated, further research into the microbial community performing fermentation could be useful.

19 Lignin as a bioadsorbent for the removal of heavy metals from water

Samira Fatemi, BE
Advisor: A. Engelberth

Metals such as lead (Pb) and cadmium (Cd) pose significant risks to human health and environmental well being when present in water. Among various ailments are kidney dysfunction, developmental disabilities, and increased risk of cancer. Current methods to remove toxic metals include membrane filtration and activated carbon adsorption, but these methods are often capital intensive. Here we investigate the utilization of lignin as a biorenewable approach to metal adsorption. Lignin was obtained from corn stover via acid hydrolysis. Metal solutions were prepared from Pb and Cd chloride salts. Solutions had initial concentrations ranging from 50 to 200 ppm, to represent typical contamination levels. Lignin was then added to the solution and left in an incubator shaker for 8 hours at 30°C. After lignin metal association, the samples were filtered and centrifuged to separate solid and liquid fractions. The initial and final concentrations of the samples were analyzed via atomic absorption spectroscopy (AAS). Langmuir isotherms demonstrate the equilibrium adsorption of Pb and Cd onto lignin. Further work will investigate the effects of varying quantities of lignin, and interactions between lignin and nonmetal substrates that may typically be found in water systems.

20 Glioblastoma Animal Model Comparison Using Multiple Reaction Monitoring (MRM) Profiling

Soo Jung Ha, BE
Advisor: K. Clase

Glioblastoma (GBM) is the most common and aggressive form of primary brain tumor. Due to its extremely malignant and invasive nature, the mean survival period of GBM patients is only 12-15 months from diagnosis. In cancer research, subcutaneous and orthotopic murine models are widely used to study human tumors. However, these common models are not able to mimic human tumor heterogeneity completely due to tumor complexity. In order to compare the commonly used models in GBM and validate the ability of different model system to mimic the human tumors, we performed multiple reaction monitoring (MRM) mass spectrometry (MS) profiling to investigate lipid expressions in subcutaneous and orthotopic mouse models.

Two different human GBM cell lines, GBM43 and GBAM1, were injected into flank site of the mice, and intracerebral implants of the GBM cell lines were performed in the right cerebral hemisphere in NOD/SCID/□chainnull mice. MRM profiling by flow injection electrospray (ESI) MS provides a platform for screening analysis of lipidomes directly from crude extracts of biological samples. In order to visualize the data, we utilized supervised statistical analysis methods (principal component analysis - PCA), univariate statistics and receiver operating characteristics (ROC) curve to show the differences of lipid profiles and define prospective biomarkers. Our findings showed that lipidomic profiles of both PCA and ROC curve results of subcutaneous and orthotopic model were significantly different. Our next step is to compare lipid expression of the tumors from animal models to human glioma tumors.

21 Extrusion-assisted extraction of insoluble dietary fiber from rice bran and its physical properties

Xu Wang, BE
Advisor: Y. Xu

In this paper, we investigated the effects of extrusion-assisted extraction on extraction rate and physical characteristics of insoluble dietary fiber (IDF) from rice bran were studied. Based on the single factor experiment, the orthogonal test was applied to optimize the parameters for insoluble dietary fiber from rice bran of extrusion-assisted

extraction. The results showed that the highest extraction rate of 56.21% was reached under the conditions which the extrusion temperature was 135°C, material moisture content was 20%, screw speed was 220 r/min, extraction temperature was 50°C, extraction time was 60 min, feed liquid ratio was 1:55 and alkali concentration was 0.25mol/L. In addition, extrusion-assisted extraction not only increased the extraction rate of insoluble dietary fiber, but also improved physical properties. The insoluble dietary fiber obtained by extrusion-assisted extraction had higher water-holding capacity, water-binding capacity, extension capacity and fat-binding capacity, and much abundant reticular structure than those obtained by enzyme-assisted extraction and acid dissolution and alkali precipitation. It can be concluded that insoluble dietary fiber treated by extrusion-assisted extraction has the higher potential to be applied as a functional ingredient in food products.

22 Investigating Impact of Mycobacterial Physiology on Mycobacteriophage Life Cycles by Mass Spectrometry

Yi Li, BE

Advisor: K. Clase

Phage is a re-emerging research object due to its ability to lyse bacteria and the high demands of new antibacterial agents. Many applications in food safety and antibacterial treatment designed based on phage's lytic life cycle have been developed. However, the precondition, lytic cycle, is not always valid. To improve the efficiency of phage's lysis activity, it is necessary to obtain better understanding of phage life cycles, especially the requirements for maintaining different life cycles. We have conjectured that the mycobacteriophage life cycles were mainly affected by the physiology of host mycobacteria in one of our research papers. Many previous researches of other groups could also support the assumption from four different perspectives. Thus, we can further assume that phage life cycles may be affected by bacterial physiology which is mainly determined by the content of growth medium. To reveal how the bacterial physiology affects phage life cycles, the phage-host interaction epitomized in the protein expression patterns of both phage and bacteria needs to be investigated. To substantiate the assumption, we selected three different phages to infect Mycobacterium smegmatis in different growth phases for subsequent protein extraction. The protein expression patterns were analyzed by high performance liquid chromatography-tandem mass spectrometry (HPLC-MS/MS) with an in-house database. The simplicity and reliability of the database has been discoursed in our previous research paper. Our long-term objective is to identify the phage proteins mediating phage lytic and lysogenic cycles and the corresponding bacterial proteins expressed during key transition points in the phage life cycles.

23 Electrospun Probiotics: An alternate for encapsulation

Zainab Akbar, BE

Advisor: T. Zahoor, J. Irudayaraj

Probiotics are defined as "living microorganisms which, when directed in adequate quantities, confer health benefits to the host, including the treatment and prevention of some pathologies". Intestinal microbiota contributes to human health by metabolizing the nutrients, enhancing the immune system and by restricting the pathogen colonization. Different strains of lactobacilli and bifidobacteria have been utilized as probiotics but their viability should be maintained from production to consumption in order to gather the maximum benefit from them. It is also necessary that bacterial strains can tolerate and maintain its viability in adverse condition of gastrointestinal tract. Therefore, for these biologically active compounds the development of a good delivery system is an important issue. Previously encapsulation was considered as a good technology to protect these entities but Probiotics face mortality due to spray drying dehydration and thermal inactivation. Electrospinning or nanofabrication can be an alternate approach to conserve and encapsulate or insert probiotics in fibers or mat, which can retain its viability. Electrospinning is a broad term used for formation of electrostatic fibers by utilizing electrical forces to produce polymer fibers with diameters ranging from 2 nm to several micrometers using polymer solutions. The Advantages of Nanofabrication includes increased immobilization efficiency due to large surface area and more viability. Present study has been designed to explore and validate the use of probiotics in electrospun fibers. These fibers will be utilized for structural analysis as well as viability studies.

24 Phosphorus Retention in Restored Agricultural Stream Floodplains

Alex Johnson, ENR

Advisor: S. McMillan

The goal of my research is to evaluate the nutrient removal potential of restored floodplains in trapezoidal agricultural ditches. This management practice is known as a two-stage ditch. Two-stage ditches have been shown to increase nitrogen removal, decrease streambank scouring during high flow events, and require little to no maintenance. However, one major question that remains is the effect that two-stage ditches have on phosphorus (P) retention. P is often a principle limiting nutrient in aquatic ecosystems. Its high concentrations in wastewater and agricultural fertilizers therefore pose a threat to water quality when these sources run off or discharge into waterways. Reducing transport of P downstream has been suggested as a benefit of floodplain restoration in urban and agricultural watersheds. During flooding events, the floodplain is inundated with slow moving stream water, which allows particulates with adsorbed P to settle out. In this sense, floodplains can act as buffers, removing P from the water as it moves downstream. However, they can also serve as a source of P when organic matter is allowed to oxidize on the benches during dry periods. This P is then later washed downstream during the next storm. Better understanding of P cycling and transport in floodplains will help engineers and watershed managers make better decisions about restoration and management of streams.

25 Impact of Controlled Drainage on Crop Yields

Amanda Locker, ENR
Advisor: J. Frankenberger

Controlled drainage is the practice of using a water control structure to hold water in agricultural fields during periods when drainage is unnecessary. The use of this practice may increase crop yields compared to subsurface drainage, as during the growing season, controlled drainage can capture water from precipitation and raise the water table for crop use. The objective of this study is to evaluate how soil type or elevation may drive the impact of controlled drainage on crop yields over a multi-year period at the Davis Purdue Agricultural Center (DPAC) in eastern Indiana. The field at DPAC has two controlled and two free draining plots. To analyze the effect of soil, the fields were divided by soil type. To analyze the effect of elevation the fields were divided into equal interval changes in elevation above the water control structures. Average crop yields by soil type and elevation were compared for the controlled and free draining fields.

26 An evaluation of denitrification rates in slumped banks and inset floodplains of agricultural channels

Celena Alford, ENR
Advisor: S. McMillan

In the Midwest, many agricultural fields have subsurface drainage that allows excess water, rich in nutrients, to drain into agricultural channels. In turn, these channels flow into rivers and streams that act as the vehicle for excess nitrogen to larger bodies of water. During periods of high flow, a higher concentration of nitrogen is exported. The construction of an inset floodplain within agricultural channels has been proposed as a viable solution to the high release of nitrogen from these systems. While traditional channel designs create highly channelized flow, inset floodplains increase the surface area of interaction between the water and ground-surface, allowing the velocity to slow and nitrogen cycling to increase. However, some traditional channel designs may allow for the formation of floodplains due to slumping, though little is known as to how these floodplains compare to inset floodplains. Our objectives are to compare (1) potential and in-situ denitrification rates, (2) temporal variability in these rates, and (3) nutrient fluxes between both systems. Potential denitrification rates were measured using gas samples from modified bottle assays, while in-situ measurements and nutrient fluxes were measured using water samples from intact cores. Samples were taken from three agricultural channels every season from both the inset floodplain downstream and the unaltered upstream reach. It is expected that the inset floodplains should have higher potential and in-situ denitrification rates, lower temporal variability, and higher nutrient fluxes than the slumped banks.

27 CSVI: A new hyperspectral index for characterizing the stress degree on vegetation by copper

**Chengye Zhang, ENR*
Advisor:

This study proposed a new narrow band index to characterize the copper (Cu) stress degree on vegetation (Copper Stress Vegetation Index, CSVI). Firstly, the spectral reflectance and biochemical data of wheat, pea, locust and ash were analysed using Pearson correlation coefficient (R) to select wavelengths sensitive to Cu stress. The calculated Pearson correlation coefficients suggested that the reflectance near 550 nm and 700 nm correlated positively with Cu contents in leaves and solutions, and negative correlation was present in the range of 800-900 nm. Secondly, the selected wavelengths of 550 nm, 700 nm, and 850 nm were used to establish CSVI, and it was compared with existing popular vegetation indices (VIs) related to heavy metal stress (NDVI, REP, DVI, PRI) by calculating Pearson correlation coefficient between VIs and Cu contents in leaves and solutions. Thirdly, verifications of CSVI on other vegetations were conducted, and the performance of CSVI was also compared with that of NDVI, REP, DVI, and PRI. The results suggested that CSVI showed significant correlation with Cu stress degree, and the correlation of CSVI was much stronger than that of other VIs for all the tested vegetations. The proposed CSVI characterizes the Cu stress degree on vegetation with advantages of better effectiveness, straightforward calculation, and robustness for different vegetations.

28 The Economic Potential of the Utilization of Aquaculture Waste Streams

Claire Haselhorst, ENR
Advisor: R. Stwalley

The high nutrient content of aquaculture effluent creates economic, environmental, and operational strains on the industry's production. The management and neutralization of the high concentrations in this waste stream is a significant challenge in this growing agricultural practice. The disposal of these nutrients is becoming increasingly difficult as concentrations increase with the intensification and advancement of aquaculture techniques. Growing financial costs for waste management create concerns of the operational feasibility for aquaculture farms. With the growing pressures on these agricultural producers, a question arises; can this waste be utilized as a resource instead of a refuse?

Aquaculture effluent can be utilized in agricultural practices as a nutrient source. The foundations of aquaponics are built on this notion. Concentrated fish waste from this production has the potential to be a valuable source of fertilizer for many forms of production. Use of the nutrients in this aquaculture product would increase the environmental and economic sustainability of the industry. While utilizing natural processes to neutralize the contents of this waste product, this use could add economic value to production of aquaculture farms by developing alternative revenue streams or increasing the productivity of other agricultural operations.

29 Developing an in-stream water quality model using tracer studies to improve representation of nutrient transport processes

Femeena Pandara Valappil, ENR
Advisor: I. Chaubey

Water quality models are useful to predict water quality status in streams by simulating landscape and in-stream nutrient dynamics. However, published studies suggest that water quality

predictions using these models may have large deviations from measured data, owing to lack of continuous measured data, input uncertainty or inaccurate representation of nutrient transport processes. Solute transport is typically simulated in existing models using simple first order decay or using physical and biogeochemical processes. An ideal water quality model should consider processes such as advection, dispersion, reactions and transient storage exchange in order to accurately predict nutrient concentrations. Most of the existing models neglect one or more of these processes. This study aims to develop a reach scale in-stream water quality model that employs all these processes at sub-daily scale. In-stream processes affecting fate of nitrogen, phosphorus and algae were considered in the model. The model developed in MATLAB programming language was validated using data collected from tracer studies in the Kielstau catchment (Germany). Concentrations of conservative and reactive tracers were monitored continuously in two separate reaches. A breakthrough curve for conservative tracer was fitted to calibrate transient storage parameters and these fitted parameters were used to test the modelled breakthrough curve for phosphate. The calibrated model was generally able to reproduce observed phosphate concentrations with R2 and NSE values of 0.9 in both reaches. The validated model can be incorporated in larger watershed scale ecohydrological models to improve representation of in-stream nutrient transport processes.

30 Sensitivity and Skill of Ecohydrologic Model Soil Water Dynamics

**Garett Pignotti, ENR*
Advisor: I. Chaubey, M. Crawford

Soil water content is of great interest in a range of ecohydrologic applications given its crucial role in a multitude of energetic, biogeochemical, climatic, and hydrologic processes and cycles. Because in situ observations of soil water content are limited by cost and spatial coverage, remotely sensed observations, model simulations, or some combination of both are often utilized in predictive analysis of ecohydrologic systems. It is therefore critical to capture the accuracy and practical limitations of such model or remotely sensed estimates. In particular, soil water dynamics in the Soil and Water Assessment Tool (SWAT) model have not been extensively evaluated with respect to accuracy nor interaction with other model variables and governing equations. Therefore, the objectives of this research seek to: 1) compare SWAT simulated soil water content to observed in situ and remotely sensed measurements and 2) evaluate SWAT model sensitivity to soil water content. Research was conducted at the Little River Experimental Watershed (LREW) near Tifton, Georgia, where 29 soil moisture stations with measurements at three depths are employed. It is expected that results from this analysis will aid in evaluating the accuracy of SWAT simulated water content as well as identifying possible areas for more targeted and rigorous model evaluation or improvement.

31 Analyzing Trends in Nutrient Uptake: Evidence from a Literary Review and Case Study

Gavin Downs, ENR
Advisor: S. McMillan

In agricultural watersheds, drainage practices and anthropogenic sources of nitrate and phosphate can have degrading effects. In watersheds where both have become a problem, stream restoration utilizing natural channel design is used to improve stream function. The goal of this study was to characterize the physical and biogeochemical changes as a direct result of a restoration effort of Horne Creek in North Carolina. Pre and post-restoration stream geometry and geomorphic features were characterized by on site measurements, while transient storage and nutrient uptake of nitrate and phosphate were determined using a steady state conservative/non-conservative tracer experiment. Stream geometry became normalized as depth increased, 0.16m to 0.20m, and width decreased, 3.10m to 2.26m. Additionally, there was a geomorphic shift in stream features from riffle/runs to riffle/pools. Stream storage characteristics showed a shift toward longer travel times in the post-restoration stream as normalized storage area (As/A) increased from .142 to .283, normalized median travel time as a percent increased from 1.59% to 8.55%, and exchange rate increase from 5.1x10^-5 to 9.8x10^-5. Finally, there was a shift from nitrate removal rate (Pre:0.0066m^-1, Post:0.0026m^-1) to phosphate removal rate (Pre:-0.0219m^-1, Post:0.0098m^-1). The results show a shift in stream characteristics from a wide shallow flow with little storage to a deeper, narrow flow. These physical changes resonated in the biological response away from nitrate uptake to phosphate uptake. The findings of this study show a need for environmental mangers to understand the functional responses stream biology activity has to physical changes of the stream channel.

32 Effect of Antecedent Flow Conditions in the Network Instantaneous Response

Josept Revuelta, ENR
Advisor: B. Engel, D. Flanagan

Antecedent flow conditions in streamways are important factors for flood risk estimation, instream aquatic life, water resources availability, and pollutant concentration. These initial conditions also represent a realistic foundation for the prediction of the basin hydrologic response in storm-based or continuous simulation models and depend on several factors such as geography, topography, climate, and anthropogenic alterations. In general, conducted research has concluded that the basin hydrologic response function is a convolution of the hillslope response, and network response functions; both of them quantified in advection and diffusive terms. However, these theoretical frameworks have been limited to flow discharge produced by excess rainfall where antecedent flow conditions, a byproduct of series of rainfall events, have been ignored. As a result, erroneous estimations in the mean and variance of the network response might affect the total hydrologic response of the basin. In this research, it is hypothesized that the presence of antecedent flow in streams might introduce significant changes in the basin's diffusive field and wave propagation effects, and consequently, the basin network response variance will

be affected. Antecedent flow conditions have been extracted from flow duration curves in Maryland, US. The diffusion coefficient and celerity throughout the channel system are computed by published hydraulic geometry relationships. The travel time distribution in the fluvial network is mathematically integrated into terms of the basin geomorphologic structure characterized by the use of the so-called area-distance function, and the probability density function of travel times as a function, flow distance, wave celerity and hydrodynamic dispersion.

33 Nutrients dynamics in riparian zones of agricultural watershed in North Carolina

Laura Ortiz de Zarate, ENR
Advisor: S. McMillan

Agricultural practices can lead to increased export of nitrogen (N) and phosphorus (P) due to the application of fertilizer. In order to improve local water quality and to avoid a potential pollution of downstream ecosystems, stream restoration is increasingly being used as a strategy to mitigate those impacts. While natural headwater streams and adjacent riparian zones have been identified as hot spots for nutrient removal, the potential for restored systems to achieve similar functions remains unknown. The goal of our research is to analyze the effects of integrated stream and riparian restoration on removal of dissolved nutrients. We compared nutrient retention in 4 agriculturally influenced streams in North Carolina: a restored stream, an incised ditch, a natural stream with a narrow riparian buffer and a natural stream with a wide riparian buffer. We measured the changes in ammonium (NH_4+), nitrate (NO_3-), phosphate (PO_4), total organic carbon (TOC) and total nitrogen (TN) in groundwater from the edge of field to the stream seasonally from Spring 2013 to Fall 2015. Preliminary results show a decreasing trend in dissolved nutrients from edge of field to the stream in restored, ditch and narrow riparian buffer sites. However, at the site with the wide riparian buffer, in-stream concentrations were much greater compared to groundwater suggesting the watershed acts as a source of nutrients. We expect our results to improve understanding of stream-riparian interactions in agricultural systems and aid managers in adopting management and restoration practices.

34 Constraints to response of water quality conservation measures within Western Lake Erie basin.

**Lawrence Sekaluvu, ENR*
Advisor: M. Gitau

Rampant eutrophication and growth of harmful algae blooms are leading to environmental and health issues within the Western Lake Erie basin (WLEB). This study aims to evaluate the challenges to water quality conservation measures within WLEB. The historic patterns and variations in water quality parameters (nitrate, total suspended solids (TSS), and total phosphorus (TP)), precipitation, landuse, streamflows, and agricultural management practices were explored across the basin from 2005 to 2015. The results across the entire basin showed no trend in TSS (0%, p = 0.98), insignificant increases in TP (0.1%, p = 0.51) and nitrate (3.4%, p = 0.33). The median TP concentrations were all above the critical value of 0.1 mg/l. The elevated TP concentration were attributed to legacy TP. Winter precipitation decreased insignificantly by 31% (p = 0.0), significant increase in spring precipitation (76%, p = 0.0), significant decrease in summer precipitation (3.2%, p = 0.63), and non-significant decrease in fall precipitation (20.5%, p = 0.06). Assessment of landuse data showed no significant changes in the past 37 years. The streamflows decreased non-significantly by15 ft3/s (p =0.35), which was attributed to number of dams within the basin. The status of the combined sewer overflow (CSOs) showed that over 40% of CSOs were under non-compliance, while 9% had significant violations. The findings indicated that changes in climate seasons, agricultural management, CSOs, legacy nutrients, and presence of many dams are the challenges constraining the response of water quality conservation measures within the basin.

35 Simulations and Analysis on the Effects of Landscape Pattern Evolution on Runoff and Sediment Based on SWAT Model

Luwen Wan, ENR
Advisor: B. Engel

To reveal the hydrological effects on changes in the landscape pattern, this study simulates the monthly runoff and sediment of the Wuhua River Basin in 1986, 1995, and 2000 based on the SWAT model under the meteorological conditions from 1957 to 2012 and in the context of the landscape pattern, calculates the rate of changes in the runoff during the wet and dry seasons and throughout the year; and examines the relativity between the rate of change in the landscape pattern and that in the runoff and sediment. Results show: First, the SWAT model is applicable to small watersheds in hot and humid mountainous areas of southern China. Second, the percentage of forest land is the highest, whereas that of land for construction is the lowest., insignificant spatial changes exist in the land use type of the River Basin from 1986 to 2000. Third, the landscape of the River Basin under the impact of human activities became fragmented as the spatial heterogeneity increased. Fourth, the uniform fragmentation is the main cause of the runoff reduction and the percentages of open forest land and land for construction may increase the total runoff. Finally, the runoff is more significantly affected by landscape pattern indices compared with the sediment, and the landscape pattern indices affect the runoff in the dry season while in the wet season for sediment.

36 Geologic Mapping Using MASTER Multispectral Data Analysis: A Case Study in Cuprite Area, Nevada, USA

Mohamed Aboelnour, ENR
Advisor: B. Engel

Multispectral MODIS/ASTER Airborne Simulator (MASTER) data covering the visible near/short wave infrared (VNIR/SWIR) and the longwave infrared (LWIR) spectral regions were investigated for the Cuprite area close to southwestern border of Nevada with California. The MASTER data had 25 bands in the VNIR/SWIR region and 10 bands in the

LWIR region and approximately 24-meter spatial resolution. Both spectral regions were geometrically and atmospherically corrected, using the empirical flat field method and the In-Scene- Atmospheric Correction (ISAC) for both VNIR/SWIR and LWIR spectral regions, respectively. Principle Component Analysis (PCA) was applied to the VNIR/SWIR region to better capture the essential information. Preliminary PCA revealed that most of the data variance was in the visible near infrared (VNIR) spectral region. Spectral Angular Mapper Classification (SAMC) was used in the SWIR region to identify the most likely minerals in the Cuprite area. The results indicated that the SAMC was found to achieve a notably high performance with and overall accuracy of 83.13%. Decorrelated Stretched (DCS) images were initially used to highlight spectral difference between geologic materials in the LWIR region. Endmember spectra were extracted from LWIR data using n-dimensional scatterplot. The distribution of these endmembers were then mapped using Mixture-Tuned Matched Filter (MTMF), a partial unmixing approach. The outcomes show a distinct mapping of tuffaceous zones and general correspondence to the regional geology. MASTER dataset exhibit the utility of spectral remote sensing for geologic mapping.

37 Effects of wheat on regulating runoff and sediment on different slope gradient and under different rainfall intensity

Qingtao Lin, ENR
Advisor:

Wheat is one of the common crops that are widely planted all over the world, but its role in regulating runoff and sediments under different slope gradient and rainfall intensity has not been fully understood. This study investigated the effects of wheat at various growth stages on reducing runoff and sediments on different slope gradient and under different rainfall intensity. Six growth stages (include stubble period), five slope gradient and three rainfall intensity were chosen. Four indices were used to assess the capacity of wheat on regulating runoff and sediments in terms of time to runoff(TR), initial loss of rain(ILR), runoff reduction benefit(RRB), sediment reduction benefit (SRB). The results showed that TR or ILR has power function relation with vegetation coverage, slope gradient and rainfall intensity. The effects of wheat on delaying runoff and increasing the initial loss of rain were similar in stubble period and tillering stage. There was a linear function relation between RRB with vegetation coverage, slope gradient and rainfall intensity. The same relation was also founded between SRB with vegetation coverage, slope gradient. But no significant different was founded between SRB with rainfall intensity. Under the conditions of large slope gradient and heavy rain, it is more effective to reduce the runoff and sediment by increasing vegetation coverage. Besides, the increasing of vegetation coverage can decrease the sensitivity of SRB with slope change.

38 Influence of stormwater control measures on hydrology and water quality in a small suburban watershed

Rachel Scarlett, ENR
Advisor: S. McMillan

Healthy streams create vital habitat for aquatic communities and function as essential components of nutrient cycles. Urban streams are being ecologically deteriorated due to increases in impervious area, piped drainage infrastructure, stream straightening and burial, and nutrient loading. The resulting flashy hydrographs, increases in runoff, and degraded water quality in urban areas have immense impacts on aquatic life and eutrophication downstream. These qualities allude to urban stream syndrome, a pertinent and consistent observation across cities. Although urban stream syndrome suggests that urbanized watersheds function as dominant transporters of material and energy to the watershed outlet, there is evidence that urban streams can be transformative ecosystems that process and cycle nutrients in a similar yet distinct manner compared to natural streams. Water retention structures, specifically stormwater control measures (SCMs), facilitate evaporation, slow down runoff to the stream, and increase processing time for nutrients— like phosphorus and nitrogen. While the effects of individual SCMs during baseflow conditions are well known, there is a knowledge gap on how an aggregation of SCMs influences hydrology and water quality during stormflow. My hypothesis is that increases in areal storage volume will drive urban watersheds from primarily water and nutrient transport systems during storms towards transformational systems— where N and P loads are reduced and flashy hydrology is dampened. To test this hypothesis, storm discharge and water chemistry were monitored in high resolution along a gradient of SCM treatment in a small suburban watershed in Charlotte, NC.

39 Understanding and Evaluating Hydrological and Environmental Impacts of Controlled Drainage at the Field Scale Using Observations and Simulated Data

Samaneh Saadat, ENR
Advisor: J. Frankenberger, L. Bowling

Controlled drainage is a management strategy designed to mitigate water quality issues caused by subsurface drainage. To improve controlled drainage system management and better understand its hydrological and environmental effects, this study analyzed water table recession rate, drain flow, nitrate and phosphorus load and surface runoff of both free and controlled drainage systems at the Davis Purdue Agricultural Center located in Eastern Indiana.

Statistical analyses, including paired watershed approach and paired t-test indicated that controlled drainage had a statistically significant effect (p-value <0.01) on the rate of water table fall and reduced the water table recession rate by 29% to 62%. A new method was developed to estimate drain flow during missing periods using Hooghoudt's equation and continuous water table observations. Estimated drain flow was combined with nutrient concentrations to show that controlled drainage decreased nitrate loads significantly ($p<0.05$) by 2.6 kg/ha to 4.4 kg/ha but slightly increased soluble reactive phosphorus and total phosphorus losses through subsurface drainage. These results underscore the potential of controlled drainage to reduce nitrate losses from drained landscapes.

Simulations based on the DRAINMOD field-scale drainage model can increase understanding of the environmental and hydrological effects over a broader temporal and spatial scale than is possible using field-scale data. DRAINMOD will also be used to evaluate the long-term effects of controlled drainage on the surface runoff and ponding, which are not currently measured and may contribute to overall water quality impacts of the practice.

40 OPPORTUNITIES FOR INCORPORATING SUSTAINABILITY AT EACH PHASE OF CIVIL INFRASTRUCTURE DEVELOPMENT

Seyedali Ghahari, Sharlan Montgomery, Tariq U. Saeed, ENR
Advisor: S. Labi

The article explores the opportunities for incorporating sustainability at each phase of civil infrastructure development. These phases include needs assessment, infrastructure planning, design, construction, operation, inspection/monitoring, maintenance and repair, and infrastructure end of life. The article has discussed in detail that sustainability could be incorporated by adopting strategies like minimum reliance on non-renewable resources, maximizing benefit to the society and environment and inducing economic prosperity over the long term, at each phase of development. Moreover, decisions at all phases of infrastructure development need to adequately and explicitly account for environmental, economic, and social consequences of the system at its subsequent phases. Some of the ways for incorporating sustainability in the infrastructure development process include: taking full advantage of intensity and direction of natural elements (sun and wind); use of durable, recycled, locally available or reusable materials; using minimal or renewable natural resources for operating system components; recycling of existing materials on the project; salvage existing materials for reuse; low-maintenance landscaping; and focusing on preventative maintenance measures rather than repair measures. Specifying materials and designs that can be reused, modified and re-purposed, recycled, dismantled, sold, upgraded, or integrated with new systems could make the development process truly sustainable.

41 Self-similarity emerges in growing urban drainage networks

Soohyun Yang, ENR
Advisor: P. Suresh, C. Rao

As urban drainage infrastructure expands in growing cities, how do the topological attributes of the engineered network evolve in time and space? Do optimized engineering practices (central control) or self-organizing principles (distributed controls) have a dominant role in the emergence of urban drainage network topological evolution?

Here, we investigated these questions by exploring the topological evolution of engineered urban drainage networks (UDNs) in three distinct urban areas (Oahu Island, Hawaii; Amman, Jordan; Melbourne, Australia), grown over decades, and compared to well-known evolutionary process in natural river networks. Scaling of UDNs were analyzed in the context of two measures of self-similarity, widely found for river networks: (1) Hacks' law of length-area scaling, and (2) exceedance probability distribution of upstream contributing area. Both power-laws emerge in each city during growth of UDNs.

For the smallest networks, the area-exceedance probability distribution is premature to represent self-similarity. As the networks grow, power-law scaling for the two measures emerges with the exponents tending towards respective 0.6 and 0.4, values observed for mature river networks. The degree of tempered power-law distribution scales with maximum network area within a narrow range (0.8 – 1.1). These results suggest that with increasing network size, urban drainage networks share functional topological attributes with river networks. We conclude that the conglomeration of engineered sub-networks exhibit inevitably self-similar topology, as the urban drainage networks grows to a mature size.

42 Extent of uncertainty in the statistically downscaled climate data

**Sushant Mehan, ENR*
Advisor: M. Gitau

The increase in frequency of extremes events like floods and droughts in different parts of globe has gained the attention of scientist to understand past, present, and future variability in climate at different spatial and temporal scales. The better understanding of climate variability or changes can help the policy makers to decide on implementing the necessary management practices to combat any adversity caused because of climate change, especially ones related to hydrology and crop growth applications. The general circulation models (GCMs) and Regional Climate Models (RCMs) have made it possible to simulate the climate data for more than 100 years at global and regional scale respectively to understand climate change. This study measures the extent of the differences in the simulated climate values from the RCM and observed ground climate data at Fort Wayne, IN from 1950-2005. The simulated projections were statistically downscaled and were ensemble from the most common available 20 RCMs and is available at resolution of 4 km grid. It was observed that the simulated values do not deviate much within different RCMs but was different from the observed data set in terms of different climate indices. Estimating the difference from the observed values will help in devising the strategy to correct the future climate scenarios simulated from the different RCMs, which can be used in different climate change application studies.

43 Using Water Quality Indices for Comprehensive Assessment of Water Quality

Valeria Mijares, ENR
Advisor: M. Gitau

With the growing global concern for water security it has become even more crucial to assess surface and ground waters for quality and ensure that the water meets the requirements for its intended use; for example, that it is safe for human consumption and sanitation, and/or in suitable condition to maintain life for all organisms. Today, a substantial amount of water quality data exists, allowing

analyses of various water quality parameters to determine current status, longterm trends, and even assess water quality impacts of policy decisions. This, however, presents a challenge, even when looking at only a single parameter. Furthermore, different are environmentally significant at different thresholds (e.g., benzo(a)pyrene, a pesticide, at 0.0002 mg/l, and nitrates at 10 mg/l), making it difficult to discern potentially harmful effects based solely on raw data. Water Quality Indices (WQIs) offer a simple and reliable way by which various water quality parameters can be expressed in common units and consolidated into an aggregate value allowing water quality data to be used more effectively. We present our current work with WQIs including their potential for flagging contaminants of concern, predicting potentially harmful conditions, and guiding and assessing prioritization of water management efforts- with particular focus on the Western Lake Erie Basin.

44 Spatial and Temporal Variation in Minimum Inter-event Time over Mainland China

Wenting Wang, ENR

Advisor:

Pluviograph precipitation records include wet periods and dry periods. Minimum inter-event time(MIT) is an index identifying individual rain event from pluviograph records. An event was defined as a duration of rainfall with the dry periods less than MIT. If the dry period in a duration equals or is greater than MIT, the duration was separated into two events. Event characteristics such as amount, duration, mean intensity and peak intensity are closely related to the MIT. Exponential distribution was used for more than 2000 stations with hourly precipitation data to obtain MIT for the rainy season (May to Sep.) over mainland China. The seasonal variations of MIT for stations in the southern part of China were also presented because stations in the northern part stopped the siphon type observation due to the snow in the cold season. Twenty-four climatology regions were divided. Results showed that for the rainy season, (1) MIT varied from 7 hr to 17 hr among 24 meteorological regions; (2) MIT were increasing from spring through autumn for the most southern regions; (3) MIT could be partly responsible for the difference of event characteristics for the difference of event characteristics from different places when they were compared.

45 The Effects of Rainfall And Irrigation Water on Cherry Water Uptake under Drip Irrigation System

Xiaoqing Cao, ENR

Advisor: Y. Peiling

The effects of rainfall and irrigation quota on cherry root water uptake were estimated by the direct inference method and the multi-source mass balance method (IsoSource model). In this study, the stable hydrogen and oxygen isotopes (δD and δ18O) of soil water, xylem sap, rainfall and irrigation water (local groundwater) in the cherry orchard using drip irrigation system were measured during 2015-2016. Then it analyzed the distribution characteristics of δ18O in soil water at the profile and proportion of the root water uptake from different soil depths and irrigation water under three irrigation treatments (T_1, T_2 and T_3, i.e. 70%, 85% and 100% of designed irrigation quota). Results showed that, the value of δ18O in soil water at the profile had better response to rainfall and was positively linked with the irrigation quota; Rainfall and irrigation both promoted significantly cherry root to access to soil water at more shallow depth; The proportion of water sources in cherry root were varied remarkably in different growth stages. With a comprehensive consideration of the characteristics of cherry water uptake and rainfall during the whole growth period in Beijing, the optimal water regulation treatment was 100% of irrigation quota before the end of hard drupe stage, 85% at the harvesting stage and 70% during the end of growth period. It can not only meet the water requirement of cherry but also improve the use efficiency of rainfall and irrigation water.

46 Orthomosaic Multispectral Imagery from UAS and Sorghum Genotypes Classification

Yan Zhu, ENR

Advisor: K. Cherkauer

Providing food and fuel for a fast growing population has become a serious concern globally. Over the last several decades, remote sensing has continued to develop as an efficient technique to help with crop management and irrigation scheduling. This includes a recent shift from more traditional sources such as manned airborne and satellite platforms to unmanned aircraft systems (UAS). The emergence of UAS technology provides the opportunity to monitor crops in much more optimal spatial, spectral and temporal resolutions. In this project, 662 multispectral images were acquired from an UAS platform over a sorghum field in agronomy center for research and education (ACRE) of Purdue University. Original images have various distortions because of the motion of the aircraft and other factors. In order to run Hseg algorithm for genotypes classification, orthomosaic of these images were created for each band and they were stacked together. After processing these images, Hseg algorithm was able to be conducted to find which genotypes of sorghum have distinct spectral characteristics compared with others.

47 Hydrologic trends in the Orinoquia Basin

Johann Vera, ENR

Advisor: B. Engel

Detection of trends in hydrologic, climate change, water quality, and other natural time series has received great use to assess the potential impact of climatic change and variability on hydrologic time series in various parts of the world. There are huge varieties of hydrological data that it is possible to analyze for trend and step change. Climatic variability is reflected in hydrologic data and can adversely affect trend test results.

Trends and variability in the hydrological regime will be analyzed for the Orinoquia Basin in Co-lombia. Ten IDEAM gauging stations inside of the Orinoquia basin with more than 20 years of streamflow and precipitation records that will be evaluated. Trends will be computed for

selected streamflow statistics to include maximum, medium and minima, precipitation annual series by using Linear Regression and the Mann-Kendall test, which is widely used to detect trends in hydrologic data. The series will be analyzed for trends to identify changes in the streamflow regime, to determine any statistically significant changes in annual minima and evaluate the role of local land use change relative to local climate change and watershed features, to analyze trends be-tween precipitation and streamflow.

The expected results are that there will be changes in flood frequencies and increases in runoff due to increased precipitation or other factors such as agricultural, land use change and industrial developments that affect hydrological variables. This will help decision makers with better plan-ning decisions in the Orinoquia Basin and potentially has application for similar watersheds.

48 Kinetic energy distribution of high volume big gun sprinkler

Maosheng Ge, ASH
Advisor:

The big gun sprinkler works on high flow rates as well as concentrated kinetic energy, which may leading to the disaggregation and mobilizing of soil particles. The high operating pressure of sprinkler gun also contributes to the high energy consumption to the irrigation system, especially when applied to hard hose travelers. In this study, a commercial big size vertical impact sprinkler was used to conduct an outdoor experiment and raindrop spectrum data were tested using a two-dimensional video distrometer and a kinetic energy distribution calculation model was built. Results show that the operating pressure of big gun sprinkler should not be less than 0.2MPa since the peak value of specific power will rise rapidly and the risk of soil erosion will increase significantly. Comparing with the spray plate sprinklers utilized in center pivots, the big gun sprinkler shows a milder precipitation process, but the precipitation lasts longer and carries more kinetic energy, reaching 2-4 times for the same amount of water. The infiltration rate under big gun sprinkler decreases linearly with the increase of the distance from the travel lane. At the end zone of the spray area, the infiltration rate falls to 20mm / h , indicating a high risk of ponding and runoff.

49 Methodology for Identification of Pore Forming Antimicrobial Peptides from Soy Protein Subunits β-conglycinin and Glycinin

Ning Xiang, ASH
Advisor: G. Narsimhan

Antimicrobial peptides (AMPs) inactivate microbial cells through pore formation in cell membrane. Because of their different mode of action compared to antibiotics, AMPs can be effectively used to combat drug resistant bacteria in human health. AMPs can also be used to replace antibiotics in animal feed and immobilized on food packaging films. In this research, we developed a methodology based on mechanistic evaluation of peptide-lipid bilayer interaction to identify AMPs from soy protein. Production of AMPs from soy protein is an attractive, cost-saving alternative for commercial consideration, because soy protein is an abundant and common protein resource. This methodology is also applicable for identification of AMPs from any protein. Initial screening of peptide segments from soy glycinin (11S) and soy β-conglycinin (7S) subunits was based on their hydrophobicity, hydrophobic moment and net charge. Delicate balance between hydrophilic and hydrophobic interactions is necessary for pore formation. High hydrophobicity decreases the peptide solubility in aqueous phase whereas high hydrophilicity limits binding of the peptide to the bilayer. Out of several candidates chosen from the initial screening, two peptides satisfied the criteria for antimicrobial activity, viz. (i) lipid-peptide binding in surface state and (ii) pore formation in transmembrane state of the aggregate. This method of identification of antimicrobial activity via MD simulation was shown to be robust in that it is insensitive to the number of peptides employed in the simulation, initial peptide structure and force field. Their antimicrobial activity against Listeria monocytogenes and Escherichia coli was further confirmed by spot-on-lawn test.

50 Effects of dietary crude protein reduction on ammonia and hydrogen sulfide emissions from a research swine building in Indiana

Shule Liu, ASH
Advisor: J. Ni

Ammonia (NH_3) and hydrogen sulfide (H_2S) are two of the major pollutant gases in animal agriculture. To understand the dynamic emission profiles of NH_3 and H_2S emissions from pig production, reduced dietary crude protein (CP) with amino acid (AA) supplementation was studied with 720 pigs in a 12-room research building for 147 days that covered weaned to finishing stages. The pigs were divided into three 4-room groups and fed with 2.1% – 3.8% reduced CP (T1), 4.4 – 7.8% reduced CP (T2), and standard (control) diets, respectively. Group-mean NH_3 emission from the control group was 68.9 g d-1 AU-1 (AU = 500 kg live mass). That from T1 (46.7 g d-1AU-1) and T2 (29.8 g d-1AU-1) were reduced by 32.2% and 56.7% ($p < 0.05$), respectively. Group-mean H_2S emission from the control group was 3.96±3.00 g d-1 AU-1; and that from T1 (4.37 g d-1AU-1) and T2 (5.42 g d-1AU-1) were increased by 10.3% and 36.9% ($p < 0.05$), respectively. The dynamic peak NH_3 emissions were observed during the earlier experimental stage than the peak H_2S emissions. The dietary treatment of CP-reduction and AA supplementation had significant effects on the manure pH, and subsequently, the NH_3 and H_2S emission rates. This study suggested that the dietary composition played too important a role on manure properties to be neglected in any attempts to investigate emission source strength, quantify and model the emission, or compare with other studies.

51 Green Synthesis of Stevia Based Nanoparticles

Muhammad Farhan Jahangir Chughtai, FOOD
Advisor: I. Pasha, J. Irudayaraj

Metal nanoparticles (NPs) are being increasingly used in many sectors of the economy, there is growing interest in the biological and environmental safety of their production. The main methods for nanoparticle production are chemical and physical approaches that are often costly as well as harmful to the environment. In

recent years, plant based nanoparticles emerged as an efficient, inexpensive and environment friendly method for nanoparticles production. Greener synthesis of nanoparticles provides advancement over other methods as it is simple and of results in more stable materials. These syntheses have led to the fabrication of limited number of inorganic nanoparticles. Plant based materials seem to be the best candidates and they are suitable for large-scale 'biosynthesis' of nanoparticles. Plant leaves, root and stem are being used for metal nanoparticle synthesis. Stevia rebaudiana is herbaceous perennial South American plant. Stevia leaf powder and extracts are used in variety of food stuffs worldwide as natural zero caloric intense sweeteners having numerous beneficial effects on human health including antidiabetic, antihypertensive, antimicrobial effect, glucose metabolism, etc. Stevia can be a good alternative for the preparation of nanoparticle with minimal harmful impacts by providing stability and safety. The main sweet components, steviol glycosides in the leaves have the ability to reduce of silver & gold ions and also act as natural stabilizers of synthesized NPs. Ag and Au NPs are excellent in providing powerful platform in biomedical applications of biomolecular recognition, bio-sensing, drug delivery, molecular imaging, colorimetric determination of microbes, heavy metal in aqueous solutions.

52 Shear-thickening Behavior of Gelatinized Waxy Starch Dispersions

**Fang Fang, FOOD*
Advisor: O. Campanella, B. Hamaker

Shear-thickening, smooth or discontinuous, is an increase in viscosity with increasing shear rate which is observed in a variety of complex fluids containing polymeric molecules. After gelatinization, starch dispersions usually exhibit shear-thinning behavior; however, we observed that gelatinized waxy corn and potato starch dispersions exhibit shear-thickening behavior around 20 s-1, a phenomenon that was not observed in gelatinized waxy wheat and rice starch dispersions nor in normal starches.

Rheology was used to further investigate this phenomenon. Shear-thickening was observed in gelatinized waxy potato starch from 10 to 50°C, and in gelatinized waxy corn starch at temperatures lower than 15°C. After storage of gelatinized starch dispersions for 2 h, 1, 2 and 7 days at 4°C, the shear-thickening behavior of the waxy corn starch sample, measured at 4°C, did not appreciably change. Conversely, the shear-thickening behavior disappeared for the waxy potato starch dispersion after 7 d storage. Viscoelastic tests on waxy corn and waxy potato starch using increasing temperature ramps (25-95°C) showed gradual increases in the phase angle indicating a transition to a more fluid behavior. The phase angle changed less in the waxy wheat starch sample and hardly changed in the waxy rice starch dispersions.

Given the importance of the food viscosity on the digestion of foods, results of this research should help to understand how viscosity in the presence of shear affects the digestion process of starchy foods. The impact on the processing of starchy foods as well as their textural properties should be also considered.

53 Effect of Anisotropic Forces on Powder Flow Properties

Camila Jange, FOOD
Advisor: K. Ambrose

Powder flow properties are crucial parameters in handling and processing operations, including transportation, mixing, compression and packaging. Interparticle forces, highly dependent on surface properties of particles, may impact the bulk flow behaviour. van der Waals, electrostatic and capillary forces are the possible interparticle interactions that could exist between particles. The aim of this study is to minimize the interference of shape and size effects on dry cohesive powders to understand solely the relation between interparticle interaction and flowability. Samples of silica beads with size range of 125 µm, 180 µm and 250 µm were coated with corn starch, molasses, butter and gluten to reproduce the cohesive effect on regular food grade products. Shear and dynamic flow property measurements were performed using the FT4 Powder Rheometer and particle size and shape characteristics were determined using Morphology G3-ID. No significant differences were found between the control (uncoated) and surface modified specimens in respect to size and shape characteristics. An increment in specific energy followed by a decrease in basic flow energy values were observed for surface modified systems with C=O and S=O bonds, respectively, 3.00 ± (0.02) and 1020.00 ± (7.00), as compared to the control, 2.58 ± (0.09) and 112.13 ± (13.72), respectively. Overall, surface modified samples presented lower flow factor and higher cohesion index as compared to the control group. These results possibly prove surface composition to be the main factor affecting interparticle interaction in dry cohesive powders.

54 Model for Prediction of Swelling Kinetics of Waxy Maize Starch

Gnana Prasuna Reddy Desam, FOOD
Advisor: G. Narsimhan

Starch pasting behavior greatly influences the texture of a variety of food products such as canned soup, sauces, baby foods, batter mixes etc. The annual consumption of starch in the U.S. is 3 million metric tons. It is important to characterize the relationship between the structure, composition and architecture of the starch granules with its pasting behavior in order to arrive at a rational methodology to design modified starch of desirable digestion rate and texture. In this research, polymer solution theory was applied to predict the evolution of average granule size of starch at different heating temperatures in terms of its molecular weight, second virial coefficient and extent of cross-link. Evolution of granule size distribution of waxy native maize starch when subjected to heating at constant temperatures of 65, 70, 75, 80, 85 and 90 C was characterized using static laser light scattering. As expected, granule swelling was more pronounced at higher temperatures and resulted in a shift of granule size distribution to larger sizes with a corresponding increase in the average size by 70 to 100% from 13 µm to 23-26 µm. Most of the swelling occurred within the first 10 min of heating.The structure of waxy maize starch was characterized by cryoscanning electron microscopy. Experimental data of average granule size vs time at different

temperatures were compared with model predictions.

55 Prediction of Swelling Kinetics of Maize and Rice Starch

*Jinsha Li, FOOD
Advisor: G. Narsimhan

Starch pasting behavior greatly influences the texture of food products such as canned soup, baby food, etc. The annual consumption of starch in the U.S. is 3 million metric tons. The overall goal of this investigation is to characterize the relationship between pasting behavior of starch and its structure and composition. In this research, evolution of granule size distribution of waxy native maize starch when subjected to heating at constant temperatures of 65 to 90°C was characterized using static laser light scattering. As expected, granule swelling was more pronounced at higher temperatures and resulted in a shift of granule size distribution to larger sizes with a corresponding increase in the average size from 12 µm to 23-26 µm. Most of the swelling occurred within the first 10 min. Pasting behavior of waxy maize and rice at different temperatures was also characterized from the measurements of G' and G" for different heating times. While G' was found to increase with temperature and decreased at larger holding times, G'' was insensitive to both conditions. Polymer solution theory was applied to predict the evolution of average granule size of starch at different heating rates in terms of its molecular weight, second virial coefficient and granule elasticity and compared with experimental data. The results from this investigation will build connection between the structure, composition and architecture of the starch granules and its pasting behavior in order to arrive at a rational methodology to design modified starch of desirable rate of digestion and texture.

56 Microbial Inactivation and Quality Retention in Orange Juice Treated by High Voltage Atmospheric Cold Plasma

Lei Xu, FOOD
Advisor: B. Tao

Although multiple studies have demonstrated atmospheric cold plasma as an effective non-thermal technology for eliminating bacteria, spores, and biological contaminants from food and non-food surfaces, few examine the application of this technique to liquid food within a package. This study explores the decontamination efficiency of high voltage atmospheric cold plasma (HVACP) on Salmonella entericaserovar Typhimurium (S. enterica) in orange juice (OJ) and evaluate its effect on the physical and chemical properties. Both direct and indirect HVACP treatment of 25 ml OJ induce greater than a 5 log reduction in S. enterica at 30 s with air and MA65 gas with no storage. For 50 ml OJ, 120 s of direct HVACP treatment followed by 24 hours storage induced a 2.9 log reduction of S. enterica in air and a 4.7 log reduction in MA65 gas. No significant ($P<0.05$) brix or pH change occured following 120 s HVACP treatment. The concentration of total vitamin C decreased by 56% after 120 s HVACP direct treatment in 25 ml air packed OJ compared with untreated OJ. Applying 120 s HVACP direct treatment reduced pectin methylesterase activity by 74% in air and 82% in MA65. Results from optical emission and absorption spectroscopy indicated the reactive gas species present when the HVACP induced microbial and enzyme inacitvation while retianing OJ quality. In summary, our results demonstrate that HVACP can be an effective non-thermal technology for controlling, or potentially eliminating, Salmonella in OJ with minimum quality alteration.

57 Synergistic Effect of Low Frequency Ultrasonication and Antimicrobial Action in Deactivation of Escherichia coli

Maya Fitriyanti, FOOD
Advisor: G. Narsimhan

The purpose of this research is to evaluate the synergistic effect of the naturally occurring antimicrobial peptide (AMP) and low frequency ultrasonication against gram negative bacteria, Escherichia coli. Low frequency ultrasonication is a non-thermal method of food preservation that has the advantage of inactivating bacterial cells without no adverse effect on food texture compare to conventional heat treatment. Antimicrobial peptides kill bacteria by pore formation in cell membranes, thus transient pores formed by low frequency ultrasonication should result in enhancement of antimicrobial activity. Deactivation of E. coli in milk (2% fat) and PBS (Phosphate-Buffered Saline) medium enriched with 5% and 10% milk (2% fat) were conducted in simultaneous treatment using AMP from pig intestine, Cecropin P1 (25 µg/ml), and low frequency ultrasound (40 W and 60 W; 20 kHz) for 15 minutes, 30 minutes, and 60 minutes. In the absence of Cecropin P1, low frequency ultrasonication treatment at a power level of 40 W resulted in a very small effect on reduction of cell density of E. coli. However, at a higher power level of 60 W, a dramatic decrease in cell density was observed which implied cell lysis. Significant synergistic effect of Cecropin P1 and ultrasonication was found at higher power level (60 W) and longer ultrasonication treatment (60 minutes). A dramatic decrease in 2 orders of magnitude in cell density was observed for ultrasonication in the presence of 25 µg/ml of Cecropin P1 compared to either ultrasonication alone or AMP action alone.

58 Free energy of pore formation by aggregates of melittin in DOPC/DOPG mixed lipid bilayer by molecular dynamics simulation

Yuan Lyu, FOOD
Advisor: G. Narsimhan

Antimicrobial peptides (AMP) inactivate microorganisms by forming pores in cell membrane through adsorption and aggregation. Energetics of addition of an AMP to a transmembrane pore is important for evaluation of growth of pores. This study characterizes the potential of mean force through molecular dynamics (MD) simulation for the addition of melittin, a naturally occurring AMP, into a DOPC/DOPG mixed bilayer for different extents of penetration into either a bilayer or a pore consisting of three to six transmembrane peptides. Water channel formation occurred only for insertion into pores consisting of four or more transmembrane peptides with the radius of water channel being larger for larger number of transmembrane peptides. The energy barrier for insertion of a melittin molecule into DOPC/DOPG lipid bilayer was highest in the absence of transmembrane peptides and decreased for number of transmembrane peptides

from three to six, eventually approaching zero. Estimated free energy barrier for insertion of melittin into an ideal paraboloid pore accounting for different intermolecular interactions were consistent with MD simulation results.

59 Camel milk: Benediction to combat Food Security

Adnan Khaliq, FOOD
Advisor: T. Zahoor, J. Huang

Camel is the nature's incredible creature for the nomads and pastoralists in the different parts of the world due to its adaptability in harsh conditions. Camel milk is nutritionally balanced in all aspects and is considered as nature's pharmacy for the masses owing medicinal and threpeutic characteristics. The camel maintains its milking potential in the stridulous climate where others livestock survival is unthinkable. Compositionally camel milk contains three times more Vitamin C as compared to bovine milk, which acts as antioxidant and also meets the nutritional requirements of peoples in hot and arid environments. Camel milk owns remarkable anti-diabetic potential contains 52 units insulin per litre. Globally, most of the camel milk is utilized in fresh form by the camel rearing peoples to fulfil their needs. The trend of human population increasing so briskly that it would be increased 35 % in 2050. This increasing trend in human population not only paying stress on already available food resources but also becoming threat of food security day by day. In this situation we have to explore the new food resources and camel milk is one of the greatest and valuable tool to combat this situation. If we figure out a way for the proper marketing and processing for the camel milk we are not able to combat the food security problem also able the new horizon's for the food to meet the population needs.

60 Increased production efficiency and reduced environmental impact through use of intelligent and efficient autonomous agricultural vehicles

Gabe Wilfong, MACH
Advisor: J. Lumkes

Autonomous and intelligent agricultural vehicle technologies have an opportunity to improve and transform conventional farming. In the years to come, the global population will require more food than ever before. Increased production efficiency is necessary to meet these demands while adhering to regulations on emissions and environmental impact. In the future autonomous agricultural vehicles will be used for various tasks such as intelligent weeding, targeted microspraying of fertilizing and pesticide, irrigation, planting, harvesting, and transportation. By modeling the functions and tasks of a robotic vehicle, along with crop behavior, the production efficiency in terms of crop yield per unit resource (human capital, energy input, time in field, environmental impact, water, etc.) can be calculated and compared to conventional farming techniques.

61 Hydraulic Hybrid Transmissions for On-highway Vehicles

**Pranay Banerjee, FP*
Advisor: M. Ivantysynova, S. Zak

Closed-circuit hydrostatic transmissions have been in use in many off-highway vehicles due to their stiff response and controllability that ensures good drivability. However, conventional hydrostatic transmissions lack energy storage. Connecting a high-pressure accumulator to the system allows energy storage and re-use, however it makes the system and the system control more complex. This work focuses on the design and control of a hydraulic hybrid architecture named the "Mode-Switching Hydraulic Hybrid" that combines the advantages of both the approaches for an on-highway vehicle. A four liter V8 Range Rover was selected as a prototype for the implementation of this concept. The transmission is sized based on a methodology that combines optimal efficiency sizing using dynamic programming and maximum performance sizing using dynamic simulations. A packaging architecture is designed using CAD modeling and implemented on the prototype vehicle. Next, a control strategy is developed that uses driver inputs and the current state of the vehicle to generate control inputs that allow the vehicle to operate in different modes like hydrostatic driving, secondary control mode, coasting, and regenerative braking mode. On-road measurements and simulation are compared for a standard drive cycle. The results are promising and show that the mode-switching hydraulic hybrid improves average fuel consumption rate by 25.51% for a 275 bar baseline control strategy. Current and future work will focus on developing control for aggressive driving and a better power management.

62 Unleashing the Health Benefits of Soy Proteomics as a Functional Ingredient

Samreen Ahsan, BE
Advisor: T. Zahoor, A. Ardekani

Plausible health benefits of soy proteomics as a nutraceutical and functional food has been well documented over the years. Soy protein fragments as 7S globulin along with β-conglycinin and 11S globulin which helps in treatment of many diseases like cardiovascular, cancer, obesity and diabeties.Soy is considered as poor's meat among all the others proteins sources and provides more options for food variety through value addition . The most important means to investigate proteomics are matrix-assisted laser desorption/ionization time-of-flight (MALDI-TOF-MS), two-dimensional polyacrylamide gel electrophoresis (2D-PAGE) and liquid chromatography mass spectrometry (LC-MS/MS). These tools are paramount practices for authentic perceiving and screening changes in composition of protein. 2D-PAGE characteristics of the protein components when established by MALDI/TOF showed preponderance breakdown of major components 7S and 11S globulin subunits. These proclamations indicate differences in the protein composition during clinical studies of soy products. It is proposed that standardization should be augmented before products are assessed for clinical studies.

63 Design and Implementation of a flywheel test rig for accelerated endurance testing of positive displacement machines.

**Mayo Olasubulumi, FP*
Advisor: M. Ivantysynova

This project involves the development of a test rig to conduct accelerated endurance tests of positive displacement machines. Two axial piston machines are tested

under extreme conditions, with periodic varying loads. An electric motor is used to drive the pump unit, which generates fluid flow to the motor unit. These varying load conditions are achieved by involving a flywheel, which the motor unit accelerates, from zero to maximum speed in a short time.

The desired acceleration of the motor is attained by controlling the displacement of the pump unit, and the motor is controlled to decelerate to zero, once it reaches its top speed. The motor is then accelerated in the opposite direction to its maximum speed and back to zero. This cycle is repeated continuously until a fault is detected with either units being tested.

The hydraulic system is modelled using Matlab Simulink® to determine appropriate operating cycles and flywheel size to be used for the test, and Solidworks® is used in designing test rig components. A control and data acquisition program, developed using LabVIEW, is used to control the test rig's operation. The autonomous operation of the test rig makes the implementation of a comprehensive safety system a very important factor, in designing the test rig and its control program. Fault detection is implemented using acquired data from pressure, temperature, speed and displacement sensors mounted at strategic locations in the system and a corresponding shutdown procedure, depending on the developed fault, is executed.

64 An Approach for Control and Diagnostics for Electro-Hydraulic Machines: the Case of a Hydraulic Crane

Riccardo Bianchi, FP

Advisor: A. Vacca

This study proposes a control approach for load handling hydraulic machines that combines control features with system diagnostic functions. The machine under study is a hydraulic crane for truck applications equipped with an independent metering valve block. The hydraulic system is Load Sensing (LS) type and the meter-in valve is post compensated, therefore the actuation speed is proportional to the opening of the meter-in valve. In this system, the meter-in valve is directly controlled according to the operator command. A suitable control needs to be defined for the discharge valve. The control proposed in this poster is a feedback control based on a PID regulator; the feedback signal is the pressure of the inlet side of the linear actuator. The gains of the PID regulator were defined through an Extremum Seeking (ES) optimization algorithm to achieve optimal performance in different operating conditions. The cost functions were defined so as to avoid the cavitation in the inlet side of the actuator, but at the same time maximize the energy efficiency. The hardware (electronic control unit, sensors) which is used for electronic controls can be exploited to implement a Prognostics and Health Management (PHM) system which can increase the reliability and the safety of the system. The combination of control and diagnostics/prognostics features can make the electronic solution more appealing for the OEMs.

X Sequential Aldol Condensation and Hydrodeoxygenation of Cellulose Fast-Hydropyrolysis Vapors for the Formation of Fuel-Range Hydrocarbons

**Richard Caulkins, BIOE*

Advisor: F. Ribeiro

H2Bioil is a process which has been proposed for the transformation of biomass feedstocks into liquid fuels in which biomass undergoes fast hydropyrolysis to form a vapor rich in highly oxygenated products. This vapor stream can then be upgraded over a downstream catalyst bed to form hydrocarbons appropriate for use as liquid fuels. A PtMo bimetallic catalyst has been developed to perform full hydrodeoxygenation (HDO) of highly oxygenated pyrolysis products into higher energy density hydrocarbons over a range of hydrogen pressures from 1 bar to 25 bar. However, the current process yields high selectivity towards products which are unsuitable for use in fuels. Pyrolysis of cellulose and poplar followed by HDO over 5% PtMo supported on multiwalled carbon nanotubes (MWCNTs) in a cyclone reactor at 25 bar H2 yielded 25.8% and 27.4% carbon selectivity towards products in the C1–C4 range, respectively. A Cu/TiO2 catalyst has been studied for the aldol condensation of both cellulose pyrolysis vapors and model compounds for cellulose pyrolysis vapors such as butanal and glycolaldehyde. We show that in a microscale pulse reactor, a dual-bed catalyst system incorporating both Cu/TiO2 and PtMo/MWCNTs is capable of significantly increasing process selectivity towards gasoline-range hydrocarbons with a cellulose feed. We show that although significant carbon is lost to coke formation and decarbonylation at low hydrogen pressures, operating at hydrogen pressures of 25 bar prevents these carbon losses. Future work will extend these experiments to intact biomass on a continuous-flow reactor.

X Temperature Dependent Cellulase Adsorption on Lignin from Sugarcane Bagasse

**Antonio Santos, BIOE*

Advisor: M. Ladisch

Sugarcane bagasse was pretreated in liquid hot water at 190°C for 20 min and then digested using either dilute acid or cellulolytic enzymes and ß-glucosidases from Trichoderma reesei and Aspergillus niger. The resulting lignin-rich solid fractions were incubated at either 30 or 45°C with cellulases and ß-glucosidase in order to measure enzyme adsorption. At 30°C adsorption was small for exoglucanase and insignificant for endoglucanase and ß-glucosidase for enzyme treated lignin. At 45°C the acid digested lignin adsorbed 40 to 80% of the enzymes, while enzyme digested lignin was significantly less with, except for exo-glucanase, 10% or less of the enzyme activity being adsorbed. Physical and chemical analysis showed that acid digested in comparison to enzyme-digested lignin, had higher lignin content, smaller particle size, larger surface area, and a greater hydrophobic character resulting in larger extents of enzyme adsorption at 45°C. These differences are eliminated if lignin solids are contacted with cellulolytic enzymes at 30°C, where adsorption is minimal for enzyme digested, pretreated sugarcane bagasse. These results point to changes in the chemistry of the lignin during hydrothermal pretreatment as a major cause for protein adsorption. Previous report shows decreases in adsorption may occur by diluting the enzyme with other proteins that block lignin from adsorbing

cellulases. The current work shows an alternate strategy would be to simply carry out enzyme hydrolysis at 30°C, instead of 45°C, and thereby avoid non-productive binding of the cellulolytic enzymes on lignin.

X **Numerical Modelling of Gerotor Units**

**Matteo Pellegri, FP*
Advisor: A. Vacca

Gerotor units are the cheapest yet most reliable pumps available on the market. Trial and error methods have been common means for the creation of new units, preventing companies from exploring a wider range of possible solutions. The advent of fast computers and advanced modelling techniques has given the chance for researchers to create simulation tools which can exploit the full potential of novel design procedures.

The main focus of this research consists of development of an omni-comprehensive simulation model that can take into account several key aspects of this type of machines starting from the geometry generation and ending with an in-depth analysis of its fluid dynamic behavior.

The final goal of the research is to create a tool that can be used by researchers and designers to identify the best possible machine for a certain application as well as finding novel and unconventional designs through virtual prototyping.

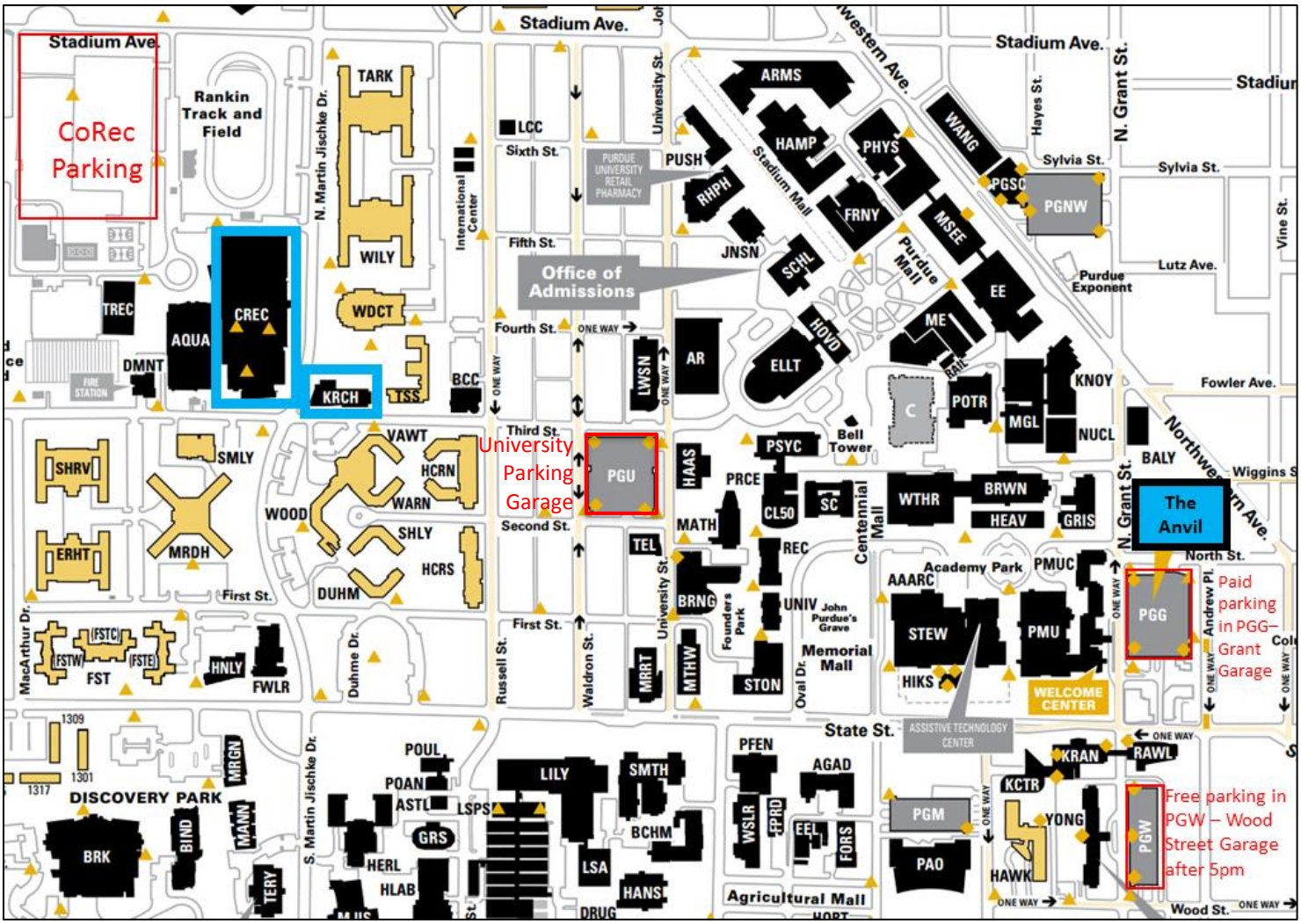
X **Investigation into the Effects of Temperature Probe Orientation on the Purdue Swine Cooling Pad**

**Darren Seidel, ASH*
Advisor: R. Stwalley

Heat stress in livestock production consistently alters several commercial aspects within the agricultural industry. Reproductive efficiency and variability, growth performance, and carcass merit are a few of those factors. Ultimately, the agricultural research community has been investigating technologies to combat the effects of heat stress to increase commercial productivity and general animal husbandry. This research project investigates the effect of the temperature probe orientation of a Swine Cooling Pad developed at Purdue University through departmental collaboration between Agricultural and Biological Engineering and Animal Sciences. The current purpose of the Purdue Swine Cooling Pad is to reduce heat stress on sows pre- and post-farrowing, and during lactation stages. The original design expresses a temperature probe orientation in a horizontal manner in which the probe's tip, where temperature data is collected, does not contact directly with the unit's platform plate. The platform plate is where the sow is laying during testing and the main component of heat transfer between the sow's warmer body temperature and the cooler groundwater running through internal copper coil system. One of the main points of interest in this Swine Cooling Pad research investigation is accurately expressing the heat transfer from the sow to the copper coil system and obtaining accurate temperature data in real-time. Several varieties of temperature probe orientations were proposed while trying to keep every other aspect of the Swine Cooling Pad the same. With the end goal being able to identify which temperature probe orientation offers the most accurate and precise data relative to known values and which orientation is the most feasible with the commercialization process for the research stakeholders.

Purdue Campus Map with Symposium Locations Highlighted

KRCH – Krach Leadership Center, 1198 Third Street
CREC – The CoRec, France A. Córdova Recreational Sports Center, 355 N. Martin Jischke Dr.
The Anvil – 320 North St., West Lafayette, IN 47906



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