ARPA-E Workshop:
A new nitrogen cycle for bioenergy crops
Participant Bio-sketches

November 14 – 15, 2023
Swissotel
Chicago, IL

A new nitrogen cycle for bioenergy production

Angela Kent

Professor

akent@illinois.edu

Relevant experience bio sketch

- An overarching goal of my research program is to understand how microbiomes can be managed to improve environmental quality and sustainability. Current work in my lab is focused on how crop genetics affect microbiome-associated phenotypes that reduce N losses through leaching and GHG production, and incorporating that into crop breeding programs.

Plant-Microbe Interactions

- I am interested in breeding plants for microbiome-associated phenotypes. In particular, I am interested in developing plant traits to reduce microbial processes that contribute to GHG production and N losses.
- **We are already making progress in this area!** We have **identified novel plant traits** that can inhibit nitrification and denitrification, and are testing these in the field.

Ideas, questions, and feedback

- What do you hope to learn from this workshop?
  - Interest in breeding crops for microbiome-associated N retention traits
  - Technologies to accelerate the phenotyping of microbiome-associated traits
- What are the ideas in the community that are inspiring you right now?
  - Engineering symbioses by pairing GMO microbes with compatible plant traits.

A new nitrogen cycle for bioenergy production

April MacIntyre, Ph.D.

Soil Microbiologist, Valent Biosciences, Libertyville, IL, USA

April.MacIntyre@valentbiosciences.com

Relevant experience bio sketch

- Joined Valent BioSciences as a Soil Microbiologist in the Rhizosphere research group in Jan. 2022. Goal of Rhizosphere group is to research and develop our arbuscular mycorrhizal fungal (AMF) technology platform
- Prior to joining VBC, postdoc at University of Wisconsin-Madison in Dr. Jean-Michel Ané's lab studying plant-growth-promoting microbes and microbial consortia
- Ph.D. in Microbiology from UW-Madison Dept. of Plant Pathology in Dr. Caitilyn Allen's lab studying plant and microbial sugar metabolism and water physiology during bacterial wilt disease

Technology or focus area

- **Your technology:** Arbuscular mycorrhizal fungi, soil microbes, biostimulants
- **Your focus area:** Bacterial nitrogen metabolism, nitrogen and phosphorus cycling, nutrient uptake efficiency, plant-bacterial-fungal interactions at varying scales (lab, greenhouse, field)
- **What about your work would attendees be interested to know?** Industry/applied perspective; microbial inoculant R&D, production, and sale

Ideas, questions, and feedback

- **What do you hope to learn from this workshop?** Meet researchers in the field; learn more about the sustainability and environmental impact of bioenergy production; expected impact of bioengineering on nitrogen cycling
- **What are the ideas in the community that are inspiring you right now?** Potential legislation for fertilizer use/application to limit environmental degradation; microbial consortia vs. single inoculants for establishing non-native populations and persistence; keystone microbial species in nutrient cycling

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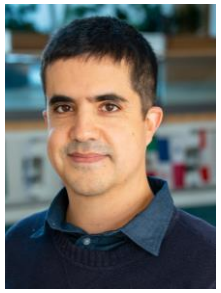

DONALD DANFORTH PLANT SCIENCE CENTER

Armando Bravo

Principal Investigator

abravo@danforthcenter.org

Relevant experience bio sketch

- Plant biologist focused on functional genetics of plant-microbe interactions.
- Expertise in Arbuscular Mycorrhizal (AM) symbiosis and nutrient exchange between plants and AM fungi.
- Principal Investigator at the Donald Danforth Plant Science Center

Technology or focus area

- The focus of my team is to understand the exchange of Carbon and Nitrogen between AM fungi and plants.
- We use molecular & cellular biology, biochemistry and genomics tools.

Interesting about my work:

- I work on the mechanisms of lipid transfer from plants to AM fungi.

Ideas, questions, and feedback

- What do you hope to learn from this workshop?
  - Novel ideas and approaches on how to reduce synthetic N fertilizer.
- What are the ideas in the community that are inspiring you right now?
  - Using non-conventional organisms to modify existing outcomes.
- What building component do you think would be most impactful and most feasible to replace?
  - The understudied organisms in the soil food web.

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CHANGING WHAT'S POSSIBLE

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DONALD DANFORTH PLANT SCIENCE CENTER

Becky Bart
Member, PI
rbart@danforthcenter.org

My research focuses on the complicated interactions between plants, microbes and the environment and encompasses disease-causing microbes such as bacteria and viruses and the less well understood multitude of beneficial microbes that associate with plants. I serve as the Director of the Subterranean Influences on Carbon and Nitrogen (SINC) Center.

Technology or focus area

- My team applies computational, lab and field-based methods to dissect the complicated web of plant, microbes and environment interactions.
- Our near-term goal is to understand how these interactions affect plant health.
- Our long-term goal is to translate this knowledge into practical solutions that increase the sustainability of agriculture.

Ideas, questions, and feedback

- I look forward to learning more about what others are doing, sharing my own ideas and giving and receiving constructive feedback.
- There is so much yet to be discovered within the realm of plant, microbe, environment interactions!
- Efficient discovery of novel, beneficial microbes is currently a major challenge. Computational approaches need to be developed to address this bottleneck.

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Kevin Kosola

Senior Research Scientist

Kevin.Kosola@bayer.com

Relevant experience bio sketch

- Crop physiologist at Bayer Crop Science since 2008
- PhD in plant physiology at UC Davis, 1991
- Academic research on nitrogen and root biology in horticultural crops and hybrid poplar
- Postdoc at University of Florida, Michigan State University
- Asst Prof, University of Wisconsin, Horticulture Dept. 2001-2008

Technology or focus area

- Focus on agronomic N use efficiency in corn
  - Improving agricultural sustainability is a business goal for Bayer Crop Science

- Kosola et al. (2023) Short-stature and tall maize hybrids have a similar yield response to split-rate vs. pre-plant N applications, but differ in biomass and nitrogen partitioning. Field Crop Research https://doi.org/10.1016/j.fcr.2023.108880

Ideas, questions, and feedback

- How can we reduce greenhouse gas emissions from N application without reducing crop yield potential?

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University of Massachusetts Amherst

Dr. Ashley Keiser

Assistant Professor

akeiser@umass.edu

Relevant experience bio sketch

- Soil ecology
- Biogeochemistry
- Coupled carbon-nitrogen cycling in soils
- Plant-soil interactions
- Managed landscapes, including corn and *Miscanthus* bioenergy cropping systems
- Stable isotope tracing

Technology or focus area

- I am interested in using ecological principles to constrain nitrogen cycling through greater plant-microbial interactions and feedbacks.
- We have shown that soil carbon stocks can be a predictor of nitrogen transformations through coupled carbon-nitrogen cycles and microbial competition for nitrogen (stoichiometry!). Importantly, increasing soil carbon concentrations reduces nitrification, which can reduce N_2O emissions.

Ideas, questions, and feedback

- To gain a better sense of the breath of disciplines and the varied approaches currently tackling this problem.

- I'm excited about efforts to alter or introduce new soil microbial communities to more efficiently capture and internally cycle nitrogen.

A new nitrogen cycle for bioenergy production

UC DAVIS
UNIVERSITY OF CALIFORNIA

Alan Bennett

Distinguished Professor

abbennett@ucdavis.edu

Alan Bennett has been an active researcher, educator, technology transfer advocate/practitioner and is the founding Executive Director of the UC Davis-Chile Life Science Innovation Center as well as the Public Intellectual Property Resource for Aggriculture (PIPRA). Bennett earned B.S. and Ph.D. degrees in Plant Biology at UC Davis and Cornell University, respectively. He has published over 170 scientific research papers in the area of plant molecular biology and is a Fellow of the American Association for the Advancement of Science (AAAS) and a Senior Fellow of the California Council for Science and Technology (CCST), a science policy advisory council for the State of California.

Technology or focus area

My team developed and tested the hypothesis that genetically isolated Mexican maize landraces may have coevolved with diazotrophic (nitrogen fixing) microbial communities to effectively fix atmospheric nitrogen and delivered reduced nitrogen to support the growth and development of the crop.

We demonstrated high levels (28-82% of total plant N) derived from atmospheric nitrogen fixation in a Sierra Mixe maize landrace. A major finding was that a viscous mucilage covering aerial roots harbored the diazotrophic microbial community. The concept that root mucilage provided a niche to support functional diazotrophs opened novel insights to understand nitrogen fixation in cereal crops.

A new nitrogen cycle for bioenergy crop production

Kula Bio

Harrison Yoon, Ph.D.
COO
yoon@kulabio.com

Relevant experience bio sketch

- COO, Growcentia, USA
- Co-Founder & Board, California Cultured, USA
- Chief Production & Operations Officer, Agrinos, Norway/USA
- President, Bioderpac SA de CV, Mexico
- CSO, Diana Group SA, France

Technology or focus area

Kula Bio is at the forefront of developing a pioneering microbial nitrogen fixation technology. This approach harnesses the power of microorganisms to transform atmospheric nitrogen into a plant-friendly form, effectively decreasing the dependence on synthetic nitrogen fertilizers, via more efficient plant-microbial interactions. This seeks to enhance agricultural sustainability and diminish environmental harm and has the potential to contribute to bioenergy production without incurring additional capital costs. These microorganisms' biological components and byproducts can carry energy for various applications, expanding its versatility

Ideas, questions, and feedback

- From this workshop, I hope to gain a deeper understanding of the innovative techniques and technologies that optimize the nitrogen cycle within crop cultivation to enhance sustainability and productivity in bioenergy production. Additionally, I look forward to discovering potential solutions for minimizing the environmental impact of synthetic nitrogen fertilizers in the bioenergy industry.
- I hope to see the community's focus on managing and controlling microbial activities in the real plant-soil system.
- Green ammonia has shown promise in addressing one of the significant challenges, namely, CO_2 emission from brown/gray ammonia production. However, it falls short in tackling the other major concern – N-leaching and N_2O emission. To safeguard our planet, we must seek additional innovative solutions.

A new nitrogen cycle for bioenergy production

Christopher Hewitt

Snr. Mgr., Public Funding

christopher.hewitt@basf.com

Relevant experience bio sketch

- Ph.D. Chemist with broad experience in business and technical leadership, innovation and collaboration management
- Current advisory board role for academic centers focused on sustainability and carbon footprint reduction.
- Support for building collaborative approaches for research and investment in order to meet BASF Net Zero commitments

Technology or focus area

- Focus is broad and driven by supporting BASF and our customers achieve our Net Zero goals.

Ideas, questions, and feedback

- What do you hope to learn from this workshop?
  - Meet and engage with different stakeholders with whom we can work to reduce carbon footprint in agriculture and downstream products and processes
- What are the ideas in the community that are inspiring you right now?
  - Dialog between different stakeholders on practical approaches to deployment of new tools and technologies and measures to capture and share benefits
- What building component do you think would be most impactful and most feasible to replace?

A new nitrogen cycle for bioenergy production

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Wei Xiong

Research Scientist V

wei.xiong@nrel.gov

Relevant experience bio sketch

- Dr. Wei Xiong is a research scientist and principal investigator at the National Renewable Energy Laboratory (Golden, CO), with a focused expertise in synthetic biology and metabolic engineering. His extensive background includes microbial biotechnology, one carbon metabolism, gas fermentation, and photosynthesis. With a profound understanding of metabolism and 13C-fluxomics, Dr. Xiong has been at the forefront of advancing the field of renewable energy through biological innovations.

Technology or focus area

- Harnessing the power of microorganisms to advance sustainable energy solutions.
- The potential to design and optimize metabolic processes for improved nitrogen/carbon recycling.
  - The development of efficient pathways for the synthesis of chemicals and fertilizers.
  - 13C and 15N metabolic flux analysis
- Attendees would be interested in Dr. Xiong's approach to leveraging computational models with experimental biology and electrochemistry, leading to new biodesign (e.g., Reductive Acetyl CoA Bicycle and Photo-electrosynthesis).

Ideas, questions, and feedback

- I am interested in developing live Nitrogen-fixing bacteria as biofertilizer
- The latest advancements in metabolic engineering and their application potential in nitrogen recycling.

A new nitrogen cycle for bioenergy production

University of Minnesota

Brett Barney

Professor

bbarney@umn.edu

Relevant experience bio sketch

- 20+ years of study related to Biological Nitrogen Fixation
- 15 years directed at improving nitrogen export in diazotrophs for biofertilizer production
- Recent studies to understand beneficial plant growth promoting bacteria and endophytes that directly associate with energy crops

Enhanced Nitrogen Fixing Microbes

- Enhancing diazotrophic bacteria for improved biofertilizer potential and modification of endophytes to direct produced nitrogen directly to requisite plant tissues
- Better understanding of Biological Nitrogen Fixation
- We have developed multiple strains of diazotrophic bacteria with enhanced nitrogen production

Ideas, questions, and feedback

- What are other entities doing to develop suitable replacements for Haber Bosch?

- The appreciation of the plant microbiome is becoming more evident and extending beyond legumes and nodule related microbes.

A new nitrogen cycle for bioenergy production

Univ. of Wisconsin-Madison

Brian F. Pfleger

Monfre Professor of CBE
brian.pfleger@wisc.edu

- BS/PhD Chemical Engineering
- 20+ Years experience in Synthetic Biology and Metabolic Engineering
- Research Areas
  - Oleochemical biosynthesis
  - Cyanobacteria synbio
  - Bioprocess development
  - RNA turnover
  - Enzyme Engineering
- PI on ARPA-E EcoSynBio project

Technology or focus area

- Engineering rhizosphere microbes to improve crop health and performance
  - We have developed a synthetic biology toolbox for three Gram-negative bacteria
  - We are working to enhance N2 fixation and association with desired plants
- Toolbox manuscript is accepted and coming soon. Tools will be deposited in AddGene.

Ideas, questions, and feedback

- I want to learn what the state of the art in engineering rhizosphere communities is
- Interkingdom signaling between plants and microbes is fascinating to me

A new nitrogen cycle for bioenergy production

PennState

Costas D. Maranas

Professor

costas@psu.edu

Relevant experience bio sketch

- Multiple decades experience in metabolic modeling of microbes, plants and communities thereof. Expertise in developing computational frameworks for interrogating possible trophic interactions between partners and engineering strategies for imparting trophic dependencies.

Technology or focus area

- My interest is to better understand carbon and nitrogen trafficking between microbes and plants in the rizosphere to enhance agronomic plant traits.
  - Metabolic modeling and computational analyses
  - Bioenergy, biorenewables.

Ideas, questions, and feedback

- Learn of new analytical measurement techniques and how they can inform computations and modeling.
- The potential to impact nitrogen use efficiency and mitigate environmental impacts.
- Engineer pre- or probiotic amendments for enhancing plant growth and reduce reliance to synthetic fertilizers.

A new nitrogen cycle for bioenergy production

Hans Carlson

Research Scientist

hkcarlson@lbl.gov

Relevant experience bio sketch

- PhD in Chemistry,
- Postdoc in Microbial Physiology
- Enzymology, microbial physiology and metabolism, mechanistic biogeochemistry
- Collaboration: Vivek Mutalik, LBNL

Technology or focus area

- Tell us a little about your interests in this area
  - Developing high-throughput screens and phage formulations to selectively modulate microbial element cycling

- What about your work would attendees be interested to know?
  - We have developed HT screens to identify selective controls on microbial N-cycling and approaches for phage cocktail design

Ideas, questions, and feedback

- What do you hope to learn from this workshop?
  - Info on microbial amendments in Ag
- What are the ideas in the community that are inspiring you right now?
  - Deployment of field scale microbials to control N cycle (e.g. Pivot)
- What building component do you think would be most impactful and most feasible to replace?
  - Fertilizer with a biological/phage/chemical

A new nitrogen cycle for bioenergy production

Chuck Rice

University Distinguished Professor

KANSAS STATE UNIVERSITY
Department of Agronomy

cwrice@ksu.edu

Bio sketch

Agricultural Mitigation and Adaptation of Climate Change: has impacted scientific understanding, implementation, and policy related to agriculture's role in climate change mitigation and adaptation.

Nitrogen Management: has researched and provided strategies on N management of cropping systems. He is considered one of the top experts on N management.

Soil Microbiology and Soil Health: has contributed to understanding soil biological health and the associated management practice to sustain or improve soil health.

Technology or focus area

- Tell us a little about your interests in this area
  - Rhizosphere microbiology
  - Design Regenerative Ag systems for Nitrogen, water, carbon, and energy efficiencies.
  - Systems
- Measuring soil carbon and N balance of intensified and diversified cropping systems

Ideas, questions, and feedback

- How to integrate bioenergy crops into regenerative agricultural systems.
- Bioinoculants to increase C and N efficiencies
- Managing the farmscape for bioenergy crops

A new nitrogen cycle for bioenergy production

Hans Carlson

Research Scientist

hkcarlson@lbl.gov

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NAU NORTHERN ARIZONA UNIVERSITY
Department of Biological Sciences
ECOS

Javier A. Ceja-Navarro

Associate Professor

Javier.Ceja-Navarro@nau.edu

Relevant experience bio sketch

I am a microbial ecologist trained in multi-omics, bioinformatics, molecular biology, and microbiology. My research focuses on analyzing the contributions of cross-domain microbial trophic interactions in nutrient cycling in ecosystems ranging from the guts of insects to soil.

Technology or focus area

- Nutrient cycling in soil is regulated by microbial activity mediated by top-down and bottom-up controllers. I am interested in applying a holistic approach to analyzing biogeochemical processes considering the associations among all microbial players in an ecosystem, i.e., bacteria, archaea, viruses, fungi, and protists.

Ideas, questions, and feedback

- What do you hope to learn from this workshop?

Potential collaborations for large-scale projects aiming to improve N and C use efficiency.

- What are the ideas in the community that are inspiring you right now?

Mostly those related to traditional knowledge of land management.

- What building component would be most impactful and most feasible to replace?

Improving land management practices to enhance N use efficiency by applying natural and engineered microbial solutions.

A new nitrogen cycle for bioenergy production

Chuck Rice

University Distinguished Professor

KANSAS STATE UNIVERSITY
Department of Agronomy

cwrice@ksu.edu

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Ideas, questions, and feedback

- How to integrate bioenergy crops into regenerative agricultural systems.
- Bioinoculants to increase C and N efficiencies
- Managing the farmscape for bioenergy crops

A new nitrogen cycle for bioenergy production

Christopher Neale

Director of Research

cneale@nebraska.edu

Relevant experience bio sketch

- Agricultural engineer with 35+ years of experience in irrigation engineering and water management and applied remote sensing to agricultural and natural systems
- Expert on evapotranspiration measurement and modeling using different techniques, including remote sensing

Technology or focus area (SmartFarm)

- Eddy Covariance techniques and automated soil GHG chambers for measuring H2O, CO2, N2O and CH4
  - Atmospheric (EC) and soil measurements of GHG gases
  - Remote sensing approaches
- Measuring complete C and N balance on three grain production fields at different mid-west locations and microclimates

Ideas, questions, and feedback

- Would like to learn more about the mechanisms involved in the release of N2O from typical production fields. CH4?
- Interested in the potential of using unmanned aerial systems (UAS) equipped with sensors to measure CH4 and N2O spatially above production fields.

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SOIL HEALTH INSTITUTE
Enriching Soil, Enhancing Life

Cristine Morgan
Chief Scientific Officer
cmorgan@soilhealthinstitute.org

Relevant experience bio sketch

- Soil Scientist
- PD of ROOTS team – measuring plant roots with MRI
- PD of SMARTFARM team – Measuring soil carbon stock *in situ*
- Experience in developing and applying soil sensor technology in the field (Proximal soil sensing)

- Digital Soil Mapping

Technology or focus area

- Tell us a little about your interests in this area
  No invasive sensing of soil properties across farm fields at high spatial resolution *in situ*
  - Measuring nitrous oxide and methane hot spot across farm fields an delivering the change in a MMRV

- Varied experience in soil measurement on farm

Ideas, questions, and feedback

- What technologies are being developed and proposed?

- Who is developing what and what is their prior experience

- I am interested in microbial approaches

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DONALD DANFORTH PLANT SCIENCE CENTER

Christopher Topp

Principal Investigator

ctopp@danforthcenter.org

Relevant experience bio sketch

- I am a root biologist who develops root imaging and analysis approaches to identify genes that control root system architecture and environmental interactions
- I have worked on how genetic variation in maize and sorghum influences plant nitrogen relations for over a decade
- I serve as co-Director of the Subterranean Influences on Nitrogen and Carbon Cycling Center of Excellence

Technology or focus area

- We have identified genes that can increase the rooting depth of maize and sorghum in the field
- At least one of these genes increases the efficiency of nitrogen capture
- We specialize in X-ray CT and X-ray microscopy to capture multiscale interactions of roots, soil, and microbes

Ideas, questions, and feedback

- As a plant biologist, I always appreciate learning more about the amazing world of microbes and how their process scale to that of plants, plots, and fields
- Modern crops have not been bred to maximize productive interactions with microbes and to capture nitrogen – lets re-emphasize these genetics
- Better root systems have myriad benefits, and we know how to manipulate them now better than ever before

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Wisconsin Crop Innovation Center
UNIVERSITY OF WISCONSIN-MADISON

Ray Collier

Mol Tech Dept Manager

rcollier2@wisc.edu

Relevant experience bio sketch

- PhD training focused on isolation and characterization of soybean plasma membrane ureide transporters
- Work with clients to design and build plant transformation constructs at the Wisconsin Crop Innovation Center
- Co-inventor of the GA*A*NTRY system (large T-DNA molecules) that can make large metabolic pathway engineering in plants a reality.

Technology or focus area

- Advancing plant transformation
  - GA*A*NTRY System
  - Expanding the capacity of what can be delivered to plants

- Imagine engineering plants with more than 20 genes; we can now think about doing it with GA*A*NTRY

Ideas, questions, and feedback

- How can the WCIC participate in plant improvement?

- Intron mediated enhancement, activation strategies, targeted integration, developmental gene mediated plant transformation as a way to break recalcitrance.

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Dr. Corey Lacey

Public Policy Manager

corey.lacey@ilsoy.org

Relevant experience bio sketch

- Doctorate in Soil Chemistry and Fertility from Purdue University
- 10+ years working in Illinois Agriculture
- Multiple publications on N cycle dynamics in agriculture systems.

Technology or focus area

- Tell us a little about your interests in this area
  - Understanding how new ideas in the space can benefit Illinois farmers
  - Investigating how state and federal policy can help grow innovative and groundbreaking concepts
  - Seeking out collaborations

Ideas, questions, and feedback

- What do you hope to learn from this workshop?
  - *Looking forward to learning the unexpected*
- What are the ideas in the community that are inspiring you right now?
  - *Approaches that reward farmers for dramatic, impactful, meaningful operational changes*
- What building component do you think would be most impactful and most feasible to replace?
  - *My hesitant guess would be concrete*

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Cristine (Cris) Handel

Global sustainability director

Cris.Handel@ValentBiosciences.com

Relevant experience bio sketch

Cris has been involved in sustainability for 25+ years, working for large corporations, consulting, startup and nonprofit companies. In the last 10 years Cris has supported the development of CoverCress (new cover crop that produces a harvestable oil grain between the corn-soy rotation), helped the development of partnerships that directly increase small holder farmer prosperity and now is focused on structuring global sustainability for Valent Biosciences to improve farmer ROI while mitigating climate change.

Technology or focus area

- My focus area is around agriculture sustainability, especially around the main points that increase farmer ROI while reducing climate change.
- Biological products impact in agriculture.

Ideas, questions, and feedback

What do you hope to learn from this workshop?

- I am hoping to meet new people and broaden horizons on nitrogen impacts in sustainability.

What are the ideas in the community that are inspiring you right now?

- Nitrogen fixation for non legume plants and ways to reduce nitrogen runoff and greenhouse gas emissions.

What building component do you think would be most impactful and most feasible to replace?

- Microbial solutions!

A new nitrogen cycle for bioenergy production

Daniela Floss, Dr. rer. nat.

Sr. Manager Rhizosphere Research, Mycorrhizal Applications & Valent BioSciences

daniela.floss@valentbiosciences.com

Relevant experience bio sketch

Sr. Manager, Rhizosphere Research *06/2023 – present*
Mycorrhizal Applications & Valent BioSciences LLC, Libertyville, IL
I am responsible for the overall leadership and scientific direction across all Rhizosphere Research groups to discover new products with emphasis on arbuscular mycorrhizal fungi (AMF) and plant growth-promoting rhizobacteria, and to develop and improve AMF *in vitro* production technology.

Manager, Rhizosphere Research *03/2019 – 05/2023*
Valent BioSciences LLC, Libertyville, IL
I led a team of scientists to execute a basic and applied research program focusing on the discovery of new rhizosphere products.

Research Scientist *02/2016 – 02/2019*
Valent BioSciences LLC, Libertyville, IL
I established methodology and conducted experiments for the development of novel AMF-based commercial products.

Postdoctoral Scientist *03/2009 – 01/2016*
Boyce Thompson Institute, Cornell University, Ithaca, NY
My work focused on molecular mechanisms underlying formation and degeneration of arbuscules, which are AMF structures required for symbiotic nutrient exchange.

Doctoral Student *04/2004 – 12/2008*
Leibniz Institute of Plant Biochemistry, Halle, Germany
I investigated biosynthesis and function of carotenoid cleavage products accumulating in mycorrhizal roots.

Technology or focus area

Using arbuscular mycorrhizal fungi (AMF) as technology platform for the discovery of microbial rhizosphere products contributing to:

i. Improved crop yield and soil health
ii. Enhanced soil carbon sequestration
iii. Reduced greenhouse gas emissions

- What about your work would attendees be interested to know?
  Basic and applied research aspects on AMF including production of AMF

Ideas, questions, and feedback

- What do you hope to learn from this workshop?
  New product concepts

- What are the ideas in the community that are inspiring you right now?
  Harnessing the rhizosphere and hyphosphere microbiome to improve plant growth-promoting and other traits

- What building component do you think would be most impactful and most feasible to replace?
  Synthetic nitrogen fertilizers

A new nitrogen cycle for bioenergy production

Doug K. Allen

Principal Investigator

Doug.allen@ars.usda.gov

Relevant experience bio sketch

- Metabolic Flux Analysis
- Central metabolism
  - photosynthesis
  - carbon and nitrogen
  - lipid metabolism
- Isotopic labeling
- Mass Spectrometry

- USDA-ARS Scientist/Donald Danforth Plant Science Center Principal Investigator & Member

Technology or focus area

- Applications of isotopes to distinguish and quantify nutrient exchanges and cellular metabolic fluxes between plants and microbes

- Analyzing spatiotemporal metabolism with isotopes is a theme in my career and is directly applicable to the frontier of plant-microbe interactions

Ideas, questions, and feedback

- I hope to network with others in this space so that my research can be more impactful and potentially find future collaborators

- I hope to bring ideas about where isotopes may contribute to our understanding and synergize with others that have complementary skills or interests

A new nitrogen cycle for bioenergy production

Emily Stuchiner
Research Associate
Emily.Stuchiner@Colorado.edu

Relevant experience bio sketch

- My research focuses on understanding the microbial metabolic pathways that govern N_2O production and consumption processes in agricultural soils. I use diverse analytical tools including gas flux measurements, soil chemical analyses, genetic measurements, and stable isotopes to address my research questions, and I am especially interested in using laser-based instruments for gas and isotopic measurements.

Technology or focus area

- I use cavity enhanced absorption spectroscopy to measure both bulk N_2O concentration and N_2O isotopomers. Using this technology, I can perform high throughput natural abundance, enriched substrate, and pool dilution $^{15}N_2O$ stable isotope measurements. However, these measurements require logistical considerations that make this approach challenging (e.g.., field deployment, calibration issues, sample acquisition, cost). However, we have learned a lot, and I would love to discuss our ideas and questions further with other attendees.

Ideas, questions, and feedback

- I would love to know about advances in (1) field-deployability of stable isotope measurements in situ, and (2) technology to make high spatiotemporal resolution N_2O flux measurements more cheaply feasible.
- I am inspired by the broader scientific community's growing interest in the importance of N_2O as a greenhouse gas to measure and manage.
- We need to develop inexpensive and high throughput systems to quantify N_2O concentration and isotopes.

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THE UNIVERSITY OF UTAH

Hanseup Kim

Professor in Elect. Eng.

hanseup@ece.utah.edu

Relevant experience bio sketch

- Ph.D. in Electrical Eng., U. of Michigan – Ann Arbor
- Professor in Electrical and Computer Engineering, U. of Utah
- Director, Utah Nanofabrication Facility
- Awardee, NSF CAREER (2012), DARPA Young Faculty Award (2011)
- PI, **ARPAE** - OPEN 2018, SMARTFARM, SEA-CO2; **DARPA** - NZERO, YFA, CSVMP, etc.

Technology or focus area

- Measurement, Reporting, Verification Technology
  - Ultra-low-power gas sensor node (integration of sensors, electronics, wireless communication units and a battery)
- Prev. work 1: 10-pW matchbox sized sensor node that detects a VOC with wireless tethering and 9-month lifetime in a sorghum field
- Prev. work 2: Low-cost optical bolometer array to cover carbon- and nitrogen-gases in soil

Ideas, questions, and feedback

- Would like to learn demands, challenges and specifications in sensing needed to contribute to controlled nitrogen cycling

- Propose to develop a closed-loop monitoring of plants as well as soils

A new nitrogen cycle for bioenergy production

KANSAS STATE UNIVERSITY

Ignacio Ciampitti

Professor

ciampitti@ksu.edu

Relevant experience bio sketch

Ciampitti is a professor in Agronomy and co-director in the Digital Agriculture Institute at Kansas State University with expertise on agricultural farming systems, digital ag, data analytics, and outreach. He is also the lead PI on a new project funded by USDA ($3M) on developing new digital dashboards for on-farm studies with a focus on nutrient budgets. Most of his recent related works include the development of new insights for effective use of nitrogen.

Technology or focus area

- Tell us a little about your interests in this area
  - Development of new insights for enhancing nitrogen use in major fields crops.
  - Integrating field, remote sensing, and crop modeling data for developing new concepts on nitrogen management.

- What about your work would attendees be interested to know?

Providing new insights on NUE versus the effective use of nitrogen for crop breeding and production.

Ideas, questions, and feedback

- What do you hope to learn from this workshop?

Establishing new collaborations and developing more interdisciplinary teams.

- What are the ideas in the community that are inspiring you right now?

Development of new technologies from crop improvement to on-farm nitrogen management.

A new nitrogen cycle for bioenergy production

Ivan Baxter

DONALD DANFORTH PLANT SCIENCE CENTER

Member and PI
ibaxter@danforthcenter.org

Relevant experience bio sketch

- Quantitative Genetics
- Bioinformatics
- High throughput elemental profiling (ionomics)
- Untargeted Metabolomics
- Image-based Phenotyping

Technology or focus area

- Maize genetics in low N environments
- Leveraging maize populations with exotic alleles

Ideas, questions, and feedback

- Looking forward to understanding more about all the approaches that could be integrated with plant genetics
- I'm excited about taking approaches developed for studying conventional cropping systems into more sustainable cropping systems like cover crops

A new nitrogen cycle for bioenergy production

James Schnable

Professor

schnable@unl.edu

Relevant experience bio sketch

Leads plant genetics, genomics, and automation team at the University of Nebraska-Lincoln.

Launched ag-tech startup commercializing instantaneous in-field nitrate sensors that can help corn farmers reduce nitrogen application 20-30% without altering yield.

Currently serves as a member of the $20M NSF/USDA Artificial Intelligence Institute for Resilient Agriculture

Technology or focus area

- Tell us a little about your interests in this area

Developing new crops and cropping systems that can reduce nitrogen runoff and use existing nitrogen mineralization more efficiently

- What about your work would attendees be interested to know?

We were able to bright Brought new high WUE/NUE crop varieties from concept to 10,000s of farmer acres in 7 years … really fast by plant breeding standards.

Ideas, questions, and feedback

What sort of goals and timelines are feasible for reducing nitrogen emissions?

How do we create low friction financial incentives for farmers to adopt new agronomic practices, crop varieties, or crop rotations.

Rethinking production and delivery of Ag Biologicals

Jane Fife, PhD
Chief Technical Officer
janefife@3barbiologics.com

Relevant experience bio sketch

- Leads R&D and Strategy at AgBioTech startup company
- Research background in Ag Biosystems engineering; fermentation, bioformulation, and application technologies of beneficial microbes
- Research interests in applying innovative technologies for more targeted delivery of Ag Biological inputs, and smarter, more sustainable Ag production

Technology or focus area

- Innovating how living microbe products are produced and delivered, creating step-change in economics and performance
  - LiveMicrobe™ Fermentation
  - LiveMicrobe™ BioPods
- Novel biomanufacturing and smarter supply chain management for on-demand fulfillment
  - Avoids over-production and waste inherent in conventional production

Fixing our perspective on N-fixing

Ideas, questions, and feedback

- What do you hope to learn from this workshop?
  - Systems thinking to improve performance of Ag Biologicals in field (plant/microbe systems; reducing to practice for improved efficiency)
- What are the ideas in the community that are inspiring you right now?
  - Stacking biological solutions to improve productivity
  - Overcoming increasing climatic variability and biotic/abiotic stresses using biological solutions
  - New microbe technologies and uses (eg, C-sequest)

A new nitrogen cycle for bioenergy production

OGANIZATION LOGO

Jaymin Patel

Postdoc

Jaymin@Berkeley.edu

Relevant experience bio sketch

- I am currently a postdoc in the Cress and Doudna Labs at UC Berkeley. My work focuses on understanding the dynamics of gene flow in complex microbial communities. Understanding these mechanics can allow us to more effectively introduce genome editing to these microbiomes.

Technology or focus area

- Tell us a little about your interests in this area
  - Our technology focuses developing precise genome editing tools for microbiomes, applying these for various applications in environment and human health.
- What about your work would attendees be interested to know?
  - We are always looking for new and exciting microbes or microbial communities to edit!

Ideas, questions, and feedback

- What do you hope to learn from this workshop?
  - I would like to better understand what defines the feasibility landscape and technoeconomics of nitrogen cycle interventions.
- What are the ideas in the community that are inspiring you right now?
  - The vast amount of work being done to understand microbial interactions at the genetic and metabolic level.

A new nitrogen cycle for bioenergy production

Jean-Michel Ané
Professor of Bacteriology
Professor of Plant and Agroecosystem Sciences
jeanmichel.ane@wisc.edu

Relevant experience bio sketch

- I am a microbiologist and plant biologist by training.
- I am interested in understanding how plants associate with beneficial microbes and, in particular, nitrogen-fixing bacteria and mycorrhizal fungi.
- I am interested in applying this knowledge to increase the benefits of these microbes for food, feed, fiber and biofuel production.

Technology or focus area

- I focus on improving biological nitrogen fixation for cereal crops (sorghum and corn).
- I have expertise evaluating nitrogen fixation in lab, greenhouse and field conditions.
- I hope that the attendees will be interested in our approaches to:
  - improve cereal crops to host nitrogen-fixing bacteria,
  - engineer nitrogen-fixing bacteria associated with these crops.

Ideas, questions, and feedback

- I hope to learn about new ideas and new technologies to solve the problems of nitrogen in agriculture.
- I think that both approaches on the plant side and the bacterial side are promising and complementary.

A new nitrogen cycle for bioenergy production

NREL

Jianping Yu

Researcher

Jianping.Yu@nrel.gov

Relevant experience bio sketch

I am a researcher at National Renewable Energy Laboratory, focusing on cyanobacteria metabolism and engineering.

I have a background in plant biology from Michigan State University, where I studied photosynthetic energy conversion, signal transduction, and flowering.

My lab has expertise in genetic manipulation of energy, carbon and nitrogen metabolism in photosynthetic organisms.

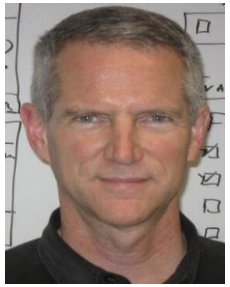
Technology or focus area

- Tell us a little about your interests in this area
  - Photosynthetic N-fixing bacteria
  - Genetic engineering
- I am starting a new DOE project on developing N-fixing cyanobacteria as biofertilizer to produce guanidine, ammonia, and urea.

Ideas, questions, and feedback

- I hope to learn new ideas on biological N fixation
- I am inspired by the recent efforts in deploying live N-fixing bacteria as biofertilizer
- I think photosynthetic N-fixing bacteria are promising biofertilizer

A new nitrogen cycle for bioenergy production



John Mullet

Professor, Biochemistry

john.mullet@ag.tamu.edu

Relevant experience bio sketch

- Sorghum genomics, genetics, biochemistry, physiology
- Research on sorghum root systems (field, rhizotrons)
- Gene regulatory network analysis of sorghum stem growth, wax production, dhurrin synthesis, and nodal root development.
- ARPA-E ROOTs, TERRA projects
- Member, GLBRC

Technology or focus area

- Tell us a little about your interests in this area
  - *Bioenergy sorghum for production of low C.I. feedstock*
  - *Developing root N-foraging technology*
  - *Producing bioenergy sorghum hybrids that can be grown with minimal or no N-fertilizer (and no irrigation).*
  - *Understanding how bioenergy sorghum's extensive 2m deep root system x microbiome adapts to minimal inputs.*

Ideas, questions, and feedback

- What do you hope to learn from this workshop?
  - *How to minimize bioenergy sorghum N-requirements and N_2O emissions*
- What are the ideas in the community that are inspiring you right now?
  - *Potential for single cell x organ x gene regulatory network analysis to enable pathway/trait engineering*

A new nitrogen cycle for bioenergy production

Colorado State Univ.

John McKay

Professor

jkmckay@colostate.edu

Relevant experience bio sketch

- PhD in Evolution and Genetics
- Collaborator with private and public breeding programs in maize and sorghum
- Co-founder of New West Genetics
- ARPA-E ROOTS PI

Genetics of root and N efficiency traits

- Tell us a little about your interests in this area
  - Mechanized destructive root sampling
  - Response to N and soil moisture
- We identify hybrids, inbreds and gene models that lead to increased drought adaptation, Nitrogen uptake capacity and root depth

Ideas, questions, and feedback

- What type of synthetic N fertilizer has lowest CI?
- Not being satisfied with incremental change
- Changing crop genetics and crop species

A new nitrogen cycle for bioenergy production

UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN

Kaiyu Guan

Blue Waters Professor

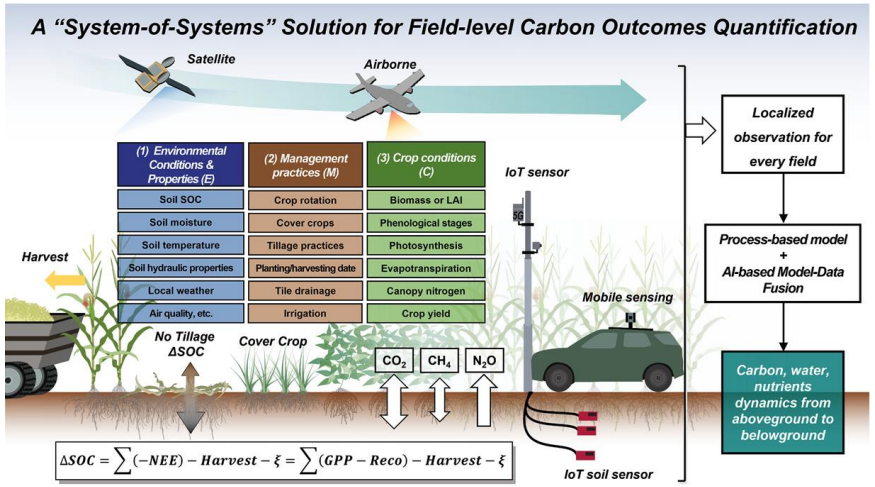
kaiyug@illinois.edu

Relevant experience bio sketch

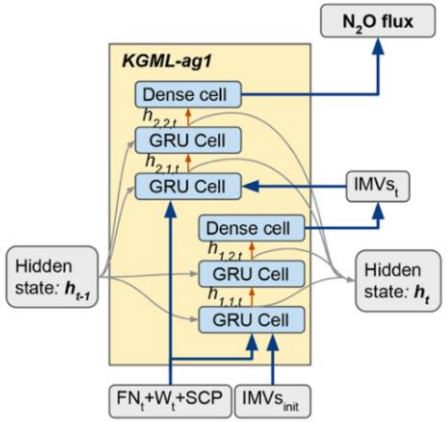
- Our research group uses satellite data, computational models, fieldwork, and machine learning approaches to address how climate and human practices affect crop productivity, water resource availability, and ecosystem functioning.
- We have keen interests in applying my knowledge and skills in solving real-life problems, such as large-scale crop monitoring and forecasting, water management and sustainability, and global food security.

Technology or focus area

1. We have developed the SYMFONI - “system of systems” solution to accurately quantify field-level GHG (N2O, CH4) and soil carbon change at the field level and scalable to millions of fields.



2. We have developed the first Knowledge-Guided Machine Learning (KGML) model for agroecosystem, including N2O and carbon cycles.



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A new nitrogen cycle for bioenergy production

Vijaya Gopal Kakani

Chair and Professor

vgkakani@okstate.edu

Relevant experience bio sketch

- Lead PI – ARPA-E – SMARTFARM-Sorghum.
- Chair and Professor, Agronomy Dept., Uni. of Florida.
- Bioenergy, Crop Physiology, Remote Sensing, Crop Modeling.
- >$14M in research grants.
- >100 research publications.
- >150 Invited and Voluntary talks.
- Fulbright-Kalam Cliamte Scholar.
- Young and Outstanding Agricultural Scientist recipient.
- Warth and Sarkeys Distinguished Professor

Technology or focus area

- Tell us a little about your interests in this area
  - Monitoring and measuring N_2O emissions
  - Management and Modeling

- Measuring and monitoring emissions at multiple scales

Ideas, questions, and feedback

- What do you hope to learn from this workshop?
- Network for Innovations to enhance nitrogen use efficiency
- What are the ideas in the community that are inspiring you right now?
- Transgenics, Autogenic, BNF, Crop Management
- What building component do you think would be most impactful and most feasible to replace?
- Reduced fertilizer application and increased nitrogen use efficiency

A new nitrogen cycle for bioenergy production

Kirsten Hofmockel

Sr. Scientist

Pacific Northwest NATIONAL LABORATORY

Kirsten.hofmockel@pnnl.gov

Relevant experience bio sketch

- Our work scales from genes to ecosystems
- We develop a mechanistic understanding of coupled carbon-nitrogen biogeochemistry
- We aim to understand the genomic foundation for metaphenomic expression in the soil habitat

Technology or focus area

- Soil Microbiome Science
- Bioenergy agroecology
- Plant-microbe-soil interactions
- Soil organic matter dynamics
- Model Soil Consortia
- Synthetic soil environments
- Stable isotope probing
- Multi-omic analyses

Ideas, questions, and feedback

- I hope to develop new collaborations to take foundational microbiome science to scale in the field
- Synthetic biology of mixed communities and real-time sensors are inspiring me

Use biochar biofertilizer in a new nitrogen cycle for bioenergy production

South Dakota State University

Name: Lin Wei

Associate Professor

Email: lin.wei@sdstate.edu

Relevant Experiences:

- Have intensive expertise and research experience on sustainable precision agriculture, biomass conversion into biofuels and bioproducts for more than 20 years.
- Serviced as PI or co-PI to secure more than $9.6 million of research funding to conduct 22 projects in the last 10 years.
- Gained 2 U.S. patents and 5 technical disclosures.
- Supervised 4 Postdocs and 30 graduate students (12 PhD and 18 M.S.)
- Published more than 80 relative peer-reviewed papers.

Technologies & Focusing Areas:

- Utilize biochar to provide hospitable environments for N-fixing bacteria thriving and stabilizing to produce effective biofertilizers using pre- or probiotic approaches.
- Integrate biochar biofertilizers with soil health to improve bioenergy crop production while promoting long-term carbon sequestration and GHG emission reduction.
  - Biochar enhances soil health by improving soil porosity and water-holding capacity to reduce or eliminate the use of synthetic N fertilizers.
  - Fixed biochar in soil for carbon sequestration.
  - Biochar absorption can reduce N loss through leaching and GHG (e.g., N_2O) emission.

Ideas, questions, and feedback:

- How to cost-effectively isolate or screen effective and robust N-fixing bacteria streams for fabricating probiotic biochar biofertilizers combined with other nutrients?
- How to optimize biochar microstructures and properties to maximize biofertilizer cost-effectiveness?
- How to integrate precision biofertilization with genetic engineering approaches to maximize productivity, profitability, and sustainability of bioenergy production?
- Probiotic biochar biofertilizers are the most impactful, but prebiotic biochar biofertilizers may be the most feasible to replace current synthetic fertilizers in near future.

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A new nitrogen cycle for bioenergy production

Nikira Labs Inc.
Science Made Simple

Manish Gupta
Chief Technology Officer
manish.gupta@nikiralabs.com

Relevant experience bio sketch

- Over 20 years of experience developing gas analyzers for both laboratory and field use
- Pioneer in the development and application of cavity-enhanced tunable diode laser absorption techniques
- Developed laboratory based nitrous oxide and nitrous oxide isotopomer analyzers

Technology or focus area

- Developing real-time, fieldable sensors for nitrous oxide quantification
- Extending the sensor technology to address isotope quantification, including site-specific isotopes
- Measuring other key nitrogen species (NO, NO_2, NH_3…) and their isotopes

Ideas, questions, and feedback

- What do you hope to learn from this workshop?
  The sensing technologies that would best benefit the nitrous oxide mitigation community.
- What are the ideas in the community that are inspiring you right now?
  Nitrous oxide mitigation using soil amendments and animal waste separation practices.
- What building component do you think would be most impactful and most feasible to replace?
  Changing agricultural practices to reduce waste conversion and over fertilization.

A new nitrogen cycle for bioenergy production

OGANIZATION LOGO

Marcus Meadows-Smith

CEO

mms@bioconsortia.com

Relevant experience bio sketch

- CEO of microbial R&D company

- Head of Biologics, Bayer
- CEO, AgraQuest (biopesticides)
- EVP, Crop Protection, Chemtura & Uniroyal Chemical (synthetic pesticides & seed treatments)

- Board of Botanical Solutions (plant extracts for biopesticides)
- Board of CropEnhancement (biopesticides)

- Farmer & winemaker (CCOF certified organic grapes)

Technology or focus area

- Tell us a little about your interests in this area
  - Microbial R&D company
  - N fixing microbes
  - Wild type microbes for EU
  - Gene Edited
- What about your work would attendees be interested to know?
  - Superior performance in field trials
  - Robust spore-forming microbes
  - 2 years life in can & 18 month life on seed
  - Easy to use, combines with pesticides & fertilizers

Ideas, questions, and feedback

- What do you hope to learn from this workshop?
  - Breakthroughs in GE Nfix microes
- What are the ideas in the community that are inspiring you right now?
  - Grower interest
- What building component do you think would be most impactful and most feasible to replace?

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A new nitrogen cycle for bioenergy production

Nithya Rajan

Professor

Nithya.rajan@ag.tamu.edu

Relevant experience bio sketch

My lab conducts basic and applied science research in crop and bioenergy production systems with a strong emphasis on reducing greenhouse gas (GHG) emissions, increasing carbon capture, and promoting sustainable agricultural management practices.

Technology or focus area

- Biological Nitrification Inhibition (BNI) in Sorghum and Corn
- Sorghum genotypes with high BNI exhibited higher nitrogen uptake and a notable reduction in N_2O emissions ranging from 28% to 63% under field conditions when compared to low BNI sorghum.

Ideas, questions, and feedback

The options to mitigate the impact of nitrogen fertilizers on N_2O emissions and nitrate leaching are currently limited, predominantly relying on crop management techniques. BNI offers a natural solution to address this critical issue, providing an opportunity to produce bioenergy feedstocks or ethanol with reduced carbon intensity.

A new nitrogen cycle for bioenergy production

KANSAS STATE UNIVERSITY

Peter Tomlinson

Assoc. Professor

ptomlin@ksu.edu

Relevant experience bio sketch

- Environmental quality Extension Specialist with Kansas State Univ
- Research specializations include
  - Soil microbial ecology and soil biology
  - Soil gas emissions i.e. CO_2, N_2O and CH_4
  - Soil quality and health
  - Water quality
- Co-PI on DOE ARPA-E Smartfarm phase 1 project focused on grain sorghum production systems

Technology or focus area

- Grain sorghum is an important feed stock for ethanol production.
- N management, plant genetics and symbiotic microbial interactions are opportunity areas for improving NUE and/or reducing denitrification.
- Projects over the past 10+ yrs have focused on management (fertilizer 4Rs, cover crops, etc.) to determine baseline N_2O emissions and mitigation opportunities in grain sorghum based cropping systems

Ideas, questions, and feedback

- What do you hope to learn from this workshop?
  - How we can advance beyond N management to GxExM approach to reduces feedstock CI values.
- What are the ideas in the community that are inspiring you right now?
  - Grain sorghum is being recognized as viable bioenergy crop in water limited environments.

A new nitrogen cycle for bioenergy production

Quentin Caudron

Sr. Manager, Agronomic Data Science

q.caudron@sound.ag

Relevant experience bio sketch

- BSc Chemistry, PhD Complexity Science and Computer Science
- Postdoc in Ecology and Evolutionary Biology
- Expertise in statistics and machine learning
- Experienced in remote sensing and satellite imagery
- Agronomy background with Corteva and Granular Ag

Technology or focus area

- Sound Agriculture seeks to create more agile and resilient agrosystems through reduced fertilizer use, healthier soils, and plant trait improvement through epigenetics
- I'm interested in the potential of symbiosis and regenerative approaches in creating greener productive ecosystems

Ideas, questions, and feedback

- The nitrogen cycle is a complex set of interdependent processes. A systems-level intervention has the potential for significant impact on current climate variables while keeping agriculture highly productive. I'd love to understand which parts of the cycle can be reliably targeted for large-scale adoption.

A new nitrogen cycle for bioenergy production

BILL & MELINDA GATES AGRICULTURAL INNOVATIONS

Rick DeRose
Scouting and Open Innovation
rick.derose@gatesagone.org

Relevant experience bio sketch

- Majority of career in multinational Ag Cos. Bench scientist, most of my career involved technology acquisition, and technical due diligence for Mergers and Acquisitions
- Focus is translating discovery research into applied research and validating it through stage gates into product development.

Technology or focus area

- Biological nitrogen fixation is a topic of interest
  - Looking
  - Improving soil fertility in soils with very low N, P, K and organics that are alkaline and high salt. Soil Temp is >35 C
- My target grower are the subsistence small holder farmers in sub-Saharin Africa and South Asia?

Ideas, questions, and feedback

- Learning new ideas and concepts that could be applicable for my grower
- Methylobacterium
- Cement and brick with strength enhanced materials containing plant fibers (ie Hemp)?

A new nitrogen cycle for bioenergy production

Texas A&M AgriLife Research

Sakiko Okumoto

Associate Professor

sakiko.okumoto@agnet.tamu.edu

Relevant experience bio sketch

Texas A&M team has been working to increase biological nitrification inhibition (BNI) in sorghum. My lab identified the cellular site of sorgoleone (the main BNI compound) biosynthesis and working to find the secretion mechanism. We have also screened >300 sorghum varieties to accelerate breeding and discover novel genes that control BNI.
Our lab also identified novel amino acid transporters, which we can use to change the N cycle between the plant and soil.

Technology or focus area

- Tell us a little about your interests in this area
  - We apply molecular techniques in crop plants to discover relevant gene functions
  - Nitrogen and membrane transport
- What about your work would attendees be interested to know?
  - We are working to increase BNI from both breeding and biotech approaches
  - We have techniques to identify and analyze key genes for nitrogen transport

Ideas, questions, and feedback

- What do you hope to learn from this workshop?
  Complementary approaches to reduce N pollution, policy landscape around N pollution
- What are the ideas in the community that are inspiring you right now?
  Integration of breeding, gene discovery, agronomy and policy in a cohesive chain to combat climate change.
- What building component do you think would be most impactful and most feasible to replace?
  Varieties. Requires no change in the hardware!

A new nitrogen cycle for bioenergy production

Sasilada Sirirungruang

Postdoctoral researcher

sasilada.s@lbl.gov

Relevant experience bio sketch

- Plant synthetic biology
- Plant specialized metabolism
- Biosynthesis

Technology or focus area

- Explore mucilage biosynthesis, which allows plants' association with microbes with nitrogen-fixing activity
- Engineer plant physiology and metabolism to enable diazotroph recruitment to its associated microbiome, and other agricultural and climate application

Ideas, questions, and feedback

- Using synthetic biology to enable biological nitrogen fixation to improve agricultural productivity and climate resiliency of plants and crops
- Reducing nitrogen waste by ensuring targeted delivery of fixed nitrogen

A new nitrogen cycle for bioenergy production

Sharon Bard

Principal

TERRA economics

sharonkbard@ gmail.com

Relevant experience bio sketch

- I am an agricultural economist specializing in biofuels and sustainable / regenerative agriculture.
- I also farm corn and soybeans with my husband in east-central Illinois.
- Past and current project topics include soy biodiesel feedstock carbon intensity (CI) quantification and economic evaluation, methodologies for estimating SOC and agricultural N_2O emissions, agricultural supply chain ESG reporting and biofuels feedstock LCA.

Technology or focus area

- Tell us a little about your interests in this area
  - Focus areas include row crop and biofuel feedstock production and CI quantification.
- What about your work would attendees be interested to know?
  - I combine the farmer and economic perspective with my knowledge of emerging opportunities and research on feedstock CI quantification to guide all sectors of the supply chain in making strategic decisions about biofuels feedstock production.

Ideas, questions, and feedback

- What do you hope to learn from this workshop?
  - Opportunities and barriers to developing and commercializing new technologies that simultaneously meet the nutritional needs of the crops and decrease the related N_2O emissions.
  - This includes scalability, TEA, the total carbon budget, and adaptability / applicability of the new technologies across multiple crops.

A new nitrogen cycle for bioenergy production

Sound Agriculture

Shawn Stricklin

Director of Data Science

s.stricklin@sound.ag

Relevant experience bio sketch

- Computational and synthetic biology for ag biotech R&D with Monsanto, GrassRoots, Bayer, Joyn Bio, and Sound Ag
- Genomics, biotech pipelines, data architecture
- Strategy and operations, technology prospecting, alliance management
- Ph.D. Molecular Genetics

Technology or focus area

- Sound Agriculture seeks to create more agile and resilient agrisystems through reduced fertilizer use, healthier soils, and plant trait improvement through epigenetics

Ideas, questions, and feedback

- Adapting to climate change, feeding 10 billion equitably, and preserving if not regenerating natural systems all require refactoring Ag. How can we work with growers to make it happen?
- I am most inspired by the hope that emerges when ecological improvement aligns with economic benefit.

A new nitrogen cycle for bioenergy production

Stephen Moose

Alexander Professor of Maize Breeding & Genetic

smoose@illinois.edu

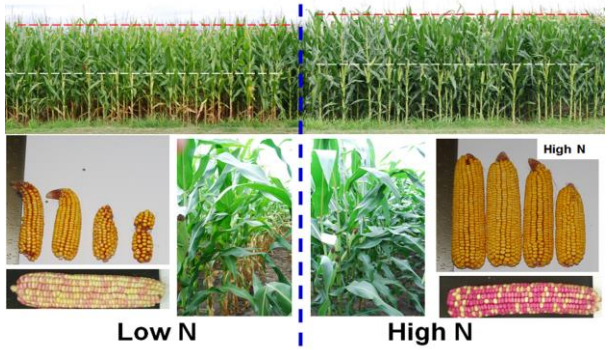
ILLINOIS Crop Sciences
COLLEGE OF AGRICULTURAL, CONSUMER & ENVIRONMENTAL SCIENCES

Bio sketch

- Lifetime of active participation in production agriculture.
- 20+ years experience with functional genomics studies of maize, sorghum, Miscanthus.
- Use genomics, genetics, & biotechnology to discover variants & improve crop performance.
- Have led crop improvement teams in industry (Dekalb Genetics & Renessen LLC) and academia (Energy Biosciences Institute, DOE CABBI, NSF CROPPS).
- Numerous collaborations with ag biotech industry, including co-authored papers.
- Investigator on PETROSS project in prior ARPA-E program (sorghum biotechnology)

Our "CornBox" field site is designed to measure trait responses to variable nitrogen supply

- 17 years of data
- gene discovery & validation with transgenics &/or CRISPR edits
- Past and current collaborations to dive deeper into root architecture and microbes, as well as both aerial and ground-based phenomics.



Ideas, questions, and feedback

- How can new knowledge about dynamic plants, soils, and weather be used to optimize nitrogen availability with plant demand?
- Would you like to bring your research to a real-world farm setting that offers genetic variation in response to nitrogen form and supply? If so, come talk to me.

A new nitrogen cycle for bioenergy production

BERKELEY LAB
Bringing Science Solutions to the World

Thomas Eng
Biologist Research Scientist/Engineer

tteng@lbl.gov

Biological Sketch

Thomas is a systems and synthetic biologist at LBNL funded primarily through the DOE Joint BioEnergy Institute. He brings expertise in building genetic tools in non-model microbes to rewire metabolism when grown in complex environments (plant rhizobiomes to stirred tank bioreactors). His graduate training focused on genetics in Molecular & Cell Biology.

Technology or focus area

- Development of CRISPR/recombineering systems in prokaryotic diazotrophs, biosensors, secretion of plant-responsive metabolites
- Computational modeling for growth coupled production of a non-native product
- “How can I track the behavior / persistence of my microbes in the soil?

Ideas, questions, and feedback

- Thomas hopes to find new collaborators in the SynAg space
- New tech: Viral and transposon based integration systems in diverse microbial hosts
- Classical allelic exchange with conjugation methods are slow and limited in success rate – let’s all adopt CRISPR.

A new nitrogen cycle for bioenergy production

Tim Schnabel, PhD

CEO & Founder

tim@switchbioworks.com

Tim Schnabel founded Switch Bioworks, transforming his doctoral and post-doctoral work in Bioengineering at Stanford into a biotechnology company focused on engineering microbes that produce cost-effective, sustainable fertilizer. In addition to his PhD, Schnabel holds an MS (’17) in Bioengineering and BS in Chemical Engineering and Economics (’15) from Stanford.

Technology or focus area

- Our goal is to dramatically improve performance of nitrogen fixing microbes as sustainable and cost-effective fertilizer.
- Wild-type microbes do not share N with plants directly and microbes that have been engineered to do so are constitutive producers, making them uncompetitive in soil due to the fitness burden of constitutive N fixation.
- We propose to switch between the two states, allowing microbes first to compete and colonize plants before switching to nitrogen fixation.

Ideas, questions, and feedback

- How can we increase colonization of desired microbes?
- How can we ensure there is enough energy in soil for microbes to fuel N fixation?
- How do we sustain R&D as a startup in a capital intensive space to see through our innovation?

Using bacteriophages to manipulate nitrogen cycle

Vivek K. Mutalik

Staff Scientist

vkmutalik@lbl.gov

Relevant experience bio sketch

- PhD in Biochemical Engineering,
- Postdoc in Microbiology, Synthetic biology
- >15yrs experience in synthetic & systems biology, microbial genetics, phage biology & engineering, bacterial pathogens, microbial physiology
- Collaboration: Hans Carlson, LBNL

Technology or focus area

- Tell us a little about your interests in this area
  - Developing high-throughput screens and phage formulations to selectively modulate microbial element cycling
- What about your work would attendees be interested to know?
  - We have developed HT screens to identify selective controls on microbial N-cycling and approaches for phage cocktail design

Ideas, questions, and feedback

- What do you hope to learn from this workshop?
  - Challenges & opportunities using microbial amendments
- What are the ideas in the community that are inspiring you right now?
  - Deployment of microbials to control N cycle
- What building component do you think would be most impactful and most feasible to replace?
  - Biologicals/phages to replace chemicals

A new nitrogen cycle for bioenergy production

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Wei Xiong

Research Scientist V

wei.xiong@nrel.gov

Relevant experience bio sketch

- Dr. Wei Xiong is a research scientist and principal investigator at the National Renewable Energy Laboratory (Golden, CO), with a focused expertise in synthetic biology and metabolic engineering. His extensive background includes microbial biotechnology, one carbon metabolism, gas fermentation, and photosynthesis. With a profound understanding of metabolism and 13C-fluxomics, Dr. Xiong has been at the forefront of advancing the field of renewable energy through biological innovations.

Technology or focus area

- Harnessing the power of microorganisms to advance sustainable energy solutions.
- The potential to design and optimize metabolic processes for improved nitrogen/carbon recycling.
  - The development of efficient pathways for the synthesis of chemicals and fertilizers.
  - 13C and 15N metabolic flux analysis
- Attendees would be interested in Dr. Xiong's approach to leveraging computational models with experimental biology and electrochemistry, leading to new biodesign (e.g., Reductive Acetyl CoA Bicycle and Photo-electrosynthesis).

Ideas, questions, and feedback

- I am interested in developing live Nitrogen-fixing bacteria as biofertilizer
- The latest advancements in metabolic engineering and their application potential in nitrogen recycling.

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UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN

Wendy Yang

Professor

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Relevant experience bio sketch

I am an ecosystem ecologist and biogeochemist. My research focuses on mechanisms driving soil greenhouse emissions and nutrient transformations in environment. In particular, I study how plant-soil-microbe interactions mediate soil nitrogen cycling and nitrous oxide emissions in natural and managed ecosystems. I also serve as the Sustainability Theme Leader for the Center for Advanced Bioenergy and Bioproducts Innovation.

Technology or focus area

- My focus area is in improving mechanistic understanding of soil nitrous oxide production and reduction in the environment so that we can develop plant, microbial, or management-based technologies to mitigate nitrous oxide emissions from agricultural fields.
- Through team science, I take an interdisciplinary systems approach to investigating plant-soil-microbe interactions.

Ideas, questions, and feedback

- I hope to learn about other opportunities and challenges to reducing soil nitrous oxide emissions beyond what I have considered.

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CLEARPATH

Jasmine Yu

Policy Advisor

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Relevant experience bio sketch

- Agriculture innovation and natural and hybrid carbon dioxide removal lead at ClearPath, a DC-based non-profit that develops and advances policies that accelerate innovations to reduce and remove global energy emissions.
- Dissertation on the biochemical pathways of bioenergy sorghum stem development under different environments.

Technology or focus areas

- Agriculture innovation policy for:
  - Increased agricultural RD&D
  - Reducing N2O emissions
  - Reducing CO2 emissions
  - Biochar research and deployment
  - Enhancing federal agency collaboration

Ideas, questions, and feedback

- What are methods to increase the variety of N2O reduction research areas?
- What is the TRL of existing N2O reduction innovations, and what is needed to support deployment?
- How can biological N2O reduction approaches be successfully adopted in the agriculture sector?