THE DEPARTMENT OF

Agricultural & Biological ENGINEERING

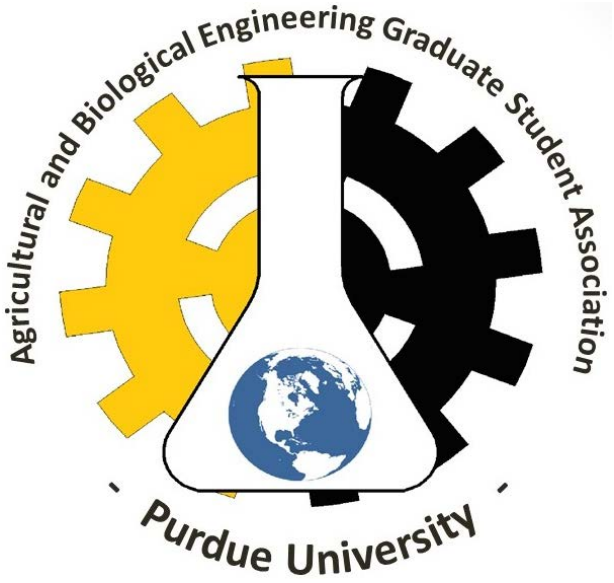
AT

PURDUE UNIVERSITY

PRESENTS:

THE 2ND ANNUAL ABE GSA INDUSTRIAL RESEARCH SYMPOSIUM

Thursday February 26, 2015



PROCEEDINGS OF THE 2nd ANNUAL ABE GSA INDUSTRIAL RESEARCH SYMPOSIUM

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Department of Agricultural & Biological Engineering
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Purdue University

SYMPOSIUM ORGANIZERS

Symposium Chair:
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Iman Beheshti Tabar
Jinsha Li

Session Chairs:

Session	Student Chair	Faculty Chair
Environmental & Natural Resources Engineering #1	Caroline Hughes	Dr. Jane Frankenberger
Environmental & Natural Resources Engineering #2	Colin Bell	Dr. Sara McMillan
Biological and Food Process Engineering	Chinmay Joflekar & Yi Cui	Dr. Martin Okos
Bio-Energy	Neal Hengge	Dr. Nathan Mosier

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Andi Hodaj

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Colleen Moloney
Rachel Sparks

Recruitment Weekend Liaison:
Elizabeth Hawkins

Faculty Chair:
Dr. Abigail Engelberth

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

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

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

Location– DLRC, MJIS, & ADM Agricultural Innovation Center

9:00 am – 9:30 am	**Registration and presentation set-up DLRC Atrium on the 1st fl.**		
9:30 am – 10:50 am	Morning Session I	**Environment and Natural Resources #1 – DLRC 228**	**Biological and Food Processes – MJIS 2001**
		Hodaj: Two-stage ditch to reduce nitrogen loads **Wallace:** Climate Change Effects on Agricultural Watersheds **Bell:** Urban storm water controls **Bampoh:** Aquatic pollutants of emerging concern	**Wu:** Anti-listerial activity of Melittin Peptide **Ku:** Rapid Salmonella Detection **Xiang:** Antimicrobial peptide from Soy Protien **Eren:** DLS data Analysis for food applications
11:00 am – 12:30 pm	Morning Session II	**Environment and Natural Resources #2 – DLRC 228**	**Bio-Energy MJIS 2001**
		Hearst: Remote Sensing Crop Canopy **Guo:** Modeling Biomass Crop growth **Feng:** Modeling Crop Rotation Patterns **Hughes:** Effects of Controlled Drainage	**Ha:** Glioblastoma Lipidomic Analysis **Zhang:** Degradation of Glucose with Maleic Acid **Pack:** Image analysis of pavement cell morphogenesis **RedCorn:** Lactic Acid Optimization
12:30 pm – 12:50 pm	**Break**		
12:50 pm – 2:00 pm	**Plenary Speaker and Lunch – DLRC 131 Daniel J. Hasler -- President and Chief Entrepreneurial Officer of Purdue Research Foundation**		
2:00 pm – 3:00 pm	**Break**		
3:00 pm – 5:30 pm	**Poster Session – DLRC 131**		
5:30 pm – 6:00 pm	**Break**		
6:00 pm – 8:00 pm	**Keynote Speaker and Dinner – ADM Center Dr. Maureen McCann -- Professor of Biological Sciences Director of the Energy Center at Purdue, Discovery Park Director of the Center for Direct Catalytic Conversion of Biomass to Biofuels**		

SYMPOSIUM GUEST SPEAKERS

Plenary Speaker:

Daniel J. Hasler (Dan) was named President and Chief Entrepreneurial Officer of Purdue Research Foundation in February 2013. His responsibilities include supervising Purdue University's entrepreneurial and technology transfer activities to drive the life-changing innovations of Purdue's many researchers through commercialization and to the benefit of the public.

Previously, Hasler served as the Secretary of Commerce for the State of Indiana and Chief Executive Officer of the Indiana Economic Development Corporation (IEDC).

He has an extensive 31-year career at Eli Lilly and Company, a Fortune 500 global pharmaceutical company headquartered in Indianapolis. While at Eli Lilly, Hasler served in a number of leadership positions, most recently as vice president for global marketing, responsible for the commercial strategy and market performance of Lilly's pharmaceutical portfolio. He also was the chief marketing officer for Eli Lilly USA. Prior to that, he led the commercial operations of Eli Lilly's largest European group for three years and was general manager and president of Eli Lilly of Brazil LTD. In 2010, Hasler was the recipient of the Lilly Lifetime Achievement Award.

A native of Paris, Illinois, Hasler is a graduate of DePauw University and has a Master of Business Administration from Duke University. He is actively involved in the Hoosier community and serves on a number of boards. Hasler and his wife, Kathy, live in Indianapolis with their two children.

Keynote Speaker:

Maureen is the Director of Purdue's Energy Center, part of the Global Sustainability Initiative in Discovery Park. She obtained her undergraduate degree in Natural Sciences from the University of Cambridge, UK, in 1987, and a PhD in Botany at the John Innes Centre, Norwich UK, a government-funded research institute for plant and microbial sciences. She stayed at the John Innes Centre for a post-doctoral, partly funded by Unilever, and then as a project leader with her own group from 1995, funded by The Royal Society. In January 2003, she moved to Purdue University as an Associate Professor, and she is currently a Professor in the Department of Biological Sciences.

The goal of her research is to understand how the molecular machinery of the plant cell wall contributes to cell growth and specialization, and thus to the final stature and form of plants. Plant cell walls are the source of lignocellulosic biomass, an untapped and sustainable resource for biofuels production with the potential to reduce oil dependence, improve national security, and boost rural economies. She is also the Director of the Center for Direct Catalytic Conversion of Biomass to Biofuels (C3Bio), an interdisciplinary team of biologists, chemists and chemical engineers in an Energy Frontier Research Center funded by the US Department of Energy's Office of Science.

P O S T E R D I R E C T O R Y

Poster #	Student Name	Research Area
1	Yuan-Hsin Cheng	ASM
2	Elizabeth Hawkins	ASM
3	Anthony Hearst	ASM
4	Matthew Koester	ASM
5	Yonggui Wang	ASM
6	Mahdieh Aghazadeh	BIOE
7	Iman Beheshti Tabar	BIOE
8	Barron Hewetson	BIOE
9	Daehwan Kim	BIOE
10	Jinsha Li	BIOE
11	David Orrego	BIOE
12	Jessica Pack	BIOE
13	Raymond RedCorn	BIOE
14	Hu Shi	BIOE
15	Weihua Xiao	BIOE
16	Leyu Zhang	BIOE
17	Ximing Zhang	BIOE
18	Yi Cui	BFPE
19	Necla Eren	BFPE
20	Xing Fei	BFPE
21	Danping Guo	BFPE
22	Soo Jung Ha	BFPE
23	Yan Huang	BFPE
24	Jen Kahn	BFPE
25	Md Shahriar Karim	BFPE
26	Seockmo Ku	BFPE
27	Yi Li	BFPE
28	Leah Liston	BFPE
29	Jing Liu	BFPE
30	Yuan Lyu	BFPE
31	Naagarajan Narayanan	BFPE
32	Coleen Riley	BFPE
33	Joyatee Sarker	BFPE
34	Malithi Wickramathilaka	BFPE
35	Xi Wu	BFPE
36	Ning Xiang	BFPE
37	Daniel Bampoh	ENRE
38	Colin Bell	ENRE
39	Amanda Brock	ENRE
40	Jingqiu Chen	ENRE
41	Younghyun Cho	ENRE
42	Qingyu Feng	ENRE
43	Tian Guo	ENRE
44	Andi Hodaj	ENRE
45	Caroline Hughes	ENRE
46	Charlotte Lee	ENRE
47	Shule Liu	ENRE
48	Igor Lopes	ENRE
49	Colleen Moloney	ENRE
50	Amanda Montgomery	ENRE
51	Sam Noel	ENRE
52	Garett Pignotti	ENRE
53	Samaneh Saadat	ENRE
54	Carlington Walace	ENRE
55	Min Xiao	ENRE
56	Tyler Bleazard	FP/MS
57	Enrique Busquets	FP/MS
58	Jordan Garrity	FP/MS
59	Tyler Helmus	FP/MS
60	Salah Issa	FP/MS
61	Paul Kalbfleisch	FP/MS
62	Jeremy Robison	FP/MS
63	Lizhi Shang	FP/MS
64	Ashley Wondergem	FP/MS
65	Matteo Pellegri	FP/MS

Research Area Key

ASM = Agricultural Systems Management
BIOE = Bioenergy
BFPE = Biological and Food Process Engineering
ENRE = Environmental and Natural Resources Engineering
FP/MS = Fluid Power & Machine Systems

1 Summary of Injury and Fatality Factors for Grain Entrapment/Engulfment cases in Grain Transport Vehicles in Agriculture

Yuan-Hsin Cheng, ASM
Advisor: *W. Field*

Since 1978, the Purdue University Agricultural Safety and Health Program has managed a database with ongoing efforts to collect and file information on documented injuries and fatalities in agricultural confined spaces. The database contains 1700 cases documented between 1964 and 2014. Of these documented cases, 135(8.2%) involved grain transport vehicles (GTVs). These cases also represented 91% of all documented cases involving all agricultural transport vehicles including forage and manure transport vehicles, with 50% of the incidents resulting in fatalities. Nearly 70% of all documented GTV incidents involved children and youth age 20 and under. Of all GTV cases, the typical victim was a male with and average age of 19. Though not completely eliminated as a risk to agricultural workers, the substantial mitigation of the risk should be recognized as a success of both educational and technological strategies initiated due to earlier high profile incidents.

2 Practicing metadata analysis with corn production data from research plots

Elizabeth Hawkins, ASM
Advisor: *D. Buckmaster*

Recent interest in the realm of "big data" in agriculture has led to a demand for tools farmers can use to analyze past yield data to drive future decisions. While sophisticated statistical analysis has been used in the past to analyze comparative field trials, better capture and interpretation of descriptive metadata will be required to reap more benefit from crop production data. One key is to utilize metadata which documents management practices and environmental conditions. Using these factors as independent variables in analysis should improve explanations in yield variations and assist in projections for decision making. Historical data from maize yield strip trials at the Southeast Purdue Agricultural Center were analyzed to determine the effects of environment and management practices on yield. Available descriptive metadata were used as explanatory variables. This pilot of "big data" approaches on research plots should provide insights for dealing with larger farm-level data resources.

3 Monitoring Canopy Expansion Rates in Experimental Soybean Fields Using Imagery from an Unmanned Aircraft System

Anthony Hearst, ASM
Advisor: *K. Cherkauer*

Unmanned Aircraft Systems (UAS) make it possible to acquire imagery of natural and cultivated landscapes with high spatial and temporal resolution. This imagery could have applications in crop monitoring and management. A study was conducted to assess the capability of a UAS to regularly acquire visual imagery of 5 ha of soybean fields with the goal of estimating canopy expansion rates for different varieties of soybean. It was found that the large number of small (6.0 m^2), irregularly-spaced experimental plots within these crop fields can be gridded and automatically extracted from the imagery by taking advantage of the precise mapping capabilities that UAS imagery offers. It was also found that the size of the canopies can be accurately measured by applying image classification techniques to the imagery. This presentation focuses on discussing the implications of these findings and also sharing some of the challenges involved in this work.

4 A Nearly Autonomous, Platform-Independent Web App for Manure Records

Matthew Koester, ASM
Advisor: *D. Buckmaster*

A major part of modern manure management is accurate application records; a key to their creation and maintenance is ease. This project involved the integration of existing technologies (smartphones, Bluetooth tags) into devices for mobile web apps which enable the autogenic creation and upkeep of these manure hauling records. This approach greatly improves the efficiency of the recording process which should help to improve the management of applied nutrients. Features of the app include: minimized keystrokes/screen taps to accurately capture source, date, spreader, operator, and field data; advice regarding spreader operation; and output to (spreadsheet for later aggregation and analysis). Given specific restraints for the operation, e.g. nutrient limitation, spreader capacity, spreading speed; the app would suggest proper rate values to maintain proper nutrient application. This web app approach could be readily adapted to other seed/spray/spread/distribute situations as well as harvest/gather operations.

5 A WebServices and GIS Based 3D Water Quality Model Management System in QingShuihai Reservoir

Yonggui Wang, ASM
Advisor: *B. Engel*

It is well recognized by worldwide scientists and decision makers that water quality models can help environmental managers understand the ecosystem functioning of the water body and help evaluate the potential benefits to the water body's water quality and living resources that might result from the reduction of wastewater and watershed pollutant loadings to the water body. The development of a modern integrated water quality model of Qingshuihai Reservoir and its watershed would permit decision-makers and water quality managers to address the following issues and/or needs: to develop an understanding of the mechanisms underlying observed trends in water quality within Qingshuihai Reservoir; to assess the potential risk for drinking water safety and its impact; to project the benefits of reductions in point source, non-point source inputs of nutrients; to provide the Authority with a user-friendly management software for basin management and drinking water security system.

6 Solvent selection for the recovery of acetic acid; Comparison of simulated and laboratory results for liquid-liquid extraction

Mahdieh Aghazadeh, BIOE
Advisor: *A. Engelberth*

Acetic acid is a well-known fermentation inhibitor for the conversion of biomass sugars to ethanol. Liquid-liquid extraction was used to extract acetic acid from a dilute aqueous solution prior to fermentation. The solvents were selected based on their ability to extract the acetic acid at a lower solvent consumption rate while not extracting water from the raffinate. A desired extraction system allows the sugars to remain intact and to leave the extraction column with the aqueous stream. A group of nine organic solvents were selected for laboratory experimentation based on the mentioned criteria. It is necessary to experimentally verify which property method best suits the simulation. Laboratory experiments were performed on a model solution mixed with varying levels of solvent. This first set of experiments narrowed the list down to four possible solvent which were then assessed using a corn stover hydrolysate to confirm which scenario best fits the extraction

7 Ozone treatment of lignocellulosic material to improve bioenergy feedstock characteristics

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

A major issue in commercial production of bio-ethanol is the limited harvest window of bioenergy feedstock in any region making long term storage of biomass inevitable. Ozone pretreatment has shown to improve the enzymatic digestibility of cellulose as well as improving storability. In this study the chemical pretreatment of highly compacted switchgrass with ozone gas was carried out in a fixed bed reactor. The experimental parameters were designed to simulate large scale treatment of biomass bales. Through a full factorial design the influence of 3 operating parameters including ozone concentration (22.5, 10 mg/L), treatment time (3,12, 24h) and air/ozone flow rate (1.5, 3 L/min) on the digestibility of biomass under room condition was studied. Enzymatic hydrolysis of the materials with a loading of 10 FPU/g glucan resulted in yields of glucose of 59% for water washed samples, a 5 fold increase compared to non-treated samples. Ozone consumption for the top part of the reactor was estimated using an ozone gas transport convection/diffusion equations.

8 Biomimetic Catalyst: Maximizing Yields of Hydroxymethylfurfural from Whole Biomass via Thermochemical Upgrading

Barron Hewetson, BIOE
Advisor: *N. Mosier*

Achieving high yields of HMF requires effective hydrolysis, isomerization, and dehydration of glucose from cellulose. We report the use of a cellulose solvent [85% w/w phosphoric acid] to dissolve and then recover cellulose from several plant biomasses (corn stover, switchgrass, and poplar) and microcrystalline cellulose (Avicel). The resultant amorphous cellulose reprecipitated from solution was subjected to a conversion process where maleic acid hydrolyzes the cellulose to glucose, $AlCl_3$ isomerizes the resultant glucose to fructose, and both acid catalysts dehydrate the fructose to HMF in a single bi-phasic reactor where HMF is continuously extracted into MTHF.
The results confirm yields of HMF (38 to 68%) can be increased by cellulose dissolution in concentrated phosphoric acid followed by hydrolysis of the re-precipitated amorphous cellulose. The increase in HMF yields is dependent upon the type of biomass. Lastly, delignified biomass produced from a deoxygenation was subjected to the same processing methods. The total sugar conversion from the delignified residue reaches greater than 95%.

9 Adaptation of yeast to inhibitors and ethanol fermentation of lignocellulosic

Daehwan Kim, BIOE
Advisor: *M. Ladisch*

Phenols produced by high plants for defense mechanism are believed to play key role in inhibition of enzyme hydrolysis. Several products released during pretreatment of lignocellulosic materials such as phenols including lignin degradation products, tannins and gallic acid are also major inhibitors that can reduce enzyme activity. *Saccharomyces cerevisiae* is the most useful yeast for fermentation of foods and ethanol. If *S. cerevisiae* has a tolerance of phenol compounds or can use these compounds as source of carbon and energy, we can expect that it could contribute to economically feasible biofuel production. From this study, we are attempted to adapt the Y-1546 yeast on several pretreated liquid which have high phenols for survival, and have tested if adapted Y-1546 yeast is improved to use the glucose and produce the ethanol than original yeast and/or other yeast.

10 Adding values to bioethanol production -- Quantification and recovery of Lutein and zeaxanthin from DDGS

Jinsha Li, BIOE
Advisor: *A. Engelberth*

Lutein and zeaxanthin are plant compounds in the carotenoid family. They are essential for development and maintenance of the retinal macula, and act as an anti-oxidant to prevent the development of cancer. Currently, the major source for them is marigold flowers and must be activated after extraction for use in human body. The US corn industry produced 42.66 million short tons of DDGS in 2011, which provides a large untapped source to recover lutein and zeaxanthin. This research investigated the recovery and purification of lutein and zeaxanthin from Dried Distillers Grains with Solubles (DDGS) that are already biologically active when ingested and are currently underutilized in this biomass stream. In this research, the compounds were extracted via Soxhlet and verified with High Performance Liquid Chromatography (HPLC). Further purification was carried out using a centrifugal Partition Chromatography (CPC), a liquid-liquid countercurrent chromatography technique. This process could add a revenue stream to the biorefinery.

11 Enzyme Catalyzed Disassembly of Corn Kernels

David Orrego, BIOE
Advisor: *M. Ladisch*

Our work addresses the goal of developing new uses for corn and relating it to Indiana's significant ethanol industry. The research is intended to benefit Indiana farmers through development of a new concept in enzyme-based

processing that deconstructs the kernel into its base components of starch, pericarp, germ (and oil), and sugars, and then transforms the sugars into value-added molecules using catalytic processing. High-value chemicals that can be produced from corn-derived sugars include furans, levulinic acid, biohydrocarbons, succinic acid and sugar alcohols. These add significant value through product diversification.

12 Quantitative image analysis of pavement cell morphogenesis in Arabidopsis thaliana

Jessica Pack, BIOE
Advisor: *D. Umulis*

The morphology of Arabidopsis thaliana cotyledon pavement cells, dynamically evolves from relatively simple un-lobed geometries into a network of interconnected puzzle-piece shaped cells. The pavement cell grows in two stages: one includes polarized lobe initiation and growth is very irregular. The second phase is heavily influenced by the shape created in the first phase and has a more regular constant growth. It is still unclear how and when the patterns of lobing are initiated in pavement cells by chemical and/or mechanical cues and one of the technological bottlenecks to addressing the problem is having a robust methodology to identify and track lobing events during the transition from simple cell geometry into lobed cells. We developed a numerical methodology to identify lobes and new lobe initiations on segmented pavement cell images. This results in a robust tool for large-scale quantification of pavement cell shape and cotyledon morphogenesis.

13 Identifying Conditions to Optimize Lactic Acid Production from Food Waste

Raymond RedCorn, BIOE
Advisor: *A. Engelberth*

There is an increased demand for lactic acid for the production of biopolymers. Food waste offers a source of soluble sugars to produce lactic acid but the optimal conditions for co-digestion with sludge had yet to be studied. Food waste was collected from cafeteria refuse bins and seeded with primary sludge to study the optimal conditions for lactic acid production. Response surface methodology was used to optimize lactic acid production based on pH, temperature, loading rate, and retention time. The resulting optimum was verified and refined to optimize for both yield and concentration of lactic acid. When optimized for concentration and yield, 58 g/L and 48 g/L lactic acid were achieved respectively and retention time was reduced three-fold over previous experiments which did not use sludge as a co-digestant. Digestion of carbohydrates indicates homolactic fermentation is the dominating microbial pathway and 97% of the theoretical yield achieved.

14 Reduction of aflatoxin in distiler grains

Hu Shi, BIOE
Advisor: *R.Stroshine*

Aflatoxins are secondary fungal metabolites that are associated with corn ear rot diseases. They are toxic and pathogenic to animals and humans. When aflatoxins contaminated corns are used for ethanol products, the aflatoxins are carried into and concentrated in the coproducts distillers grains. This situation causes potential great health risk to animals fed with distiller grains. Our research aims to develop methods to reduce aflatoxin levels in distiller grains prior to/during/after ethanol production process, methods under investigation includes Pre-cleaning and sorting the aflatoxins contaminated corns, adding food additives, and microwave heating and ozone treatment of the coproducts. The methods and procedures developed could be deployed in the ethanol industry to ensure the quality of the distillers grains and safeguard the safety of animals consuming distiller grains.

15 Microwave-assisted Methanolysis of Lignocellulose into Methyl Levulinate

Weihua Xiao, BIOE
Advisor: *N. Mosier*

The microwave-assisted methanolysis products from different components in biomass were identified by GC-MS. Methyl levulinate and levoglucosenone derived from cellulose and furfural derived from hemicellulose were identified as the dominant compounds in corn stover methanolysis products. The microwave-assisted methanolysis of glucose, fructose, sucrose, and cellulose yield higher methyl levulinate conversion at 160 °C with less solvent consumption and shorter reaction time required than previously reported using conventional heating.

16 Study of Adsorption Characteristics of Enzymes on Biomass Material by Liquid Chromatography

Leyu Zhang, BIOE
Advisor: *M. Ladisch*

Severe pretreatment conditions make cellulosic enzyme more accessible not only to cellulose, but also to lignin. The adsorption of enzyme protein to lignin decreases the cellulase activity. Adding other proteins such as Bovine Serum Albumin (BSA) is proved to be effective to prevent cellulase adsorption to lignin, because it adsorbs more easily on lignin than enzyme. However, the cost of BSA is still relatively high. We need to find alternative protein with similar adsorption property to lignin. We study the adsorption profile of enzyme and other proteins on lignin using liquid chromatogrphy apparatus assembled in our lab. The column is packed with lignin. A mixture of enzyme and other proteins (including BSA) goes through the column and gives elution profile for each component. The result of the experiment helps better understand the mechanism of the protection effect by BSA, as well as other proteins.

17 Kinetics of Maleic Acid and Aluminum Chloride Catalyzed Dehydration and Degradation of Glucose

Ximing Zhang, BIOE
Advisor: *N. Mosier*

We report the positive effect of maleic acid, a dicarboxylic acid, on the selectivity of hexose dehydration to 5-hydroxymethyfurfural (HMF), and subsequent hydrolysis to levulinic and formic acids. We also describe the kinetic analysis of a Lewis acid ($AlCl_3$) alone and in combination with HCl or maleic acid to catalyze the isomerization of glucose to fructose, fructose to HMF, HMF to levulinic and formic acids, and degradation to humins. Results show that $AlCl_3$ significantly enhances the rate of

glucose conversion to HMF and levulinic acid in the presence of both maleic acid and HCl. In addition, the degradation of HMF to humins, rather than levulinic and formic acids, is reduced by 50% in the presence of maleic acid and $AlCl_3$ compared to hydrochloric acid combined with $AlCl_3$. The results suggest a different reaction mechanism for the dehydration of glucose and rehydration of HMF between maleic acid and HCl.

18 Reaching the far side of MBD3 protein: from single-molecule behavior to clinical implication

Yi Cui, BFPE

Advisor: *J. Irudayaraj*

Epigenetics studies a series of modifications occurring on chromatin that are able to fine-tune gene expression without altering DNA sequences. Of the elucidated mechanisms, DNA methylation is the most extensively investigated one due to its direct effect on gene silencing. Methyl-CpG-binding domain protein 3 (MBD3) belongs to a family of nuclear proteins in close relation with DNA methylation, but exhibits elusive epigenomic integration and more diverse functions in contrast to other MBD proteins. In this presented work, a set of single-molecule fluorescence tools, together with advanced bioimaging, molecular biology and bioinformatics, are implemented to probe the intracellular activity of MBD3 in DNA methylation homeostasis. Notably, these uncovered new behaviors provide us invaluable information to interpret the regulatory landscape of MBD3 in human malignant glioma. Thus we expect our work to be of tremendous interest to scientists involved in both basic and applied epigenetics research as well as in translational medicine.

19 Revisiting the two most popular methods of DLS data analysis for Food Applications

Necla Eren, BFPE

Advisor: *O. Campanella*

Correlation functions are the main quantitative outcome of dynamic light scattering (DLS) experiments. Decay characteristics of the correlation function helps to characterize factors that affect particle motion or diffusion, such as particle size and particle size distribution. As a system deviates from being monodisperse, as is the case for most food systems, extracting physical parameters from the correlation function becomes challenging. To overcome this difficulty, numerous algorithms have been developed. However, the complexity of the algorithms has never made the concept easier for experimentalists who are not experts in data processing. Here we provide self-learning and assessment material for testing the performance of Regularized Inverse Laplace Transform (RILT) and Non-Linear Functional Fitting (NLFF). All the NLFF methods were robust to changes in initial parameters in the case of low noise. With increased noise, NLFF with dLS was found to be more sensitive to the changes in initial parameters.

20 Effects of Thermal and Shear Treatments on Rheological Properties of Tomato Suspension

Xing Fei, BFPE

Advisor: *O. Campanella*

The viscosity of tomato products has long been thought to be attributed to pectin. However recent findings revealed that the contribution of tomato cell clusters is significant. In this study, tomato suspensions were prepared from tomato fruits using combinations of thermal treatments (hot or cold Break) and shear treatments (low or high shear). Tomato pulps were produced from centrifugation of such suspensions. The viscosity of suspension and the viscoelastic properties of pulp were investigated. The results showed that high viscosity could be generated from red tomato suspension by the treatments containing hot break or low shear. For green tomato, the viscosity of suspension solely depended on shear treatment and high viscosity was derived from low shear treatment. The viscoelastic properties of tomato pulp had a positive correlation with the viscosity of suspension which indicated the viscosity of suspension may be partly determined by the mechanical properties of tomato cell clusters.

21 Kernel and Bulk Density changes due to Moisture Content, Mechanical Damage, and Insect Damage

Danping Guo, BFPE

Advisor: *K. Ileleji*

Kernel density and bulk density are two important properties of grains in grain industry. The researches on relationships between densities and Moisture Content (M.C.), densities and mechanical damage, and densities and insect damages have been done with corn kernels. The results show that M.C., mechanical damage and insect damage do affect both kernel density and bulk density. Resulting data , averaged over all lots of samples, are presented graphically with polynomial equations. It is shown that there is polynomial relationship between M.C. and densities, and also linear relationship between mechanical damage/ insect damage level and densities. By knowing these relationships, kernel density/ bulk density could be used as tools to give a quick test of M.C., internal insect damage, and mechanical damage. Further machine could be developed to test these physical properties of corn kernels.

22 Lipidomic Analysis of Glioblastoma Multiforme using Mass Spectrometry

Soo Jung Ha, BFPE

Advisor: *K. Clase*

Glioblastoma multiforme (GBM) is the most common and malignant form of primary brain tumors. Novel approaches and technologies from systems biology have the potential to identify biomarkers for new therapeutic targets. This study employed lipid profiling technology to investigate lipid biomarkers in human GBM xenograft models. Primary patient cell lines were injected into the flank and the right cerebral hemisphere of NOD/SCID mice and tumors were harvested. Mass spectrometry was used to analyze the lipid profiles of tumor samples, and statistical and clustering analyses were performed to detect the differences. Lipids with the greatest fold effect in the comparison of ectopic versus orthotopic tumor models fell predominantly into four main classes of lipids: glycosphingolipids, glycerophoshpoethanolamines,

triradylglycerols, and glycerophosphoserines. These results underscore the importance of the surrounding physiological environment on tumor development and are consistent with the hypothesis that specific classes of lipids are critical for GBM tumor growth.

23 The Scale Invariance of Dorsal/Ventral Patterning for Morphogen-Regulated Zebrafish Emrbyo

Yan Huang, BFPE
Advisor: *D. Umulis*

The same development pattern is often preserved in embryos of different sizes within and among most species, but it is an open issue how the relative patterns are scaled with system size. Zebrafish is a great model to explore the mystery of dynamic scaling because the optical transparency of zebrafish embryos makes them ideally suited for microscopic imaging of life processes. In zebrafish, the dorsal/ventral patterning displays such robustness that embryos 10~20% smaller by reducing vegetal yolk can develop into a proportionally patterned fish. This study seeks to address how dorsal/ventral patterning in different size embryos in zebrafish and a closely-related species giant danio scales relative to overall size. To explore these questions, we are going to integrate a reaction-diffusion model of the patterning network with our measurements for bmp gradient formation in the early embryo.

24 Collagen-Fibril Templates for Tunable Mesoporous Silica Hybrid Materials

Jen Kahn, BFPE
Advisor: *J. Rickus*

Porous coatings at the surface of living cells have application in human cell transplantation by controlling transport across the cell surface. Sol-gel-derived mesoporous silica materials are good candidates for such coatings, owing to their biocompatibility, aqueous synthesis conditions, and thin film formation. Diffusion and transport across the coating correlates to long-range microstructural properties. This work investigates tunable collagen-fibril matrices as templates for controlling silica microstructure. These matrices direct silica formation at the level of individual collagen fibrils. We varied fibril density, silicic acid concentration, and silicification time and characterized resulting hybrid materials by SEM, EDX, and rheology. Microstructural properties of the collagen-fibril template are preserved in the silica surface of hybrid materials. Additionally, increased fibril density increases the absolute amount of templated silica, and increased exposure time leads to increase in silica content relative to collagen. Silica coating, not starting collagen stiffness, dominates hybrid material mechanical properties.

25 Robustness and scaling in two-component morphogen patterning systems

Md Shahriar Karim, BFPE
Advisor: *D. Umulis*

Embryonic development requires intricate and highly reproducible mechanisms of pattern formation so cell fate is assigned at the right time and location. To identify the mechanisms of pattern regulation, we developed a Two Component System (TCS) model of morphogen (m) and modulator (M), that interact to spatially alter the transport and reaction properties of each other. Initial analysis of TCS reveals that a mutually repressive relation of the transport and reaction properties between 'm and M' yields mechanisms that scale and exhibit robustness.

26 Rapid Concentration, Recovery and Detection of Salmonella in food samples

Seockmo Ku, BFPE
Advisor: *M. Ladisch*

A novel protocol was developed for rapid concentration, recovery and detection of Salmonella in food samples at bacterial cell levels equivalent to 1 CFU/g or less. A microfiltration approach followed by centrifugation was used to concentrate the cells with protease added at the beginning of the process to minimize membrane fouling. The enzyme was found to have no significant effect on cell viability. Enzyme hydrolyzed food homogenates were concentrated by 500 fold in 1 to 2 hours. The number of Salmonella cells recovered exceeded the number initially present in the food when enzyme treatment was coupled to a short enrichment time step (3 to 5 hours). The entire process of sample preparation, concentration, cell recovery and PCR was completed in 7 to 9 hours and was able to detect 1 CFU/g of Salmonella as confirmed by enrichment and plating on a selective medium.

27 Validation of Mycobacteriophage Genome Annotation by Mass Spectrometry

Yi Li, BFPE
Advisor: *K. Clase*

Mycobacteriophages are viruses that infect Mycobacteria. Phage proteins are traditionally studied by nucleotide sequence based methods. Phage host interactions are complex and thus it is important to validate in silico annotations with a wet lab also examining the phage-host interaction. In this research, fifteen mycobacteriophages isolated through the Howard Hughes Medical Institute (HHMI) Science Education Alliance (SEA) were examined by liquid chromatography and tandem mass spectrometry (LC-MS/MS). Phage samples were incubated with host cell culture overnight, proteins extracted, digested and subjected to LC-MS/MS. The results were analyzed using Mascot and peptides of host cells and phages were identified by searching MS spectral data in separate bioinformatics databases. We found the proteomic data could be used to cluster new phages based upon protein comparison with previously characterized phage genomes. We detected unexpected peptides that were not predicted by the genome annotation. Our findings highlight the importance to examining the phage-host system.

28 Development of a Phase Change Material for Use in Concrete Pavements to Reduce Icing

Leah Liston, BFPE
Advisor: *B. Tao*

Phase change materials (PCMs) are used as an effective way of storing thermal energy. Thermal energy is absorbed/released when PCMs undergo a phase change. Incorporating PCMs into concrete at airports has been suggested

as a means of preventing surface ice formation on runways. The present study reports on the experimental development of a phase change material from mixtures of fatty acid methyl ester (FAME) providing solid-liquid transition behaviors near 0°C with a high enthalpy of fusion. The phase behavior of FAME mixtures was dependent on the composition and the molecular properties of the FAME. The phase behavior of binary mixtures of medium length saturated FAME, methyl laurate and methyl myristate, demonstrated ideal properties for PCMs. Current findings of this study indicate that the developed mixture has the properties necessary to be a high performance PCM with the potential to reduce the levels of icing on concrete pavements.

29 Quantitative mRNA Detection with Second Harmonic Super-resolution Microscopy

Jing Liu, BFPE

Advisor: *J. Irudayaraj*

Cell-specific information on the quantity and localization of key mRNAs at single copy sensitivity in single cells is critical for evaluating basic cellular process, disease risk, and efficacy of therapy. Quantification of over-expressed mRNAs beyond the diffraction limit is constrained by the optical property of the probes and microscopy techniques. In this report, nano-sized barium titanium oxide ($BaTiO_3$, BTO) crystals were utilized as probes for mRNA quantification by a second harmonic super-resolution microscopy (SHaSM). The SHaSM was able to detect single copy of the human epidermal growth factor receptor 2 (Her2) mRNA at a resolution of 55.6 nm with ability to resolve multiple mRNA copies in a diffraction limited spot. Our single cell quantification technique shows better specificity and selectivity over current single molecule approaches for transcript detection. The developed approach has strong potential in clinical research and in the early diagnosis of life threatening diseases such as cancer.

30 Pore Formation in DOPC/Dopg Bilayers By Antimicrobial Peptide Melittin

Yuan Lyu, BFPE

Advisor: *G. Narsimhan*

Antimicrobial peptides (AMP) kill microbial cells through insertion and damage/permeabilization of the cytoplasmic membranes. Since their mechanism of action differs from that of antibiotics, they could be very useful for combating drug resistant microbes and for treatment of microbial infections. Pore formation in DOPC/DOPG bilayers by antimicrobial peptide melittin was investigated by explicit solvent molecular dynamics (MD) simulation to mimic their permeation action on the cell membrane of microorganism. The effects of number and orientation of melittin inside the lipid bilayer on the formation of water channel (pore) was characterized. The salient features of the simulation results were then compared with experimental data for pore formation as inferred from (i) leakage of fluorescent dyes (calcein, FD4 and FD20) of different molecular weights encapsulated within liposomes exposed to melittin and (ii) the antimicrobial activity of melittin against Gram positive bacteria listeria monocytogenes as characterized by absorbance and plate count.

31 Harnessing Cell Substrate Sensing Towards Effective Scaffold-based Skeletal Muscle Regeneration

Naagarajan Narayanan, BFPE

Advisor: *M. Deng*

Muscle degenerative diseases and volumetric muscle loss pose a significant healthcare challenge. Current cell-based strategies are hindered by the low survival and poor distribution of transplanted cells resulting from the lack of supportive microenvironment (cell niche). The structure of muscle tissue is characterized by oriented muscle fibers, which constitute a natural cell microenvironment. The long-term objective of our research is to develop bioengineered cell niche for muscle regeneration. In the present work, the scaffolds with varying alignment and fiber diameters from micro-scale to nano-scale were fabricated from degradable polyesters using a novel custom-made rotating collector. C2C12 myoblast cells were seeded on scaffolds and analyzed for cell alignment, adhesion, and growth during in vitro culture. Cells responded to fiber topography as evidenced from the differences in cellular responses. These experiments provided critical insight on cell topography sensing which will aid in optimization of scaffold properties for muscle regeneration.

32 Use of X-Ray Powder Diffraction and Reitveld Analysis of Multi-Component Food Systems

Coleen Riley, BFPE

Advisor: *M. Okos*

X-rays are commonly utilized to create images at different energy levels to measure different properties of processed materials. Currently, a dual-purpose flow meter is being designed to utilize x-ray powder diffraction (XRPD) to measure both flow rate and composition of food products. A robust procedure to determine the mass fraction of components within a powder system the Reitveld method; however, this method is most effective on crystalline mixtures. Data was collected in a Shimadzu 6000 diffractometer at room temperature using Ni-filtered CuKα (λ=1.5418 Å) radiation with the x-ray tube operating at 40 kV and 30 mA, and set to take 1s long images every 0.04 2Θ over a diffraction angle range of 8-38 2Θ. Present work seeks to verify a whole-pattern analysis of primarily-amorphous systems to determine the mass fraction of both amorphous and crystalline components within food mixtures through use of the General Structural Analysis System (GSAS).

33 Mathematical Modeling of Hematopoietic Stem Cell Transplants

Joyatee Sarker, BFPE

Advisor: *D. Umulis*

Hematopoietic stem cell transplants (HSCTs) are a curative solution to people who have undergone remission for leukemias and other myelogenous disorders. Mathematical modeling of HSCTs can help elucidate the mechanisms of the adverse events that result from HSCTs such as transplant rejection and Graft versus Host Disease. We developed a semi-mechanistic ordinary differential equations (ODE) computer model to describe the hematopoietic stem cell proliferation and differentiation processes that are

required in transplantation. We successfully characterized the mechanisms that show the complex interactions between macrophages, lymphocytes, and neutrophils. We aim to use this multi-lineage mathematical model to predict patient responses to chemotherapy, immunosuppression, and specified donor infusions, and optimize the treatment to prevent graft versus host disease.

34 A preservation technique for surgical grafts and medical implants: A study on DNA-antimicrobial peptide conjugates

Malithi Wickramathilaka, BFPE

Advisor: *B. Tao*

Pre-operative medical device sterilization, and vascularized tissue preservation are crucial in order to prevent bacterial infections. Current methods of sterilization such as saturated steam, and radiation cannot be applied to live tissues. This study investigates synthesizing a bioconjugate with two complimentary single stranded DNA (ssDNA) attached to the two ends of an antimicrobial peptide (AMP). The complimentary binding of the ssDNA is exploited to recover the valuable AMP. Initial attempts to directly attach both non-phosphorylated and phosphorylated ssDNA of varied lengths (45, 15, and 12 base pairs) to peptides with 5-6 amino acids yielded negative results. The alternative strategy of using ethylenediamine as a pseudo peptide, concluded with positive results. Matrix-assisted laser desorption/ionization time-of-flight (MALDI TOF) results indicated a stable conjugate, and Fourier transform infrared spectroscopy (FTIR) results indicated phosphoramidate bond formation. 31P NMR was not suitable for bond characterization because of the phosphate groups present in the DNA backbone.

35 Anti-listerial activity of Melittin Peptide

Xi Wu, BFPE

Advisor: *G. Narsimhan*

Antimicrobial peptides (AMP) belong to a large and varied class of relatively short peptides family that have the ability to penetrate the cell membrane, form pores which eventually lead to cell death. Melittin, an AMP with 26 amino acids, and its mutant with a higher charge and lower hydrophobicity, exhibited antimicrobial activity against eight strains of Listeria with this activity being highest against *L. monocytogenes* F4244, completely deactivating when added at different times to a growing population. Wild type and mutant melittin both were found to exhibit cytotoxicity to Caco-2 cells in the concentration range of 2 to 10 µg/ml with the cell viability being less than 1.65%. Because of the predominant effect of decrease in hydrophobicity, mutant melittin was found to exhibit lower antiliterial activity as well as lower cytotoxicity.

36 Antimicrobial peptide segments from Soy Protein for Use in Food Safety

Ning Xiang, BFPE

Advisor: *G. Narsimhan*

Antimicrobial peptides (AMPs) kill microbial cells through insertion and damage/permeabilization of the cytoplasmic cell membranes and has applications in food safety. Soy protein may be such an attractive, cost-saving candidate for commercial consideration because the protein subunits have amino acid sequences that contain several α-helix or 3-10 helix domains which possess characteristics of AMPs. Possible AMP segments were identified from soy β-conglycinin (7S) and glycinin (11S) based on number of amino acids, positive charge, hydrophobicity and hydrophobic moment. Explicit solvent molecular Dynamics (MD) simulation was employed to assess the secondary conformation of these peptides in POPC/POPG bilayers to mimic their permeation action on the cell membrane of microorganism. The effects of number of peptides, their orientation and hydrophobic moment on the deformation of membrane and formation of water channel were investigated. The antimicrobial activity of three synthetic selected peptides against *Listeria monocytogenes* and *E. coli* was demonstrated.

37 Identifying the functional relationship(s) between species abundance and chemical pollutants of emerging concern in aquatic ecosystems

Daniel Bampoh, ENRE

Advisor: *S. Singh*

Research, data and literature remain sparse when it comes to investigating the regional and global impact of anthropic chemical species on biodiversity loss. Some of these chemicals have become contaminants of emerging concern in aquatic ecosystems. This study contributes to sealing the gap in research by examining the relationship between the concentration trends of emerging pollutants and biodiversity loss. The approach is based on deriving empirical relationship between concentration of pollutants and biodiversity loss by regression analysis. Preliminary results show that the Aberjona River at Winchester (MA) and the Charles River at Watertown (MA) experienced mean loss of 23.4% of all native fish species (American Eel, White sucker, Brown Bullhead, Pumpkinseed, Bluegill and Yellow Perch) from 1992 to 2008, as the residence-time Pesticide Toxicity Index (PTI) rose by 12.1% during the period.

38 Effect of Stormwater Control Measures on Urban Hydrological Regimes

Colin Bell, ENRE

Advisor: *S. McMillan*

Increasing urbanization is associated with negative changes to hydrological regimes, but stormwater control measures (SCMs) are designed to mitigate the effects that urbanization has on receiving stream ecosystems. We examined the impacts of urban development and SCM implementation on peak discharge, runoff ratios and precipitation-stormflow time lags at four watersheds in Charlotte, North Carolina, USA. Controls on these response metrics were informed by watershed factors, including total imperviousness (TI), effective imperviousness (EI), and a newly-developed mitigation factor (MF), as well as hydrometeorological factors. While increased peak discharge was highly correlated with precipitation, the strength of this relationship was controlled by EI. Both long-term and event-scale runoff ratios were controlled by MF, as this metric implicitly accounts

for SCM storage and vegetated cover. The time lag between precipitation and stormflow was controlled by TI, as this watershed metric limits the amount of water that infiltrates and follows slower, subsurface flow paths.

39 Evaluating the Impact of a Woodchip Bioreactor on Phosphorus Loads

Amanda Brock, ENRE
Advisor: *I. Chaubey*

Nitrate leached from fields has made its way to the Gulf of Mexico where it is used by algae to grow. This algae then uses up all of the oxygen in the water. To combat this, denitrifying bioreactors are being looked at for their potential to reduce nitrate in water. Previous research on a bioreactor located at Throckmorton Purdue Agricultural Center found that nitrate in the water was reduced, but phosphorus increased. Three water columns constructed using the same wood chips as those in the field bioreactor showed that nitrate was decreasing and phosphorus was increasing. However, phosphorus concentrations were increasing very differently between them. A fungus was found to be growing in two of the three columns, but the amount was different between the two. It appeared that the more fungus there was the greater the phosphorus coming out was. More tests still need to be done.

40 Land Use/ Land Cover Change Impact on Runoff Depth of Contiguous United States based on L-THIA Tabular Tool

Jingqiu Chen, ENRE
Advisor: *B. Engel*

Land use/ Land cover change over time, which is dominated by increasing urbanized area in many locations, has significant impacts on hydrologic processes. Long-Term Hydrologic Impact Analysis (L-THIA) estimates long-term average annual runoff for land use and soil combinations, based on long-term climate data for that area (L-THIA, PURDUE). In this study, a new version of -LTHIA called L-THIA Tabular Tool was applied to evaluate land use/ land cover change impact on runoff depth of the Contiguous United States based on the National Land Cover Database (NLCD) for 2001, 2006 and 2011. The preliminary analysis results showed that the classification rule discrepancies / classification errors in some land use types such as forest, shrub/ scrub, herbaceous, barren land and open water in NLCDs overwhelm the urbanization impacts on runoff. The magnitude of classification result differences limits the analysis. The next step will focus on refining the approach and overcoming limitations to assess the urbanization impact on runoff.

41 Development of a GIS---based spatially distributed Clark's unit hydrograph method (Distributed---Clark) for runoff routing

Younghyun Cho, ENRE
Advisor: *B. Engel*

In this study, a GIS-based spatially distributed Clark's unit hydrograph method (Distributed-Clark) is proposed that can simulate spatially distributed rainfall-runoff flow (runoff routing). Distributed-Clark is developed based on the combined concept of Clark's unit hydrograph and Maidment's unit hydrograph spatial decomposition methods; it is a lumped conceptual and distributed features model (hybrid hydrologic model). The objectives of this paper are as follows: (1) to present a spatially distributed Clark's unit hydrograph method, compared with the original and modified Clark's method; through this method, a set of separated (Thiessen polygon, grid cell based, etc.) unit hydrographs are derived, (2) to apply the derived a set of separated unit hydrographs to spatially distributed rainfall (in this study, Thiessen polygon weighted); it can also consider NEXRAD radar-based precipitation, and (3) to evaluate the performance of the proposed method by making comparisons of simulation results for spatially distributed and averaged (lumped) rainfall data.

42 Corn/soybean rotation pattern analysis from 06 to 14 in the Upper Mississippi River Basin

Qingyu Feng, ENRE
Advisor: *I. Chaubey*

Corn and soybean are two most important crops in the Upper Mississippi River Basin. They were usually grown in rotation. The objective of this project is to identify the major corn/soybean rotation types in the Upper Mississippi River Basin (UMRB), and prepare a map for the SWAT model in the area. The rotation was recognized by summarizing land use type information from 2006 to 2014. This information would be helpful to recognize land use change trends in the watersheds and help improve the representation of SWAT model for the UMRB area.

43 Development and Improvement of the Simulation of Woody Bioenergy Crops in the Soil and Water Assessment Tool (SWAT) Model

Tian Guo, ENRE
Advisor: *B. Engel*

Populus is expected as one of bioenergy feedstocks to produce significant quantities of biofuel. It is important to quantify hydrologic and water quality responses to Populus growth when Populus is planted in large area. In this study, Populus growth and its impacts on runoff, sediment and nitrate-N losses were simulated by SWAT. Tree growth algorithms and parameters for hybrid poplar (*Populus balsamifera* L. x *P. tristis* Fisch) and eastern cottonwood (*Populus deltoides* Bartr.) were improved. The modified SWAT model was used for simulation of Populus growth and the impacts on water quantity and quality at the field scale, and the model was evaluated based on comparison of simulated biomass yield, runoff, sediment and nitrate-N losses with observed values. Suggested values and potential parameter ranges for hybrid poplar and cottonwood were reasonable, and performance of modified SWAT simulating biomass yield of Populus, and impacts of Populus growth on runoff, sediment and water quality was reasonable. Thus, the modified SWAT model can be used for biofeedstock production modeling for Populus, and

hydrologic and water quality response to its growth.

44 Monitoring a two-stage ditch and its impact on water quality

Andi Hodaj, ENRE

Advisor: *L. Bowling*

A two-stage ditch involves modifications of a traditional drainage ditch to resemble more the features of a natural stream. The idea is to create or simulate extended benches on both sides of the ditch that would develop naturally over a period of time in a stream because of geomorphological processes. Previous research in Indiana and Ohio has shown that two-stage ditches offer the potential to reduce sediment load and extend the interaction time between water and vegetation on the benches allowing larger uptake of nutrients from the vegetation on the extended benches, and increasing the denitrification rates in the bench soil during high flow events. Purdue University constructed a two-stage ditch on September 26, 2012 at Throckmorton Purdue Agriculture Center (TPAC), 10 miles south of the city of Lafayette, Indiana where discharge rates and nutrient loads are being monitored to estimate the impact that the two-stage ditch has on those.

45 Developing soil moisture metrics to assess yield impacts of drainage water management in the Midwest

Caroline Hughes, ENRE

Advisor: *J. Frankenberger*

Agricultural fields in four Midwestern states are being monitored to evaluate the effects of controlled tile drainage versus conventional drainage. Though controlled drainage has already been shown to reduce nitrate losses and may reduce downstream flooding, this study seeks to determine if the practice can also improve corn yields by providing increased soil moisture during crucial growth stages. Soil moisture measured at several depths is being resolved into metrics quantifying moisture stress, with the goal of comparing the relationship between stress and yield in conventional and controlled fields throughout the Midwest.

46 Corn Belt Tile Drainage: Simulating Drainflow Timing and Volume with the Variable Infiltration Capacity (VIC) Macroscale Hydrologic Model

Charlotte Lee, ENRE

Advisor: *L. Bowling*

The Corn Belt, a Midwestern region dominated by slowly permeable soils and precipitation that often exceeds crop needs, depends on tile drainage systems to enhance agriculture productivity. Impacts of tile drainage on nutrients and hydrologic regimes can be mitigated through drainage water management (DMW). It is necessary to understand how management practices may vary across this region based on climate and other factors affecting drain flow. To better understand the influences of soil, drainage system, and climate on tile drainage the Variable Infiltration Capacity model is used to simulate drainflow across this region assuming continuous corn vegetation coverage. Drainflow data from 16 field sites are used to calibrate the model and create baseline drainflow conditions. Sixteen different simulation scenarios will be analyzed across climate zones to determine effects of soil, drainage system, and climate on tile drainage timing and volume. Results will provide implications for DWM in the Corn Belt.

47 Dynamic Modeling of Ammonia Concentrations in Two Layer Hen Houses

Shule Liu, ENRE

Advisor: *J. Ni*

Ammonia (NH_3) is a primary air pollutant in poultry houses released from manure. High NH_3 concentration in poultry houses can lead to adverse effects in human health and livestock welfare. The release of NH_3 is determined by a combined effects of many factors affecting local climates above manure. However, those effects are not limited to the time of observation, but delayed and inconstant over time. The DLNM method is able to identify the dynamic dependency between influencing factors and NH_3 concentrations in layer hen houses. Ventilation rates affected NH_3 concentrations in winter differently from summer.

48 Nitrogen and soil runoff losses after application of raw dairy manure and digestate at a no-till corn field

Igor Lopes, ENRE

Advisor: *J. Ni*

Anaerobic digestion technology (ADT) has been presented as a viable method for manure treatment with the increased manure availability and environmental pollution concerns . As a result,there has been an increased interest on the use of ADT digestate as fertilizer and its environmental impacts. A two year field study was conducted at the Purdue Agricultural Center in Indiana to evaluate nitrogen and soil losses through runoff after dairy manure and digestate application at a no-till field. Twenty four field plots and a total of two raw manure treatments and two digestate treatments were used as well as two controls (fertilized and unfertilized). Rainfall simulation was performed within 24 hours after fertilizer application. Runoff results have shown greater total runoff, nitrogen and soil losses at fields that had digestate applied. Raw manure presented greater solid contents which possibly contributed to the observed lower runoff and nitrogen losses.

49 Assessing the SWAT Model Tile Drain Routines for Simulating Phosphorus Transport

Colleen Moloney, ENRE

Advisor: *J. Frankenberger*

Tile drains have become the norm in Midwestern agriculture as a way to modify and control the hydrology in a field. These drains, along with regular fertilizer use, causes increases in chemical runoff directly into local waterways. The Soil and Water Assessment Tool (SWAT) has yet to be used to simulate chemical transport from tile drains. This study is meant to fill that gap and determine the effectiveness of SWAT's tile drain routines in modeling these outputs. Initial progress has been made in this study in regards to data exploration and tile integration within the site. The watershed used is located in central Ohio and has been monitored for eight years.

50 The effects of different biofuel crops and fertilizer rates on subsurface

water quality and yield on marginal land

Amanda Montgomery, ENRE
Advisor: *I. Chaubey*

This research is focused on determining subsurface nutrient losses of annual and perennial biofuel crop production, with differing nutrient applications. The samples are collected from research plots at the Throckmorton Purdue Agricultural Center. Subsurface water samples were collected using 12-inch suction cup lysimeters; four replicates of each crop. Crops sampled include:. miscanthus, switchgrass, dual purpose sorghum, and maize. Samples are analyzed for nitrate-nitrogen and soluble reactive phosphorus. The results indicate a greater loss of nutrients from those crops receiving fertilizer than those that receive no fertilizer. The greatest loss of nutrients to the subsurface water comes from the annual row crops - sorghum and maize. Data indicate Miscanthus has a greater yield, regardless of fertilizer treatment, followed by dual purpose sorghum, maize and switchgrass. These data will be used to determine the field-scale level water quality impacts of these crops.

51 Assessing the value of low cost versus high cost soil moisture sensors

Sam Noel, ENRE
Advisor: *D. Buckmaster*

Current soil moisture sensing technology is geared towards research-grade, high-accuracy sensors that are cost prohibitive for many production agriculture operations where high spatial resolution is desired. Furthermore, the use of data from these sensors for the purpose of making irrigation management decisions remains more an art than a science, which is of particular concern in regions of the country where groundwater is limited. This study will analyze the variability of five different soil moisture sensors of differing technologies. An apparatus will be constructed from a 5-gallon bucket into which a single sensor will be installed. Gravimetric methods for determination of volumetric water content will be implemented to enable accuracy assessments of sensor readings. It will be determined whether several inexpensive sensors can be substituted for one of the more expensive sensors through statistical methods that exploit a multi-sensor approach. Additionally, it will be determined whether such approaches will enable in situ calibration.

52 Impact of Spatial Scale on Calibration and Model Output for a Grid-based SWAT Model

Garett Pignotti, ENRE
Advisors: *I. Chaubey & M. Crawford*

The traditional implementation of the Soil and Water Assessment Tool (SWAT) model utilizes common landscape characteristics known as hydrologic response units (HRUs). Discretization into HRUs provides a simple, computationally efficient framework for simulation, but also represents a significant limitation of the model as spatial connectivity between HRUs is ignored. SWATgrid, a newly developed, distributed version of SWAT, provides modified landscape routing via a grid, overcoming these limitations. However, the current implementation of SWATgrid has significant computational overhead, which effectively precludes traditional calibration and limits the total number of grid cells in a given modeling scenario. Moreover, as SWATgrid is a relatively new modeling approach, it remains largely untested with little understanding of the impact of spatial resolution on model output. The objective of this study was to determine the effects of user-defined input resolution on SWATgrid predictions in the Upper Cedar Creek Watershed (near Auburn, IN, USA).

53 Drainage Water Management Effect on Water Table Recession Rate

Samaneh Saadat, ENRE
Advisor: *J. Frankenberger*

Subsurface tile drainage is a common practice in Midwest to remove excess water from the field, however, this process can results in an increase of nitrate loads. One way to decrease subsurface drain flow and thus nitrate loads is to install drainage water management (DWM) control structures (outlet). DWM control structures are managed by raising and lowering the outlets, and thus the water table level in the field. The timing of different managements depends on the season and agricultural operations. The objective of this study is to evaluate the effect of control structure's management on water table in an agricultural field in Indiana determining the water table recession rates.

54 Quantifying the Effects of Future Climate Conditions on Runoff, Sediment and Chemical Losses for Different Watershed Sizes

Carlington Walace, ENRE
Advisors: *B. Engel & D. Flanagan*

Assessing the sensitivity of agricultural watersheds to possible changes in future climate is imperative when developing management practice plans. Despite numerous studies on the impact of climate change at different local and regional scales, it is still necessary to evaluate the impact of these changes on highly agricultural watersheds with modified hydrologic landscapes.

Like much of the Midwest, the hydrology in northeastern Indiana is dominated by subsurface tile drainage supplemented with surface drainage of closed depressions (potholes). The closed depressions are sites within the landscape formed from glaciation, and in which runoff water tends to collect because there is no natural outlet. In order to maximize crop production, farmers often install tile risers to drain the closed depressions.

In this study, the Soil and Water Assessment Tool (SWAT), and downscaled weather data generated using the MarkSim weather file generator were used to evaluate the potential impact of changes in temperature, rainfall and solar radiation on streamflow, sediment and chemical losses in hydrologically modified watersheds located in northeastern Indiana.

55 Characterizations of Digested Manure and Nutrient Losses after Digestate Land-Applications in Laboratory-scale

Min Xiao, ENRE
Advisor: *J. Ni*

The use of digestate as an organic fertilizer and its environmental impact has not yet been sufficiently investigated. A soil box study with artificial rainfall simulation was conducted in lab. This experiment consists of runoff and

leachate collection from soil boxes after artificial rainfall. There are a total of 14 treatments with 4 replicates each.The treatments are influent manure, digestate and digestate liquid. Samples will be analyzed for N, P and sediment losses. The expectation is that anaerobic digestion will alter the physical and chemical properties of dairy manure, hence affect the nutrient losses via runoff and leaching from soil after digestate land application.

56 Application of a Novel Blended Hybrid Hydraulic Transmission in an On-Road Vehicle

Tyler Bleazard, FP/MS
Advisor: *M. Ivantysynova*

Hydraulic hybrids have demonstrated great potential in reducing the fuel consumption of both on-road and off-highway vehicles. Currently a number of hydraulic hybrid transmission architectures exist, each with their own benefits and deficiencies. The novel blended hybrid transmission, developed at the Maha Fluid Power Research Center, combines features of a hydrostatic transmission and a parallel hybrid, resulting in a transmission that has a similar response to a mechanical transmission with the benefits of being continuously variable and efficiently capturing brake energy. In addition this, the blended hybrid transmission improves efficiency over the series hybrid transmission by allowing the transmission to operate at lower pressures for a given load. To better demonstrate the benefits of the blended hybrid transmission, researches at the Maha Fluid Power Research Center are in the process of applying this transmission to an on-road SUV which will be covered in the presentation and poster.

57 Displacement-Controlled Multi-Actuator Hydraulic Hybrid Machine Systems

Enrique Busquets, FP/MS
Advisor: *M. Ivantysynova*

Environmental and economic factors have a direct impact on the advancements of new fluid power technologies. Gradual development on more efficient and productive systems has been made over the past two decades; however, no major advancement has led to radical improvements using the current state-of-the-art technology. In search for a drastic improvement on the overall efficiency and productivity of fluid power systems, researchers have focused on alternative technologies. One promising alternative is displacement-controlled (DC) actuation. This technology has been the focus of extensive research at the Maha Fluid Power Research Center at Purdue University, demonstrating substantial energy and fuel savings as well as reduced cooling power requirements and improved controllability. The basis for the advantages of DC actuation reside in the complete elimination of resistance control. Different from the state-of-the-art valve-controlled hydraulic systems, DC actuation uses pump displacement to control actuator motion.

58 High Performance Valves Enabled by Kinetic Energy

Jordan Garrity, FP/MS
Advisor: *J. Lumkes*

High speed actuation systems are critical to improving efficiency and dynamic performance in fluid power applications. This project aims to develop a high speed actuator to enable high-bandwidth valves and improve the overall performance and efficiency of fluid power systems. An Energy Coupling Actuator (ECA) works through periodically coupling a kinetic energy source that is constantly moving with a linear movement found in a poppet valve or spool and is controlled through the use of magneto-rheological fluid. This innovative concept intends to solve the compromise between fast switching and large nominal flow rates found in currently available high speed valves. Simulation has shown a performance of 100 L/min nominal flow at 5 bar Δp with a 3 ms on/off response. The final prototype was also able to reach this target. The project will continue to implement the ECAV with both a poppet and a spool valve body for experimental investigation.

59 Actively Controlled Digital Pump/Motor

Tyler Helmus, FP/MS
Advisor: *J. Lumkes*

Current state of the art variable displacement pump/motors have high efficiencies when operating at high displacements. However, the efficiency significantly decreases at low displacements. Digital pump/motors aim to increase the efficiency and range of operation of the fluid power system by minimizing leakage, friction and compressibility losses. This method replaces a traditional valve plate with electrically controlled high speed on/off valves connected to each piston cylinder. This project uses a continually improving coupled-physics dynamic model as well as a test stand of a digital hydraulic pump/motor to understand the design tradeoffs and operating characteristics. With these tools, different operating strategies (flow limiting and flow diverting) can be investigated. The results show sequential flow limiting strategy yields the lowest power loss in both pumping and motoring with a minimum efficiency higher than 70%. Additionally, it was found that small variances in the valve response cause a significant drop in unit efficiency.

60 An updated summary of agricultural confined –related incidents – 1964-2013

Salah Issa, FP/MS
Advisor: *W. Field*

This paper provides a general update on confined spaces cases in 2013 and general trends observed during the period 1964 to 2013 with a focus grain entrapment cases. This is based on the PACSID database that contains over 1600 incidents with more than a 1000 of these cases grain-related entrapments. This represents 62% of all documented cases. The paper focuses on grain entrapments due to its prominence in the database and importance in the national discourse. Overall, entrapments were recorded in 42 states with the most occurring in the Corn Belt region. The five year average for grain entrapments remains at a high of 36.4 cases per year. In addition, data for other confined space incidents such as asphyxiation, electrocution, falls and equipment entanglements is summarized in this paper. Lastly, this paper will discuss the impact of adding over 160

new cases on our prior findings and research.

61 Computational Valve Plate Design

Paul Kalbfleisch, FP/MS
Advisor: *M. Ivantysynova*

My recent research has been focused on the design of the valve plate, located within the pump that influences both the oscillating moments and oscillating pressure ripples. This is the only component of the pump that can influence both sources of auditory noise found with in hydraulic systems. My recent research in optimization has shown great success as compared to my predecessors in successfully implementing a fast and efficient optimization algorithm to minimize both sources of noise as well as maximizing the efficiency of the machine.

62 The Practical Utility Platform: Transportation and Power Solutions for Africa

Jeremy Robison, FP/MS
Advisor: *J. Lumkes*

Sub-Saharan Africa needs better transportation and agricultural power. The Practical Utility Platform or PUP is an off road vehicle that was designed and built to provide Sub-Saharan Africa with an affordable method of transportation and agricultural mechanization. This utility vehicle is capable of hauling a load of 900 kg and can reach speeds up to 35 km/hr while costing less than $2000 US dollars. For added value, the PUP also acts as a utility platform for a number of implements and attachments for added utility including water pumps, maize grinders, cultivators, planters, and generators. These attachments can boost a farmer's productivity and mechanize previously strenuous work. Additionally, this utility vehicle can be built and repaired using resources that are commonly found in Sub-Saharan Africa. All of these aspects combine to form one vehicle that addresses Sub-Saharan Africa's transportation and agricultural power needs.

63 Next Steps towards Digital Prototyping of Pumps and Motors

Lizhi Shang, FP/MS
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The goal of this project is to predict outlet port and case flow temperature to enable computational design of axial piston machines. The temperature prediction considers the combination of calculating the Energy dissipation in lubricating interfaces, churning losses,temperature variation due to Compression/expansion,Heat transfer, and finally heat transfer due to Convection. My design methodology effectively encompasses all the required physical phenomenon to accurately predict the fluid temperatures found with a pump.

64 The Impact of a Shaped Piston on Power Loss of Piston/Cylinder Interface

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Study how to reduce energy dissipation between the piston and cylinder at a wide range of operating conditions while increasing performance such as increasing swash plate angle, increasing maximum pressure, and increasing speed.

65 Modelling of positive displacements machines: the case of external gears pumps

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In this poster the approach used for the modelling of positive displacement machine such as external gear pumps using a simulating tool developed over several years of research called HYGESim which is currently under development at Maha Lab. Problems peculiarity and solutions of this problem are shown in this poster.