ICOFPE 2024

The International Conference for On-farm Precision Experimentation

ICOFPE 2024 CONFERENCE PROGRAM

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2024.ofpe.org

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Welcome to the 2024 International Conference for On-farm Precision Experimentation

Welcome to all, and thanks for taking some of your valuable time out to participate in ICOFPE 2024! The conference will be attended by over one hundred people from a wide range of agricultural professions, including farmers, Certified Crop Advisors, agronomists from some of the country's leading agricultural cooperatives, representatives from several private business operating in the precision agriculture and digital agriculture sphere, and professional researchers from the private and public sectors.

On-farm precision experimentation is building steam. It's fairly obvious that precision agriculture technology can be used to run large-scale "checkerboard" agronomic field trials. People have been discussing the possibilities of OFPEs for over twenty years with good reason--OFPEs have the potential to revolutionize agronomic research. They bring together the statistical advantages of small-plot trials and the scale advantages of strip trials to generate fantastic amounts of useful data. Most importantly, they allow farmers to generate data on the same fields that they want to manage.

DIFM ran over one hundred trials in 2023 in fifteen states and four countries. The data coming out of these trials is unparalleled. But our goal is to make it possible for tens of thousands of OFPEs to be conducted per year, not hundreds. We envision a future in which farmers can work with their advisors to run OFPEs much in the manner that they currently take and analyze soil samples: every few years in various parts of various fields they pay for soil sampling and rely on agronomists and other advisors to turn the information from those samples into actionable management recommendations. In the same way, DIFM wants to make it possible for farmers and their advisors to be running trials on various fields, doing so continually, and using the data to make improved management decisions. The bottleneck to the realization of this plan, of course, is that under current conditions it is not possible for farmers to convert the data into useful information—every farmer can't have a PhD-level statistician or artificial intelligence researcher on staff. That's why DIFM is developing trial design software, an automated data processor, an automated data analysis engine, and interactive statistical- and AI-based "decision-tools" that can make it possible for regular folks to improve their crop production management based on real data for their own fields. ICOFPE 2024 is all about introducing an early version of the DIFM "cyber-infrastructure" to the world.

DIFM's cyber-infrastructure is very new, and very much still in development. Dozens of researchers from over fifteen U.S. universities are working on developing its various components and making them work together seamlessly. We expect the development of the cyber-infrastructure to continued for years to come. ICOFPE 2024 is just a start. We hope that conference attendees will be patient with the inevitable glitches that come with software and analysis development in early stages.

DIFM researchers have agreed to develop the cyber-infrastructure as an open product, made available to the world for free, much like the current computing programming system R and the spatial analysis software QGIS are now managed. Of course, individual farmers' data will always be owned by the individual farmers. Even if that data is stored and managed in DIFM's database, it will never be given away or sold to outside parties.

Thanks for coming to South Padre! Please, please, please test drive what we've developed and help us to make it better! This is just the beginning.

Very Best,

David Bullock
Professor, University of Illinois Department of Agricultural and Consumer Economics
Principle Investigator, Data-Intensive Farm Management Project

Acknowledgements
The DIFM project major funding comes from a USDA-NRCS Conservation Innovation Grant, On-farm Trials program, Award Number NR213A7500013G021. USDA-NIFA provided a $50,000 USDA-NIFA Conference Grant, GRANT13671487/2022-07107. The travel of many of the land-grant university-based researchers came from the NC-1210 Multistate Project supported by the National Information Management and Support System. We especially welcome Purdue University's Dr. Ron Turco, who is NIMSS's Administrative Advisor working with the project. Travel, lodging and conference expenses of attendees who are faculty in community college ag-tech programs was funded by a USDA-NIFA Education and Workforce Development Grant 2023-67038-40104.

Organizing Committee

General Chair
David Bullock, *University of Illinois, USA*

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Speaker Biographies

Aaron Sundquist

After recently graduating from Mitchell Technical College with a degree in precision agriculture, Aaron started a business called AccurAg Aerial Solutions, which utilizes drones for mapping and spraying custom aerial application on crops and pastures. He has become the Project Coordinator for the On-Farm Precision Experiment community college grant project and is a member of the South Dakota Air National Guard – 114fw.

Andre Colaco

Dr. André Colaço (pronounced 'Colasso') holds a bachelor's degree in Agronomy from the University of São Paulo (USP), Brazil. He earned both his master's and doctorate degrees in Agricultural Systems from the same institution. Presently, he serves as an Assistant Professor in the Biosystems Department at USP. Previously, Dr. Colaço worked as a Research Scientist at the Australian National Research Agency, CSIRO. Additionally, he holds the role of Associate Editor for the Precision Agriculture journal. His primary research area is Precision Agriculture, with an emphasis on Data Mining, On-Farm Experimentation, and Intelligent Decision Support Systems.

B. Wade Brorsen

B. Wade Brorsen is regent's professor and A.J. and Susan Jacques Chair in the Department of Agricultural Economics at Oklahoma State University. He received his BS and MS in agricultural economics from Oklahoma State University, his MS in statistics from University of Wisconsin, and his PhD in agricultural economics from Texas A&M University.

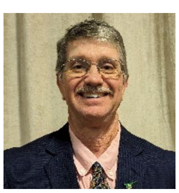
Bob Dunker

Robert Dunker is an Agronomist and Field Trials Coordinator for the Data Intensive Farm Management Program. He has over 40 years of experience conducting large and small plot research on cropping systems for the Departments of Agronomy and Crop Sciences at the University of Illinois. His activities have included management oversight of the Morrow plots, which is the oldest continuous experimental plots in the US and second only to the Rothamsted Plots in England. He was the Superintendent of the Crop Sciences Research and Education Center on the University of Illinois at Urbana-Champaign campus. He has been a Certified Professional Agronomist and Certified Crop Advisor consulting on numerous soil and crop issues.

Bond Knodle

Bond Knodle is an eighth-generation farmer from Montgomery County, Illinois. On his family farm, Bond Is directly involved in maintaining, calibrating, and operating the Planters and other equipment needed for precision farming.

Bond has been recognized as the Illinois FFA Section 19 Star Greenhand and Fiber Oil Placement winner. He has received Best in Show and Champion Cover Crop project at the Illinois State Fair and received the Emerald Award in Project Learning on Crops from Illinois 4-H.



Brent Rendel

Rendel Farms began operating over 120 years ago in what was then known as Oklahoma, Indian Territory. For the past 27 years, Brent Rendel has operated Rendel Farms in Miami, Oklahoma alongside his family. Today, with his mother and nephew, their combined farm operations produce over 6000 acres of crops annually which include wheat, corn, grain sorghum, soybeans, and canola. The farm operation places a heavy emphasis on research and experimentation to identify better ways to maximize grain production and profit.

Brent is a 1986 graduate of Oklahoma State University with a Bachelor of Science degree in Mechanical Engineering. Following graduation, he was commissioned as an officer in the United States Navy and served as a Nuclear Submarine officer. He was on active duty for 7 years and continued his service for another 15 years in the Navy Reserves until his retirement from the military.

Brent is a graduate of the Oklahoma Agricultural Leadership Program Class XII and was recognized with the Oklahoma State University Master Agronomist Award for 2007. He has won many other ag production and technology awards over the years including the National Farmer PrecisionAg Award of Excellence in 2019.

Brent is the Secretary/Treasurer of the Oklahoma Oilseed Commission and serves as the Chairman of the Oklahoma Soybean Board. Both organizations support Oklahoma agriculture promotion, research and public education through the oversight and distribution of producer checkoff funds. On a national level, Brent serves on the Board of Directors representing Oklahoma on the United Soybean Board (USB).

Bruce Maxwell

Dr. Bruce Maxwell is Professor of Agroecology/Applied Plant Ecology in the Department of Land Resources and Environmental Science at Montana State University in Bozeman, Montana. Bruce came to Montana State University in 1992 from the University of Minnesota where he was Assistant Professor of Weed Ecology. He holds a doctorate degree in Crop Science and Forest Ecology from Oregon State University. He completed his MS degree in 1984 in Agronomy and a BS degree in Botany in 1977 at Montana State University. Following his BS degree he spent 2 years with his wife Anne in the Peace Corps in Micronesia. He served as Director of the Montana Institute on Ecosystems from 2019 to 2022 and as LRES Department Head in 2008 and 2009. Maxwell was instrumental in creating the interdisciplinary Sustainable Food and Bioenergy Systems (SFBS) undergraduate degree program at MSU. He is currently lead investigator of a project on agricultural management optimization under high uncertainty. Other recent studies have focused on the invasion of pines in the Southern Hemisphere, specifically in Patagonia and South Island, New Zealand. He has also initiated studies on identifying the distribution and metapopulation dynamics of plants of cultural significance on Tribal lands where bison have been reintroduced in Montana. Maxwell was lead author for the Agriculture Sector of the Montana Climate Assessment in 2017 and was appointed by the Governor of Montana in 2019 to be on the Montana Climate Solutions Council. He was co-author of the Montana Climate Change and Human Health Report in 2021. Maxwell has received national awards for best researcher, outstanding teaching, best peer reviewed research papers and outstanding graduate student from the Weed Science Society of America. During his career he has published over 130 scientific peer reviewed journal articles and 13 invited book chapters, chaired and been a member of numerous national agricultural and ecological research grant review panels and been a member of two National Academy of Science National Research Council Committees on Agriculture. He was a Fulbright Fellow in Argentina in 2007. Most recently, Maxwell was on the organizing committee for the national Agroecology Summit in 2023.

Custódio Efraim Matavel

Custódio Efraim Matavel is a researcher at the Leibniz Institute for Agricultural Engineering and Bioeconomy (ATB). He holds a PhD in Agricultural Sciences and a Master's in Agricultural Economics. With a strong background in research and multiple publications, Custódio Matavel 's current work revolves around the economic analysis and assessment of digital tools in the agricultural sector.

David Bullock

David S. Bullock is a Professor in the Department of Agricultural and Consumer Economics at the University of Illinois. He received his Ph.D. from the Department of Economics at the University of Chicago in 1989. The major focus of his current research is on the economics agricultural technology and information. He is the Principal Investigator of the seven-year USDA-sponsored “Data-Intensive Farm Management” project, which uses precision agriculture technology to conduct large-scale, on farm agronomic experiments, to generate data that improves farmers’ management of nitrogen fertilizer and other inputs. Bullock has published widely in prestigious economics, agricultural economics, and agronomy journals, including the Journal of Political Economy, the American Journal of Agricultural Economics, and Agronomy Journal. He teaches PhD courses in microeconomic theory and has been cited numerous times for outstanding instruction of graduate courses. He has been publishing research on the economics of precision agriculture technology since 1998.

Flavia Souza

PhD candidate in the Agricultural Engineering Graduate Program at São Paulo State University "Júlio de Mesquita Filho" - Unesp/FCA (2021-present) with a Research Scholar Period at Louisiana State University - AgCenter (2022-2023) and another Research Scholar Period at UConn (University of Connecticut) (2023-present). Master's degree in the Agriculture - Energy in Agriculture Graduate Program at Unesp/FCA (2018-2021), focusing on soybeans, geoprocessing, and artificial intelligence. In graduate studies, dedicated to research in Precision Agriculture and digital agriculture, focusing on the use of Unmanned Aerial Vehicles (UAVs) for data collection in crops and the application of machine learning techniques in the analysis of collected data. Graduated in Agronomic Engineering from the USC of Bauru, Brazil (2017). During undergraduate studies, conducted applied research, extension, and technological innovation activities, with a focus on watershed management and the productivity, quality, and nutrition of sugarcane, with an emphasis on geoprocessing.

Giorgio Morales

Giorgio Morales is a Ph.D. student in computer science at Montana State University and a current member of the Numerical Intelligent Systems Laboratory (NISL). He holds a BS in mechatronic engineering from the National University of Engineering, Peru, and an MS in computer science from Montana State University, USA. His research interests are deep learning, explainable machine learning, computer vision, and precision agriculture.

Haiying Tao

Assistant Professor of Soil Nutrient Management and Soil Health
https://www.researchgate.net/profile/Haiying-Tao

Research Interests:

- Nutrient and carbon cycling in soil-plant-atmosphere system
- Best management practices for fertilizer and amendment applications to optimize yield and economic return, while minimizing environmental impacts. Such as precision agriculture, big data, remote sensing
- Soil health evaluation and improvement
- Crop residue management and manure management for soil health, crop yield, and value-added products such as feedstock for energy production

Heather Hampton-Knodle

As a farmer, past communications consultant and association manager, Heather Hampton-Knodle is dedicated to developing rural economies through incentivizing investments in telecommunications, innovative workforce development and enabling entrepreneurship.

While serving as the Montgomery County Board Economic Development Committee Chairman, she laid groundwork to leverage $6000 in public funds for close to $10 Million fiber to the premises private company buildout.

Heather was the founding chairman of the Montgomery County Economic Development Corporation, the Central Illinois Economic Development Authority and the Montgomery CEO (Creating Entrepreneurial Opportunities) program.

She served as the appointed Chairman of the Current and Future Needs for Connectivity Working Group (2021-2023) and Vice Chairman of the Accelerating Broadband Deployment Working Group (2019-2021) of the Federal Communications Commission Precision Agriculture Task Force and as a Citizen Member appointee to Illinois Governor Pritzker's Rural Affairs Council.

Heather farms with her husband Brian in south central Illinois where they have used precision agriculture technologies on their farm since 1996. She serves on the Advisory Board of AIFARMS, a national Artificial Intelligence institute for agricultural innovation, based at the University of Illinois.

Jaco Minnaar

Jaco Minnaar, born in 1976 and hailing from the central regions of South Africa, spent his formative years on the very farm he actively manages today. His journey into agriculture continued in 1998 when he successfully obtained his qualification as an agricultural engineer, leading him to embrace a full-time farming role in 1999. With a specialization in the cultivation of maize, soya beans, sunflowers, and wheat, coupled with the management of cattle and game, Jaco has been instrumental in steering the course of development for his farming enterprise.

Embracing precision farming techniques since 1998, Jaco has successfully implemented these practices throughout his entire business. His commitment to innovation and efficiency has been a driving force in optimizing agricultural processes.

Jaco Minnaar proudly represents the fourth generation of the Minnaar family to steward the Uitsny farm. Originally acquired by his great-grandfather in 1918, Uitsny has evolved into an integral part of a larger farming unit encompassing several contiguous farms and separate parcels of land.

Recognized for his outstanding contributions, Jaco was honoured as the Free State Agriculture's Young Farmer of the Year in 2011 and reached the national young farmer finalist stage. This accolade reflects his dedication, leadership, and excellence within the agricultural community.

Since 2003, Jaco has actively participated in organized agriculture. He is currently holding the esteemed position of President of AgriSA, a leading organization representing all primary agricultural producers in South Africa.

In addition to his role with AgriSA, Jaco serves on the board of Senwes, a leading agricultural supplier and off taker specializing in grain handling, storage, and equipment supply. His involvement in these key positions underscores his deep understanding of the agricultural sector and his commitment to contributing to its growth and sustainability.

Jaco Minnaar's journey, marked by a rich family legacy and a passion for advancing agriculture, continues to leave an indelible mark on the industry. His leadership, combined with a forward-thinking approach, positions him as a driving force in the ongoing evolution of South Africa's agricultural landscape.

James Lowenberg-DeBoer

Prof. James Lowenberg-DeBoer holds the Elizabeth Creak Chair in Agri-Tech Applied Economics at Harper Adams University (HAU), Newport, Shropshire, UK. He is responsible for economics in the Hands Free Farm (HFF) team at HAU. He was co-editor of the journal Precision Agriculture 2016-2022 and past president of the International Society of Precision Agriculture (ISPA). His research focuses on the economics of agricultural technology, especially precision agriculture and crop robotics. His work on the economics of robot regulation helped pave the way for the UK Code of Conduct for the Use of Autonomous Mobile Machines in Agriculture and Horticulture. Lowenberg-DeBoer's research and outreach is founded in hands-on experience in agriculture, including production of maize and soybeans in NW Iowa in the USA.

John Sheppard

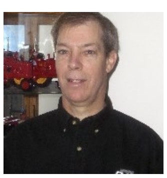
Dr. John Sheppard is a Norm Asbjornson College of Engineering Distinguished Professor of Computer Science at Montana State University. Recently, he was named Interim Director of MSU's Center for Science, Technology, Ethics, and Society (C-STES). He holds a BS in computer science from Southern Methodist University and an MS and PhD in computer science from Johns Hopkins University. In 2007, he was elected as an IEEE Fellow "for contributions to system-level diagnosis and prognosis." Prior to entering academia, he was a Fellow at ARINC Incorporated, a defense aerospace company in Annapolis, MD where he worked for almost 20 years. Dr. Sheppard performs research in probabilistic graphical models, deep learning, evolutionary and swarm-based algorithms, distributed optimization, and applications to system-level test, diagnosis, and predictive health. Recently, his research has expanded into the areas of prostate cancer diagnosis, precision agriculture, and wildfire management. He has published over 200 papers in peer-reviewed conference proceedings and journals as well as two books on the subject of system-level diagnosis.

Julie Anne Wilkinson

Julie Anne Wilkinson is an agronomist with a master's degree in plant biology. She has been responsible for coordinating organic field crop research projects for CETAB+ since 2016. She has expertise in project management, particularly in organic field crop varietal trials, and is currently leading several participatory projects with farmers.

Katsutoshi Mizuta

Katsutoshi Mizuta, Ph.D., is currently a full-time assistant professor at Ohio Wesleyan University Department of Environment and Sustainability (and a part-time postdoc at University of Minnesota Precision Agriculture Center). Toshi has led a multistate research project for the development of precision soil and crop management tools in collaboration by conducting +70 on-farm trials with growers and crop advisers in Minnesota and Indiana over 3 years. He organizes various extension activities to transmit scientific findings. He received his B.Sc. in environmental engineering in 2014 from Soka University in Japan. He then received his M.Sc. in soil, water, and ecosystem sciences (SWES) in 2016 and his Ph.D. in SWES (minoring in food and resource economics). The highly interdisciplinary nature of his work has led to collaborations with various scientists, companies, and government agencies, resulting in +15 publications, +30 conference presentations, and various awards. He also has research experience in various cropping systems and landscapes from a local to regional scale using cutting-edge technologies (AI, proximal, airborne, and satellite remote sensing) based on big data of soil, crop, biome, climate, terrain, and geology. In addition, he teaches Soil Morphology, Digital Agriculture, and Earth Science for undergraduate and graduate students. Toshi is interested in extending his collaborations through his participatory research program to improve current agricultural production systems agronomically, economically, ecologically, and socially.



Keith Wendte

Keith Wendte is a retired engineer who uses data management & precision tools to assist in the management of the family farm. Wendte graduated from the University of Illinois with BS/MS degrees in Agricultural Engineering and an MBA from Keller Graduate School of Management.

Wendte recently wrapped up a 37-year career as an engineer for International Harvester, CaseIH and CNH Industrial. Wendte manages data and analysis for his family's 7,200-acre operation from an office more than 200 miles away in the Chicago area. The family grows corn, soybeans and wheat in Effingham County, IL.

Maria Villamil Mahecha

I'm a professional in animal sciences with a focus on the food industry, employing non-invasive chemometrics tools for the analysis of food products. My expertise lies in research and innovation, where I leverage my skills to contribute meaningfully to the field. With a keen ability to listen and collaborate effectively within a team, I am currently pursuing my master's degree at North Dakota State University in the department of Agricultural and Biosystem Engineering.

My current research involves measuring Variable Rates Nitrogen (VRN) using spectral images captured by Unmanned Aerial Vehicles (UAVs). I apply advanced Geographic Information System (GIS) tools and modeling.

Marion Delport

Marion Delport is the manager for the Data Science division at the Bureau for Food and Agricultural Policy (BFAP). Her current position involves data analytics and maintenance, supporting internal skills development and offering modelling and data analysis support on various BFAP projects, including the management of the DIFM trial programme in South Africa.

She completed her Master's degree in Mathematical Statistics at the University of Pretoria (2017) and spent time at the United Nation's Food and Agricultural Organisation (FAO) as well as the Organisation for Economic Cooperation and Development (OECD) in 2015 and 2017. She has also presented her work at the Conference of the South African Statistical Association as well as the Agricultural Economics Association of South Africa Conferences.

Simphiwe Maseko

I am a PhD student at the University of Pretoria in South Africa specializing on cropping systems modelling. My current research is on big data analytics in precision agriculture, involving the in-depth comparison of process based and machine learning models. Yield predictions can be useful in guiding management decisions and implementing spatial precision agriculture. However, there is range of factors that go into determining how much inputs to apply at a field in a given growing season. In my study I am using DIFM datasets to develop a simplified yield prediction model using machine learning for subfield maize yield predictions. My research further investigates the abilities of process-based models and ML techniques to informing optimal seeding rates, fertilizer applications and timing for improved yields and environmental sustainability.

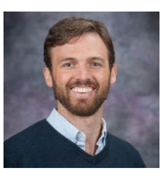
Mona Mousavi

I'm Mona Mousavi, a Ph.D. student at the University of Nebraska in Lincoln, working with Professor Taro Mieno on precision agriculture.

Nicholas Cizek

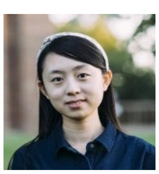
Nick Cizek is an applied physicist specializing in precision measurement (Ph.D. Stanford). Before founding FarmTest in 2019, he worked for 4.5 years at The Climate Corporation / Monsanto / Bayer Crop Science. Specifically, he led teams designing and executing in-field trials to measure the performance of advanced nitrogen management systems. He initially joined Climate to help design and deploy a sensor network to collect local data to improve the value of their predictive agronomic optimization models.

FarmTest envisions a future where all farms optimize their management practices based on statistically rigorous in-field performance data. To enable this, FarmTest's mission is building software tools that let growers easily measure which management practices pay off on their own fields using their own farming equipment. This includes software for designing, executing, and analyzing on-farm performance tests. FarmTest believes that when farmers and their trusted advisors have well-characterized performance data specific to their own fields, farm profits and farm efficiencies will improve.



Pedro Rossini

Born in Uruguay, Pedro holds a degree in Agronomy and Animal Science from Universidad de la República in Montevideo, Uruguay. He obtained a Master's degree from Kansas State University with a focus on precision agriculture and soil physics and is the Co-founder of Pronutritional Agrotechnologies, a crop consulting company specializing in digital agriculture. ProNutrition is a leading company in Uruguay, managing more than 60 thousand hectares and doing research through on-farm trials 80 sites a year.



Qianqian Du

Qianqian is a PhD student in Agricultural and Consumer Economics department at the University of Illinois. Prior to Illinois, Qianqian received her M.S. degree in Agricultural Economics from the University of Nebraska-Lincoln. Her research interests are in precision agriculture, with the aim of using different sources of data and combining them with other information to improve resource use efficiency, productivity, quality, profitability, and the sustainability of agricultural production.

Sasha Loewen

Sasha Loewen is a post-doctoral fellow at the University of Manitoba in Canada where he researches precision agriculture and agroecology. Sasha grew up on a conventional, then organic, grain farm in Manitoba, where his school and farming experiences made him interested in sustainable agricultural research. Sasha worked with Dr. Bruce Maxwell at Montana State University where he completed a PhD in Ecology and Environmental Sciences studying the use of precision agricultural tools in organic grain systems. Sasha returned to Winnipeg to work in the Natural Systems Agriculture Lab where he is a science advisor to the Canadian Food Grains Bank on their nature-based agronomy work in east Africa, and pursues precision agroecology research on Manitoba farms.

Scott Wahl

Dr. Scott Wahl is the IT Directory for the Data Intensive Farm Management program, developing the cloud infrastructure and programming to help analyze farm data. He has a background in machine learning and network analysis, as well as many years of experience working in full-stack development. Before working at DIFM, he worked many years at a non-profit to support campaign finance transparency. Later he worked on technical language processing, and a procurement recommendation system.

Simon Cook

Simon Cook was the Western Australia Premiers Fellow and professor of digital agriculture at Murdoch and Curtin Universities in Australia. He has been developing data uses for agriculture since the 1990s and was one of the first to realize the power of on-farm experimentation as a farmer-centric, data-intensive change process. He has over 35 years of applied research experience in Australia, the UK, Africa, Latin America and Asia. Currently he resides in Cali, Colombia.

Susan VanderPlas

Susan Vanderplas is an assistant professor of Statistics at University of Nebraska Lincoln. Her research interests include data visualization, statistical forensics, and scientific communication.

Takashi Tanaka

Dr. Takashi Tanaka received his PhD in Agriculture at Graduate School of Agriculture, Kyoto University, and started to work as Assistant Professor at Faculty of Applied Biological Sciences, Gifu University in 2017. He is studying data analytical approach for agronomy and crop science using precision agriculture technologies such as satellite/UAV-based remote sensing and yield monitoring system. He has experience in developing machine learning models that contributes to decision support system in farm management. His ultimate goal of R&D is to enhance farmers' income and agricultural productivity while reducing environmental impacts. He was promoted to Associate Professor in 2022.

Taro Mieno

Taro Mieno is an Associate Professor at the Department of Agricultural Economics at the University of Nebraska-Lincoln since 2015. The core of his academic interests lies in the intersection of agricultural production, policy, resource uses, and the environment. In particular, he is interested in precision agriculture for sustainable and profitable agricultural production, water economics (particularly around groundwater-irrigated agriculture) for sustainable high-productivity production, and agricultural policies (such as crop insurance) and their implications on agricultural production and resources use.

Terry Griffin

Dr. Terry Griffin is Associate Professor and Cropping Systems Economist at Kansas State University specializing in farm management and digital technology. He holds BS in Agronomy and MS in Agricultural Economics from University of Arkansas and a PhD in Agricultural Economics from Purdue University. For his achievements in advancing digital agriculture, Griffin has received the 2014 Pierre C. Robert International Precision Agriculture Young Scientist Award, the 2012 Conservation Systems Precision Ag Researcher of the Year, and the 2010 PrecisionAg Award of Excellence for Researchers. He is past-Treasurer of the International Society of Precision Agriculture. He has authored two patents on digital agriculture. In addition to presenting his applied research throughout North America, Terry has delivered invited presentations across Africa, Australia, and Europe.

Viacheslav (Slava) Adamchuk

Originally from Kyiv, Ukraine, Dr. Adamchuk obtained a mechanical engineering degree from the National Agricultural University of Ukraine (currently National University of Life and Environmental Sciences of Ukraine), located in his hometown. Later, he received both MS and PhD degrees in Agricultural and Biological Engineering from Purdue University (USA). In 2000, Dr. Adamchuk began his academic career as a faculty member in the Department of Biological Systems Engineering at the University of Nebraska-Lincoln (USA). Ten years later, he assumed his current position in the Department of Bioresource Engineering at McGill University (Canada), while retaining his adjunct status at the University of Nebraska-Lincoln. Currently, he serves as the Chair of the Bioresource Engineering Department. Dr. Adamchuk leads a Precision Agriculture and Sensor Systems (PASS) research team that focuses on developing and deploying soil and plant sensing technologies to enhance the economic and environmental benefits of precision agriculture. His team has designed and evaluated a fleet of proximal sensor systems capable of measuring physical, chemical and biological attributes directly in a field. Most sensors produce geo-referenced data to quantify spatial soil/plant heterogeneity, which may be used to prescribe differentiated treatments according to local needs. Through studies on sensor fusion and data clustering, he investigated the challenges faced by early adopters of precision agriculture. Through his outreach activities, Dr. Adamchuk has taught multiple programs dedicated to a systems approach in adopting smart farming technologies around the world.

Xiaofei Li

Dr. Xiaofei Li serves as an assistant professor in the Department of Agricultural Economics at Mississippi State University. His primary research interest lies in the economics of precision agriculture, with a specific focus on the estimation of site-specific production functions. He is also interested in on-farm experiments, crop yield modeling, livestock production, risk management, and spatial data analysis. Dr. Li instructs courses of the economics of precision agriculture, agricultural production economics, and food & fiber production.

Yuxin Miao

Dr. Yuxin Miao is Director of Precision Agriculture Center, and Associate Professor of Precision Agriculture and Nutrient Management in the Department of Soil, Water and Climate at University of Minnesota. He has rich experience conducting on-farm research in both developing and developed countries, involving precision nitrogen management, variable rate seeding, variable rate sulfur, variable rate irrigation, and more integrated precision crop management systems, etc. He is the recipient of the Pierre C. Robert Precision Agriculture Young Scientist Award from International Society of Precision Agriculture (ISPA) in 2012, the Outstanding Chinese Alumni Award of University of Minnesota in 2014, American Society of Agronomy (ASA) Kingenta Agricultural Science Award in 2022, and ASA Tengtou Agricultural Science Award in 2023. He is the founding leader of the ISPA Precision Nitrogen Management Community. He is serving as Editor-in-Chief of European Journal of Agronomy and Associate Editor for several journals, including Precision Agriculture, Agronomy Journal, Remote Sensing, and Farming System.

Training Session Schedule

Equipment Needed: Personal computer

January 8, 2024: DIFM Cyber-Infrastructure Training Sessions

Designing OFPEs, Part I
Hands-on training creating OFPE's using the trial design tool developed by DIFM-CIGOFT (Cyber-infrastructure)
Trainer: Robert Dunker (University of Illinois, USA) & Brittani Edge (University of Illinois, USA)

Getting Data into and out of Your Database, Part I
Training on DFIM's Database, how to get data in and out (Cyber-infrastructure)
Trainer: Scott Wahl (IT Director, Data-Intensive Farm Management Project, USA)

Using the Data to Make Decisions, Part I
Training on making real decisions based on the data that's been generated, collected, and analyzed (Cyber-infrastructure)
Trainer: Divid Bullock (University of Illinois, USA) & Brittani Edge (University of Illinois, USA)

Session	Room	13:00 – 14:20	14:30 – 15:50	16:00 – 17:20
Designing OFPEs, Part I	Great White	Group 1	Group 2	Group 3
Getting Data into and out of Your Database, Part I	Tarpon	Group 2	Group 3	Group 1
Using the Data to Make Decisions, Part I	Marlin	Group 3	Group 1	Group 2

January 9, 2024: Practice, Practice, Practice: Working with Simulated Data

Designing OFPEs, Part II
Trainer: Robert Dunker (University of Illinois, USA) & Brittani Edge (University of Illinois, USA)

Getting Data into and out of Your Database, Part II
Trainer: Scott Wahl (IT Director, Data-Intensive Farm Management Project, USA)

Using the Data to Make Decisions, Part II
Trainer: Divid Bullock (University of Illinois, USA) & Brittani Edge (University of Illinois, USA)

Session	Room	11:10 – 12:30	13:30 – 14:50	15:00 – 16:20
Designing OFPEs, Part II	Great White	Group 1	Group 2	Group 3
Getting Data into and out of Your Database, Part II	Tarpon	Group 2	Group 3	Group 1
Using the Data to Make Decisions, Part II	Marlin	Group 3	Group 1	Group 2

Symposium I: OFPE in Practice

Day At-a-Glance: Monday, January 8, 2024

07:15 – 08:00	Registration & Morning Coffee ***Room: Grand Ballroom Foyer***		
08:00 – 09:20	Session 8A: Beginning the Discussion ***Room: Great White***		
09:20 – 09:30	Break		
09:30 – 10:50	Session 8B: Presentations of OFPE Trials and Results ***Room: Great White***		
10:50 – 11:00	Break		
11:00 – 12:00	Session 8C: Presentations of OFPE Trials and Results ***Room: Great White***		
12:00 – 12:50	Lunch Presentation ***Room: Great White***		
12:50 – 13:00	Break		
13:00 – 14:20	Session 8D: DIFM Cyber-Infrastructure Training Session (Group 1) ***Room: Great White***	Session 8D: DIFM Cyber-Infrastructure Training Session (Group 2) ***Room: Tarpon***	Session 8D: DIFM Cyber-Infrastructure Training Session (Group 3) ***Room: Marlin***
14:20 – 14:30	Coffee Break		
14:30 – 15:50	Session 8E: DIFM Cyber-Infrastructure Training Session (Group 1) ***Room: Marlin***	Session 8E: DIFM Cyber-Infrastructure Training Session (Group 2) ***Room: Great White***	Session 8E: DIFM Cyber-Infrastructure Training Session (Group 3) ***Room: Tarpon***
15:50 – 16:00	Break		
16:00 – 17:20	Session 8F: DIFM Cyber-Infrastructure Training Session (Group 1) ***Room: Tarpon***	Session 8F: DIFM Cyber-Infrastructure Training Session (Group 2) ***Room: Marlin***	Session 8F: DIFM Cyber-Infrastructure Training Session (Group 3) ***Room: Great White***
17:20 – 17:30	Break		
17:30 -18:30	Session 8G: End-of Day Discussion ***Room: Great White***		

Day At-a-Glance: Tuesday, January 9, 2024

08:00 – 08:30	Registration & Morning Coffee ***Room: Grand Ballroom Foyer***		
08:30 – 09:50	Session 9A: Plenary II: What's Under the Hood? ***Room: Great White***		
09:50 – 10:00	Break		
10:00 – 11:00	Session 9B: Farmer and Agronomist Presentations of OFPE Trials and Results ***Room: Great White***		
11:00 – 11:10	Break		
11:10 – 12:30	Session 9C: Practice, Practice, Practice: Working with Simulated Data (Group 1) ***Room: Great White***	Session 9C: Practice, Practice, Practice: Working with Simulated Data (Group 2) ***Room: Tarpon***	Session 9C: Practice, Practice, Practice: Working with Simulated Data (Group 3) ***Room: Marlin***
12:30 – 13:30	Lunch Presentation ***Room: Great White***		
13:30 – 14:50	Session 9D: Practice, Practice, Practice: Working with Simulated Data (Group 1) ***Room: Marlin***	Session 9D: Practice, Practice, Practice: Working with Simulated Data (Group 2) ***Room: Great White***	Session 9D: Practice, Practice, Practice: Working with Simulated Data (Group 3) ***Room: Tarpon***
14:50 – 15:00	Coffee Break		
15:00 – 16:20	Session 9E: Practice, Practice, Practice: Working with Simulated Data (Group 1) ***Room: Tarpon***	Session 9E: Practice, Practice, Practice: Working with Simulated Data (Group 2) ***Room: Marlin***	Session 9E: Practice, Practice, Practice: Working with Simulated Data (Group 3) ***Room: Great White***
16:20 – 16:30	Break		
16:30 -18:00	Session 9F: All-Conference Discussion ***Room: Great White***		

Symposium II: OFPE in Professional Research

(in concurrence with the 2024 Annual NMISS NC-1210 Meeting, "Frontiers in On-farm Experimentation")

Day At-a-Glance: Wednesday, January 10, 2024

07:30 – 08:00	Registration & Morning Coffee ***Room: Grand Ballroom Foyer***		
08:00 – 09:20	Session 10A: Research Reports: OPFE Results ***Room: Great White***		
09:20 - 09:30	Break		
09:30 – 10:50	Session 10B: Research Reports: OPFE Results ***Room: Great White***		
10:50 – 11:00	Break		
11:00 – 12:20	Session 10C: Presentation and Discussion ***Room: Great White***		
12:20 – 13:00	Working Lunch and Discussion ***Room: Great White***		
13:00 – 14:20	Session 10D: Breakout Groups: Planning for 2024 ***Room: Great White***	Session 10D: Breakout Groups: Planning for 2024 ***Room: Tarpon***	Session 10D: Breakout Groups: Planning for 2024 ***Room: Marlin***
14:20 – 14:30	Coffee Break		
14:30 – 16:10	Session 10E: Research Reports: Varied Topics ***Room: Great White***		
16:10 – 16:20	Break		
16:20 – 17:30	Session 10F: General Discussion ***Room: Great White***		

Day At-a-Glance: Thursday, January 11, 2024

07:30 – 08:00	Registration & Morning Coffee ***Room: Grand Ballroom Foyer***		
08:00 – 09:40	Session 11A: Research Reports: Varied Topics ***Room: Great White***		
09:40 – 09:50	Break		
09:50 – 10:40	Session 11B: Breakout Group: Coming Up with a Plan ***Room: Great White***	Session 11B: Breakout Group: Coming Up with a Plan ***Room: Tarpon***	Session 11B: Breakout Group: Coming Up with a Plan ***Room: Marlin***
10:40 – 10:50	Break		
10:50 – 12:30	Session 11C: Research Reports: ML and AI ***Room: Great White***		
12:30 – 13:10	Lunch (on your own)		
13:10 – 14:30	Session 11D: Breakout Groups: Planning for 2024 *Room: Great White*	Session 11D: Breakout Groups: Planning for 2024 *Room: Tarpon*	Session 11D: Breakout Groups: Planning for 2024 *Room: Marlin*
14:30 – 14:40	Break		
14:40 – 15:30	Session 11E: Wrap-Up Discussion ***Room: Great White***		
15:30 – 17:00	DIFM Project Management Committee Meeting ***Room: Great White***		

Technical Program: Monday, January 8, 2024
OFPE in Practice

07:15 – 08:00
Registration & Morning Coffee
Room: Grand Ballroom Foyer

08:00 – 09:20
Session 8A: Beginning the Discussion
Room: Great White

Welcome and Introduction: What's So Great About On-farm Precision Experimentation?
Bruce Maxwell (Montana State University, USA)

The Basics: Getting Your Trial In and Getting Your Information Out
Robert Dunker (University of Illinois, USA)

The OFPE in Community Colleges Project
Aaron Sundquist (Mitchell Technical College, USA)

Why Agricultural 'Big Data' Needs On-Farm Precisions Experimentation
David Bullock (University of Illinois, USA)

09:20 – 09:30
Break

09:30 - 10:50
Session 8B: Presentations of OFPE Trials and Results
Room: Great White

Brent Rendel (Rendel Farms, USA)

Keith Wendte (Wendte Farms, Ltd, USA)

Jaco Minnaar (Uitsny Farming, South Africa)

Julie Anne Wilkinson (Center for the Transfer of Expertise in Organic and Local Agriculture, Quebec)

10:50 – 11:00
Break

11:00 – 12:00
Session 8C: Presentations of OFPE Trials and Results
Room: Great White

Conducting OFPEs in a Commercial Environment in Uruguay
Pedro Rossini (ProNutrition Agrotechnologies, Uruguay)

Trials and Triumphs: Insights from Three Distinct Farm Precision Projects Across 300 Farms (virtual)
Maxime LeDuc (McGill University, USA)

On-Farm Research on Your Customer's Farms with Their Equipment
Nicholas Cizek (FarmTest, USA)

12:00 – 12:50
Lunch Presentation
Room: Great White

Implementing OFE on the Ground: Lessons from Australia
Simon Cook (Murdoch University, Perth, Australia)

12:50 – 13:00
Break

13:00 – 14:20
Session 8D: DIFM Cyber-Infrastructure Training Session (Group 1)
Room: Great White

Designing OFPEs, Part I
Robert Dunker (University of Illinois, USA) & Brittani Edge (University of Illinois, USA)

13:00 – 14:20
Session 8D: DIFM Cyber-Infrastructure Training Session (Group 2)
Room: Tarpon

Getting Data into and out of Your Database, Part I
Scott Wahl (IT Director, Data-Intensive Farm Management Project, USA)

13:00 – 14:20
Session 8D: DIFM Cyber-Infrastructure Training Session (Group 3)
Room: Marlin

Using the Date to Make Decisions, Part I
David Bullock (University of Illinois, USA) & Brittani Edge (University of Illinois, USA)

14:20 – 14:30
Coffee Break

14:30 – 15:50
Session 8E: DIFM Cyber-Infrastructure Training Session (Group 1)
Room: Marlin

Using the Date to Make Decisions, Part I
David Bullock (University of Illinois, USA) & Brittani Edge (University of Illinois, USA)

14:30 – 15:50
Session 8E: DIFM Cyber-Infrastructure Training Session (Group 2)
Room: Great White

Designing OFPEs, Part I
Robert Dunker (University of Illinois, USA) & Brittani Edge (University of Illinois, USA)

14:30 – 15:50
Session 8E: DIFM Cyber-Infrastructure Training Session (Group 3)
Room: Tarpon

Getting Data into and out of Your Database, Part I
Scott Wahl (IT Director, Data-Intensive Farm Management Project, USA)

15:50 – 16:00
Break

16:00 – 17:20
Session 8F: DIFM Cyber-Infrastructure Training Session (Group 1)
Room: Tarpon

Getting Data into and out of Your Database, Part I
Scott Wahl (IT Director, Data-Intensive Farm Management Project, USA)

16:00 – 17:20
Session 8F: DIFM Cyber-Infrastructure Training Session (Group 2)
Room: Marlin

Using the Date to Make Decisions, Part I
David Bullock (University of Illinois, USA) & Brittani Edge (University of Illinois, USA)

16:00 – 17:20
Session 8F: DIFM Cyber-Infrastructure Training Session (Group 3)
Room: Great White

Designing OFPEs, Part I
Robert Dunker (University of Illinois, USA) & Brittani Edge (University of Illinois, USA)

17:20 – 17:30
Break

17:30 – 18:30
Session 8G: End-of Day Discussion
Room: Great White

Technical Program: Tuesday, January 9, 2024
OFPE in Practice

08:00 – 08:30
Registration & Morning Coffee
Room: Grand Ballroom Foyer

08:30 – 09:50
Session 9A: Plenary II: What's Under the Hood?
Room: Great White

What's Under the Hood?: Statistics
Taro Mieno (University of Nebraska, USA)

What's Under the Hood?: Artificial Intelligence and Machine Learning
John Sheppard (Montana State University, USA)

What's Under the Hood?: Data Processing
Brittani Edge (University of Illinois, USA)

09:50 – 10:00
Break

10:00 - 11:00
Session 9B: Farmer and Agronomist Presentations of OFPE Trials and Results
Room: Great White

Heather Hampton-Knodle and Bond Knodle (Knodle, Ltd, USA)

Marion Delport (Bureau for Agricultural and Food Policy (BFAP), South Africa)

Aaron Sundquist (Micthell Technical College, USA)

11:00 – 11:10
Break

11:10 – 12:30
Session 9C: Practice, Practice, Practice: Working with Simulated Data (Group 1)
Room: Great White

Designing OFPEs, Part II
Robert Dunker (University of Illinois, USA) & Brittani Edge (University of Illinois, USA)

11:10 – 12:30
Session 9C: Practice, Practice, Practice: Working with Simulated Data (Group 2)
Room: Tarpon

Getting Data into and out of Your Database, Part II
Scott Wahl (IT Director, Data-Intensive Farm Management Project, USA)

11:10 – 12:30
Session 9C: Practice, Practice, Practice: Working with Simulated Data (Group 3)
Room: Marlin

Using the Date to Make Decisions, Part II
David Bullock (University of Illinois, USA) & Brittani Edge (University of Illinois, USA)

12:30 – 13:30
Lunch Presentation
Room: Great White

Making Decisions with Data Visualization (virtual)
Susan VanderPlas (University of Nebraska, USA)

13:30 – 14:50
Session 9D: Practice, Practice, Practice: Working with Simulated Data (Group 1)
Room: Marlin

Using the Date to Make Decisions, Part II
David Bullock (University of Illinois, USA) & Brittani Edge (University of Illinois, USA)

13:30 – 14:50
Session 9D: Practice, Practice, Practice: Working with Simulated Data (Group 2)
Room: Great White

Designing OFPEs, Part II
Robert Dunker (University of Illinois, USA) & Brittani Edge (University of Illinois, USA)

13:30 – 14:50
Session 9D: Practice, Practice, Practice: Working with Simulated Data (Group 3)
Room: Tarpon

Getting Data into and out of Your Database, Part II
Scott Wahl (IT Director, Data-Intensive Farm Management Project, USA)

14:50 – 15:00
Coffee Break

15:00 – 16:20
Session 9E: Practice, Practice, Practice: Working with Simulated Data (Group 1)
Room: Tarpon

Getting Data into and out of Your Database, Part II
Scott Wahl (IT Director, Data-Intensive Farm Management Project, USA)

15:00 – 16:20
Session 9E: Practice, Practice, Practice: Working with Simulated Data (Group 2)
Room: Marlin

Using the Date to Make Decisions, Part II
David Bullock (University of Illinois, USA) & Brittani Edge (University of Illinois, USA)

15:00 – 16:20
Session 9E: Practice, Practice, Practice: Working with Simulated Data (Group 3)
Room: Great White

Designing OFPEs, Part II
Robert Dunker (University of Illinois, USA) & Brittani Edge (University of Illinois, USA)

16:20 – 16:30
Break

16:30 – 18:00
Session 9F: All-Conference Discussion
Room: Great White

07:30 – 08:00
Registration & Morning Coffee
Room: Grand Ballroom Foyer

08:00 – 09:20
Session 10A: Research Reports: OPFE Results
Moderator: Yuxin Miao, *University of Minnesota, USA*
Room: Great White

08:00
Informing Site-specific Input Management for Maize in KwaZulu Natal, South Africa, Using On-farm Experimentation and Statistical Techniques
Marion Delport (Bureau for Agricultural and Food Policy (BFAP), South Africa & Stellenbosch University, South Africa)
Jaeseok Hwang (University of Illinois, Urbana-Champaign, USA)
David S. Bullock (University of Illinois, Urbana-Champaign, USA)
Taro Mieno (University of Illinois, Urbana-Champaign, USA)
Helga Ottermann (Bureau for Agricultural and Food Policy (BFAP), South Africa)

The determination of optimal input levels for yield and profit maximisation has been researched for over half a decade. In practice however, evidence suggests an over-reliance on yield-based algorithms (originally designed as data-extensive methodology) for both data-extensive and data-intensive management advice solutions. This paper presents a practical application of Data Intensive Farm Management (DIFM) trial data for a dataintensive methodology to determine site-specific management practices for a given maize field. Geographically weighted regression was used to estimate spatially varying input response curves then management zones were defined using k-means clustering and finally, multiple regression models were fit per management zone in order to find profit maximizing input rates. Results indicated that for three of the four management zones, profit maximizing rates resulted in gross profits higher than yielded by standard management (+R5794 ha-1 in Zone 1, +R7125 ha-1 in Zone 2, -R6048 ha-1 in Zone 3 and +R1738 ha-1 in Zone 4). Furthermore, if the profit maximizing rates were to be used across the whole field, based on the defined management zones, the total profit for this field would be 14% higher than if the standard management would have been followed.

08:20
Precision Weed Management Using Cover and Cash Crop Seed Rates
Sasha Loewen (University of Manitoba, Canada)

Integrated weed management is integral to organic farming, with increased crop seeding rates as one effective weed suppression tactic. Precision agriculture, which uses guidance and sensor technologies to direct site-specific management, could allow for targeted weed management using variable seeding rates. On farm precision experimentation (OFPE) can be used to predict sub-field weed biomass response to a range of varied seed rates across whole fields. We collected OFPE data from five site-years to compare five simulated precision seeding strategies of both cover and cash crops. The five strategies included a business-as-usual uniform rate, an optimized (for max net return) uniform rate, an optimized (for max net return) variable rate, an optimized (for min weed) variable rate, and a hybrid variable rate approach with cells either optimized for max net return or min weeds. Site-specific variable seeding rate net returns improved over farmer chosen uniform seeding rate by $115 ha-1 on average. When variable seeding rates were optimized to minimize weed biomass, weeds were reduced on average by 10 kg ha-1 relative to the farmer chosen uniform seed rates. The hybrid variable rate approach which balanced net return and weed minimization improved both net return and weed suppression compared to farmer-chosen seeding rates in every site-year. The various seeding rate strategies represent different methods from which farmers can choose to implement OFPE on their own fields to optimize sub-field specific planting rates and to increase their field-scale ecological knowledge.

08:40
Precision Irrigation for sustainable agriculture in the Southern High Plains
Wenxuan Guo (Texas A&M University, USA)

The goal of this study is to enhance water use efficiency and water conservation by precisely allocating water in terms of quantity, location, and timing within the field. The specific objectives of this project are to evaluate the impact of variable rate irrigation (VRI) on crop growth and yield and to explore the utility of satellite and Unmanned Aerial Systems (UAS) remote sensing in capturing spatial and temporal patterns of cotton growth in response to irrigation rates within the field. The results highlight the potential remote sensing in precision agriculture and provide valuable insights for implementing site-specific irrigation strategies to optimize cotton production at a within-field scale.

09:00
Measuring the Estimation Bias of Yield Response to N Using Combined On-Farm Experiment Data
Qianqian Du (University of Illinois, USA)

Accurately evaluating yield response to nitrogen (N) can increase crop managemet profitability and sustainability. Many studies estimate yield response by fitting a regression model to data collected from different fields, as statistical analysis requires varied input application levels. One way to attain more observations, of course, is to combine from multiple fields. But analyzing such combined data requires that heterogeneity across fields be accounted for in the regression analysis along with the variation in input rates. In other words, noisy variation among different fields may challenge yield response estimation within each field.

This study uses data from 27 large-scale on-farm precision experiments with trial design rates centered on farmers' status quo rates to test the potential danger of generating biased estimates of yield response functions. A Latin square trial design is used to make N orthogonal to other factors, so within-field N variation can be considered clean. Modeling field fixed effects eliminates cross-field variation so yield response to N can be measured unbiasedly. Models with and without field fixed effects are run. The yield response functions from the two models showed different slopes, which provides a visual representation of the bias resulting from the pooled estimation. Use of the Mundlak approach indicated that ignoring the endogeneity of regressors with respect to field effects leads to an unreliable estimation of yield response to N.

09:20 - 09:30
Break

09:30 - 10:50
Session 10B: Research Reports: OPFE Results
Moderator: Sasha Loewen, *Montana State University, USA*
Room: Great White

09:30
Evaluating Different Strategies to Analyze On-farm Trial Data: A Case Study for Nitrogen Trials
Katsutoshi Mizuta (University of Minnesota, USA)
Yuxin Miao (University of Minnesota, USA)
Junjun Lu (University of Minnesota, USA)
Renzo Negrini (University of Minnesota, USA)

The Precision Agriculture Center at the University of Minnesota is in the process of developing a '5S' precision nitrogen(N) management (5SPNM) technology for corn. This technology is sensing-based, customized for specific years, hybrids and sites, and climate-smart. The primary goal is to improve N use efficiency, profitability, and yield by optimizing in-season N fertilizer application rates. To assess the effectiveness of PNM strategies implemented in on-farm trials, various methodologies are available. Traditional statistical techniques like analysis of variance (ANOVA) are valuable for evaluating overall performance, assuming uniform environmental and management factors within a field. Another approach involves delineating the field into many smaller transects, assuming uniform conditions within each transect, to identify optimal PNM strategies for different locations. However, spatial variability persists even within individual transects. The aim of this study was to develop a machine learning-based approach to analyze on-farm trial data and compare it with other on-farm data analysis approaches. Machine learning models were constructed with soil-landscape data, historical yield data, and management data to estimate corn yield. Subsequently, these models were employed to simulate the yield and economic returns associated with different N management strategies. Through the comparison of various evaluation approaches, we expect to demonstrate the advantages and limitations of different analytical approaches and identify suitable strategies to analyze on-farm trials.

09:50
Estimating Maximized Resilience in Response to Nitrogen Rates on a Field with Multiple Years of OFPE Data
Bruce Maxwell (Montana State University, USA)
Paul Hegedus (Montana State University, USA)
Sasha Loewen (Montana State University, USA)
Hannah Duff (Montana State University, USA)
John Sheppard (Montana State University, USA)
Amy Peerlinck (Montana State University, USA)
Giorgia Morales (Montana State University, USA)
Anton Bekkerman (Montana State University, USA)

10:10
On-farm Evaluation of the Potential Benefits of Variable Rate Sulfur Application for Corn in Minnesota
Renzo Negrini (University of Minnesota, USA)
Yuxin Miao (University of Minnesota, USA)
Katsutoshi Mizuta (University of Minnesota, USA)
Kirk Stueve (Stueve Ag Enterprise, USA)
Daniel Kaiser (University of Minnesota, USA)
Jeffrey Coulter (University of Minnesota, USA)

The ongoing decline in sulfur (S) atmospheric depositions and high yield crop production have resulted in S deficiency and the need for S fertilizer applications in corn cropping systems. Many farmers are applying S fertilizers uniformly across their fields. Little has been reported on the within-field spatial variability in optimal S rates and the potential benefits of variable rate S applications. The objectives of this study were to 1) assess within-field variability of optimal S rates (OSR), and 2) evaluate the potential benefits of variable rate S application in corn fields. Three on-farm variable rate S trials were conducted in western and southeastern Minnesota in 2022. The trials used five S rates (0, 10, 20, 30, and 40 lb S ac-1 or 0, 11.2, 22.4, 33.6, and 44.8 kg ha-1) in a randomized complete block design. Each field was delineated into grids with a dimension of 70-80 ft (21.34-24.38 m) wide and 150-600 ft (45.72-182.88 m) long, depending on the farmer’s applicators. The preliminary results indicated that two corn fields located in western Minnesota where no S fertilizers were conventionally applied would benefit from higher S application rates. The field in southeastern Minnesota received S applications at 30 lb S ac-1 (33.6 kg S ha-1) for the past several years and would benefit from a lower S rate. The OSR varied within all three fields, ranging from 0 to 40 lb ac-1. The farmer’s common application rate of 30 lb ac-1 (33.6 kg S ha-1) would be suitable in 15%, 16% and 37% of the three fields, respectively. These fields did not need any S fertilizers in 11%, 26% and 25% of the areas, respectively. A higher rate of 40 lb ac-1 (44.8 kg ha-1) was optimum in 6%, 32% and 12% of the fields, respectively. The moderate rate of 10-20 lb ac-1 (11.2-22.4 kg ha-1) would be optimum in 68%, 25%, and 25% of the fields, respectively. More analyses will be performed to determine the potential economic benefits of site-specific S applications and the implications for precision S management will be discussed.

10:30
Value of Multiple Field Experiments Data as a Positive Externality
Jaeseok Hwang (University of Illinois, USA)

On-farm precision experiments (OFPE) offer non-biased data collection across entire fields, addressing the spatial variability of field characteristics. In contrast to strip or small plot trials, this method allows farmers to directly apply experimental results to fertilizer decisions without the need for scaling-up or parameter adjustments. Despite these advantages, barriers such as high costs and time inconsistency prevent more farmer from conducting OFPE in their own field. This study investigates the potential of utilizing combined OFPE data from multiple fields to estimate the yield response function and Economically Optimum Nitrogen Rate (EONR) in a specific manageable field where OFPE has not been implemented. The research addresses a critical gap in understanding whether data from different locations can be effectively leveraged in fields without direct experimentation. By doing so, it contributes to overcoming the barriers preventing on-farm precision experiments’ broader implementation. The positive externality of this approach, if successful, holds implications for policy and agricultural practices. However, our results indicate that the combined data from other fields has limited positive externality due to constraints in data quality, quantity, and spatial diversity.

10:50 - 11:00
Break

11:00 - 12:10
Session 10C: Presentation and Discussion
Moderator: Fernando Miguez, *Iowa State University, USA*
Room: Great White

The DIFM Cyber-infrastructure: What Is Done and What Is to Be Done
Scott Wahl (IT Director, Data-Intensive Farm Management Project, USA)

The Data-Intensive Farm Management Project: Towards the Future
David Bullock (University of Illinois, USA)

Evaluation of Variable Rate Applied Enhanced Efficiency Nitrogen Fertilizers
Haben Asgedom Tedla (Agriculture and Agri-Food Canada, Canada)

Investment on nitrogen (N) fertilizers is a major expense of wheat and canola growers, and variable rate application of N fertilizers could help optimize its usage. In the growing season of 2023, our first-year field experiment was conducted at four sites (i.e., Watrous and MacDowall – Saskatchewan and two fields in the vicinity of Strathmore, Alberta, Canada). The main objectives are to (i) determine performance of Enhanced Efficiency N Fertilizers - EENF (ESN, SuperU, urea mixed with eNtrench) vs. urea on canola and wheat productivity, (ii) evaluate management zones (MZ) delineation mapping techniques, and (iii) assess economic feasibility of the EENF and MZ. AgLeader SMS and Phyton programing were used to develop MZ from yield map, EC, elevation, NDVI, SWAT, and Meta-maps. Then experimental stations were selected in two contrasting MZ. Each experiment station contains nine treatments of three N rates a) control (no application), b) flat rate (average rate of the field), and c) variable rate (average of the zone) determined according the 4R Guidance, and the N fertilizers were sourced from i) conventional – Urea, ii) urea mixed with eNtrench, iii) blend of ESN and Urea, and iv) SuperU. Triple super phosphate (TSP), and potassium sulphate fertilizers were applied based on soil analysis results and crop demand. Complete weather stations (ATMOS) per site and six continuous soil moisture sensors (TEROS 12) with data loggers (ZL6) were installed. Following a drone flight equipped with thermal and multispectral cameras, plant and soil samples were collected during in-season and at harvest,. Currently, plant and soil samples are being processed and preliminary findings will be discussed.

Space weather impact on on-farm experiments: potential threats and downtime cost estimates
Terry Griffin (Kansas State University, USA)

The impact of space weather on agricultural production and food distribution is an emergent topic. Space weather associated with 11-year solar cycles such as coronal mass ejections (CME), sunspots, and other phenomena impacts life and operations on Earth. Some space weather events are more frequent than others. Severe events affecting the power grid in the northern half of the continental United States are relatively less common. Less severe but more common events such as aurora borealis are associated with radio blackouts due to ionospheric scintillation, especially at more extreme latitudes. Ionospheric scintillation interferes with satellite communications including global navigation satellite systems (GNSS) signals such that location fixes are not likely for up to a few hours. Without GNSS lock, farm equipment would not be able to operate using automated guidance, automated section control, coverage map sharing, and variable rate applications of fertilizer, seed, and crop protection chemicals. Without access to GNSS and full capabilities of precision agricultural technology, implementation and harvest of on-farm experiments would be severely limited. Whole-farm downtime models formulated as linear programs were used to assess production and returns under a range of scenarios. When GNSS became unavailable for on-farm experimentation for half a day, substantial reductions in returns to fixed costs resulted. Results are of interest to researchers, crop consultants, and farm operators conducting on-farm experiments.

12:10 – 13:00
Working Lunch and Discussion
Moderator: Bruce Maxwell, *Montana State University, USA*
Room: Great White

13:00 - 14:20
Session 10D: Breakout Groups: Planning for 2024
Room: Great White

Analytical Engine
John Sheppard (Montana State University, USA)

13:00 - 14:20
Session 10D: Breakout Groups: Planning for 2024
Room: Tarpon

Trial Implementation Discussion and Review
Robert Dunker (University of Illinois, USA)

13:00 - 14:20
Session 10D: Breakout Groups: Planning for 2024
Room: Marlin

Extension: Making Videos
Haiying Tao (University of Connecticut, USA)

14:20 – 14:30
Coffee Break

14:30 - 16:10
Session 10E: Research Reports: OPFE Results
Moderator: B. Wade Brorsen, *Oklahoma State University, USA*
Room: Great White

14:30
Development of Decision-Support Tools Using Large On-Fram Data Sets (virtual)
Viacheslav Adamchuk (McGill University, Canada)
Maxime Leduc (Mon Système Fourrager, Canada)
Md Saifuzzaman (McGill University, Canada)
Hamed Etezadi (McGill University, Canada)

Contemporary decision-support tools may be the most beneficial outcome of big data phenomenon in agriculture. Thus, instead of a limited number of well-crafted field trials, precision agriculture tools, used in conjunction with numerous public data sources, provide unique opportunities to construct numeric simulation models using on-farm production data that represent dispersed agro-climatic conditions across many crop production regions. This presentation will offer an overview of a numeric simulation framework that has been used to define the probability of different potential production outcomes based on extensive farm observation databases. Although the original study investigated the optimization of nitrogen fertilization in corn, our recent findings pertain to predicting alfalfa winter survival. The proposed approach provides decision makers with a visualization of the probability distribution for different levels of potential outcomes when they apply different management scenarios, such as the rate of fertilization or the number of forage crop harvesting events per year. These potential changes in crop management are applied to specific production environments, including cropping and tillage systems, climate, prices, etc. Unlike the conventional artificial intelligence tools, the proposed methodology provides consistent results even with a relatively low number of observations already in a database, and the output changes with time as more observations become available.

14:50
Model Averaging in Experimental Design: A Pathway to Determining Economic Nitrogen Levels in Limited-Plot Conditions (virtual)
Custódio Efraim Matavel (Leibniz Institute for Agricultural Engineering and Bioeconomy, Germany)
Andreas Meyer-Aurich (Leibniz Institute for Agricultural Engineering and Bioeconomy, Germany)
Hans-Peter Piepho (Universität Hohenheim, Germany)

The quest for sustainable agriculture places a premium on accurately determining economic nitrogen levels. In experimental setups limited by plot numbers, pinpointing the best combination of repetitions and nitrogen levels to minimize variance poses a challenge. This study employs model averaging techniques to address this issue, aiming to enhance the experimental design process. Through methodical evaluation, we highlight combinations that offer reduced variances, shedding light on their potential economic and agricultural benefits. While model averaging offers valuable insights, its integration into the experimental design for determining nitrogen levels requires careful consideration. By presenting a method grounded in data and analysis, this study offers researchers and farmers an additional tool to refine their experimental approach, aiming for better economic returns and informed nitrogen application decisions for uniform and site-specific fertilizer application.

15:10
On-Farm Experimentation: How Many Plots, Which Input Levels, and How Many Years?
Davood Poursina (Oklahoma State University, USA)
B. Wade Brorsen (Oklahoma State University, USA)

There is no agreement on the optimal way to conduct on-farm experiments, which is what motivated this paper. Some experimenters only use input levels expected to be close to the optimum, while others use very high and very low levels of inputs. Some conduct experiments on the whole field and some only use part of the field. The research here seeks to determine the optimal portion of the field on which to experiment, the input levels to use, and when to quit experimenting. A Monte Carlo simulation is used and then the optimization is conducted using a stochastic grid search. A linear stochastic plateau model with spatially varying plateau parameters is the underlying model. The results would likely differ if a nonparametric functional form had been estimated. The optimal design is to experiment on only a few of the plots and to use input levels that are relatively high and relatively low. The third year was the best time to quit experimenting. With a spatially varying coefficient model, much information is gained without experimenting on every plot. It is costly to use non-optimal levels of inputs and so it is optimal for most of the field to receive the current optimal level. Also, the big value in experimenting is when the farmer's prior for the optimal input level is off. Variable rate application is much less important. Thus, the recommended approach is to experiment on a few plots scattered throughout the field.

15:30
All for One and One for All: A Simulation Assessment of the Economic Value of Large-Scale On-Farm Experiment Network
Xiaofei Li (Mississippi State University, USA)

While on-farm experiments offer invaluable insights for precision management decisions, their scope is usually confined to the specific conditions of individual farms and years. To address this limitation, aggregating data from numerous farms of various crop growth conditions into a comprehensive dataset appears promising. However, the quantifiable value of this experiment network remains elusive. This study conducted a simulation-based assessment of the economic value of large-scale on-farm experiments, using crop variety selection as a case study. A hypothetical region was simulated comprising one thousand soybean production fields of diverse soil types and weather conditions. Each field was implemented with an on-farm soybean variety trial. Yields for each variety were simulated based on presumed true yield responses to soil types and weather conditions that are derived from historical Mississippi variety trial data. By constructing this large-scale on-farm experiment dataset, an optimal soybean variety prediction model was developed to recommend the individualized variety for each field. The profitability of soybean production for all fields was calculated based on current market prices. Results revealed a substantial improvement in farming profitability from the large-scale experiment network compared to the scenario of no experiment and network (where farms randomly selected one variety for their entire acreage). Furthermore, the profitability improvement diminishes when the scale of the experiment network decreases (e.g., reducing participation to one hundred fields) or when the number of trial varieties per field reduces, highlighting the economic benefits of broader farmer participation and more intensive trials by each participant in on-farm experiment network.

15:50

Quadratic-Plateau Geographically Weighted Regression Model for Estimating Site-specific Economically Optimal Input Rates

Chishan Zhang (University of Illinois Urbana-Champaign, USA)
Xiaofei Li (Mississippi State University, USA)
Taro Mieno (University of Nebraska-Lincoln, USA)
Chunyuan Diao (University of Illinois Urbana-Champaign, USA)
David Bullock (University of Illinois Urbana-Champaign, USA)

Site-specific input management allows farmers to adjust nitrogen application rates based on within-field variability. An emerging approach is using on-farm precision experiments (OFPE) to collect spatial yield response data to estimate site-specific economically optimal nitrogen rates (EONR). Various statistical methods have been applied for this purpose, but existing geographically weighted regression (GWR) models are limited in not accommodating nonlinear yield response functions like the quadratic-plateau (QP) commonly exhibited for crops like corn. This study develops a QP-GWR approach to estimate site-specific EONRs from OFPE data. Extensive simulations mimicking real-world spatial variability reveal QP-GWR has substantially lower bias and error variance in estimating EONRs compared to traditional GWR models when evaluating against the true QP response. The quadratic GWR tends to systematically overestimate while the linear plateau GWR underestimates EONRs. Counterintuitively, inferior statistical performance does not necessarily cause poorer economic outcomes. This highlights the need to evaluate both statistical and economic metrics in applied precision agriculture. Analysis of an empirical OFPE dataset further illustrates differences between QP-GWR and alternatives. Together these findings demonstrate QP-GWR's promise, when yield plateaus, to enhance optimization recommendations from on-farm experiments through correctly specified nonlinear response functions.

16:10 – 16:20
Break

16:20 – 17:30
Session 10F: General Discussion
Moderator: David Bullock (University of Illinois, USA)
Room: Great White

07:30 – 08:00
Registration & Morning Coffee
Room: Grand Ballroom Foyer

08:00 – 09:40
Session 11A: Research Reports: Varied Topics
Moderator: Terry Griffin, *Kansas State University, USA*
Room: Great White

08:00
How Do Statistically Valid On-Farm Precision Experiments Create Value?
James Lowenberg-DeBoer (Harper Adams University, United Kingdom)

On-Farm Precision Experiments (OFPEs) create value by collecting data that changes decisions. Analysis converts that data to information. The value of information equals revenue change because of the decision changed, minus cost of implementation, data, information and analysis. The opportunity cost of farmer, researcher and agri-business time and expertise is one of the largest costs in implementing OFEs. Time during the planting and harvest windows is particularly precious. Precision agriculture (PA) hardware and software allows trials to be preplanned and implemented automatically, thereby reducing the time commitment during planting and harvest. Designed trials that employ inferential statistics are particularly valuable because in addition to treatment effects, they provide estimates of the reliability of that treatment effect. Inferential statistics do not "hallucinate" the way that artificial intelligence (AI) machine learning algorithms can. For most agronomically important questions designed trials will be needed to gather information over the relevant data range. It is unlikely that observation of natural (unplanned) experiments would cover a wide enough data range. Natural experiments occur because of variability in farmer knowledge and experience, and from equipment malfunction and human error. Data from those unplanned experiments can be useful, but is unlikely to include enough low and high input levels, all commercially relevant forms of those inputs or a wide enough variation in field operation timing provide reliable estimates. Unfortunately, inferential statistics can only deal with a limited number of variables and interactions so many complex genotype x environment x management (GEM) interactions will beyond even the most sophisticated statistical analysis. To maximize value OFPEs must focus on decisions about a small number of variables (usually 3 or 4 variables) that are likely to have consistent responses over the next few years.

08:20
Using a Crop Simulation Model to Assess Space-time Uncertainty on Crop Yield Response in a Synthetic Corn Field
Takashi S. T. Tanaka (Gifu University, Japan)
Yui Yokoyama (Gifu University, Japan)
Taro Mieno (University of Nebraska–Lincoln, USA)

Crop yield can spatially vary over the time due to unpredictable uncertainties in edaphic and meteorological factors. Therefore, precise site-specific crop yield response modelling has been considered key to making a better recommendation on site-specific management. On-farm precision experimentation is expected to facilitate understanding of site-specific crop yield response to agronomic management. This study aimed to explore not only spatial but also temporal variability of crop yield response to nitrogen input rate. For that purpose, crop yield response data was synthesized by feeding spatially-varying environmental and crop physiological parameters generated from gaussian simulations to a process-based crop simulation model (i.e., WOFOST) in a 51-ha field over 42 years (1980–2022). Using the synthetic data, spaciotemporal changes in economically optimal nitrogen rates (EONR) was evaluated. The result showed that temporal variability in EONR was higher than spatial variability. This finding warned that a prescription map optimized in a certain season based on on-farm precision experimentation may not be able to provide a solution for the subsequent seasons because it is difficult to forecast long-term weather uncertainty. To optimise site-specific crop management strategy, practitioners should focus on crop management practices in the later growing seasons rather than simple basal fertiliser application as the former is less affected by the temporal uncertainty in meteorological factors.

08:40
EONR Prediction: The Criteria for Model Selection
Mona Mousavi (University of Nebraska, USA)

Machine learning (ML) models such as Random Forest (RF) and Boosted Regression Forest (BRF) have been used as statistical tools for analyzing experimental data and providing site-specific Economic Optimal Nitrogen Rate (EONR) recommendations. To achieve this, previous studies have often relied on selecting ML models based on their performance in predicting yield. This study uses Monte Carlo simulations and considers various ML models including RF, BRF, linear, Spatial Error (SE) and Causal Forest (CF) to introduce a new approach based on the spatial cross-validation to select a ML model for predicting site-specific EONR. by comparison between yield-based selection approach and our local EONR prediction approach we found that models that excelled in yield prediction did not consistently perform well in predicting EONR accurately. Our proposed local EONR model selection approach consistently outperforms the yield-based model selection method when it comes to choosing a model for effectively predicting site-specific EONR.

09:00
On-farm Evaluation of a Practical and Innovative Satellite Remote Sensing- based Precision Nitrogen Management Technology
Junjun Lu (University of Minnesota, USA)
Yuxin Miao (University of Minnesota, USA)
Katsutoshi Mizuta (University of Minnesota, USA)
Ana M. Ona (Purdue University, USA)
Renzo Negrini (University of Minnesota, USA)
Lorena Nunes Lacerda (University of Minnesota, USA & University of Georgia, USA)
Daniel J. Quinn (Purdue University, USA)
Jeffrey Coulter (University of Minnesota, USA)
David Mulla (University of Minnesota, USA)

Improper management of nitrogen (N) fertilizers in the cropping systems of the U.S. Midwest has resulted in significant N leaching into the Mississippi River Basin that flows to the Gulf of Mexico. The majority of the U.S. Midwest states need to develop a plan for a nutrient loss reduction strategy to decrease N and phosphorous loadings into waters and the Gulf of Mexico by 45% by 2050. In Minnesota, high nitrate concentration and loads have not been significantly reduced in surface and ground waters over the last twenty years. Corn cropping systems have been identified as a dominant non-point source of nitrate loads to surface and ground waters. A practical, and innovative satellite remote sensing-based precision N management (PNM) technology has been developed to improve N use efficiency and reduce N losses for corn by the Precision Agriculture Center at University of Minnesota. The objective of this research was to conduct on-farm trials to evaluate this PNM technology across diverse environmental conditions. Fifty on-farm N trials were conducted in Minnesota and Indiana from 2021 to 2023. A series of preplant N rate strips were set up based on the farmer's total N rate (FNR). Nitrogen rates included 35-80%FNR, 100% FNR, 120-130%FNR. The N strips were further delineated into smaller sections (grids) ranging from 45 to 60 m long x 23.33-26.67 m wide. PlanetScope satellite images were used to monitor crop growth conditions and estimate sidedress N rates at V7-V9 stages for each grid receiving 35-80%FNR as preplant N. Yield monitor data, as-applied N data and corn and N prices were used to evaluate the agronomic and economic performance of this PNM technology compared with farmer practice. The DNDC model was used to evaluate the environmental impact of the PNM technology. The preliminary results indicated that the remote sensing-based PNM technology generally increased N use efficiency while maintaining crop yield, but the economic returns can be higher, similar or lower comparable to farmer practice, depending on the weather conditions, farmer N management practices and corn and N prices. More analyses are being performed and the results will be presented at the conference.

09:20

Optimizing nitrogen management in Texas corn using UAV-based multispectral imagery

Gurjinder Baath (Texas A&M University, USA)

Optimizing nitrogen (N) management is crucial for maximizing corn productivity and minimizing environmental impacts. Excessive nitrogen application during early crop growth can result in N loss to the atmosphere, causing economic losses and environmental pollution. Generalized fertilizer N recommendations are inadequate to account soil system complexity and accurately synchronize N supply and demand. Due to imminent fluctuations in fertilizer prices, and low nitrogen use efficiency, there is an urgent need to rapidly develop reliable N management tools. Unabated, excessive N applications will continue to exacerbate environmental pollution and compound economic losses. This research work aims to develop site-specific N recommendation models. The models will be built with multivariate data collected using unmanned aerial vehicles (UAV) and other platforms to synchronize N supply and demand and improve nitrogen use efficiency. Our working hypothesis is site-specific models will account for site-specific variability and recommend accurate N rate. Recent findings derived from field experiments conducted at two sites in central Texas (Temple and Riesel) will be presented with discussion on site-specific N responses of corn.

09:40 - 09:50
Break

09:50 - 10:40
Session 11B: Breakout Group: Coming Up with a Plan
Room: Great White

Decision Tool

David Bullock (University of Illinois, USA)

09:50 - 10:40
Session 11B: Breakout Group: Coming Up with a Plan
Room: Tarpon

How to Work with Farmers in 2024?

Robert Dunker (University of Illinois, USA)

09:50 - 10:40
Session 11B: Breakout Group: Coming Up with a Plan
Room: Marlin

Extension: Cyber-infrastructure Training

Haiying Tao (University of Connecticut, USA)

10:40 - 10:50
Break

10:50 - 12:30
Session 11C: Research Reports: ML and AI
Moderator: Xiaofei Li, *Mississippi State University, USA*
Room: Great White

10:50

Identification of Soybean Planting Gaps Using Machine Learning

Flávia Luize Pereira de Souza (University of Connecticut, USA and São Paulo State University, Brazil)
Maurício Acconcia Dias (University Center of Hermínio Ometto Foundation, Brazil)
Tri Deri Setiyono (Louisiana State University, Louisiana)
Sérgio Campos (São Paulo State University, Brazil)
Haiying Tao (University of Connecticut, USA)
Luciano Shozo Shiratsuchi (Louisiana State University, Louisiana)

Soybean, a vital component of global agriculture, holds significant economic importance in Brazil. This study aimed to develop an algorithm capable of identifying gaps in soybean planting within images and classifying them into gap and non-gap categories. To achieve this, the research compared the performance of three algorithms: Decision Tree, SVM, and Multi-Layer Perceptron (MLP) Neural Network, in detecting soybean planting gaps in UAV images. The findings revealed that the MLP Neural Network exhibited the most promising performance after fine-tuning its settings, showcasing its potential for accurate image classification. This breakthrough could have significant implications for precision agriculture and crop management. These results serve as a solid foundation for future algorithm development aimed at detecting planting gaps through image analysis.

11:10

The Role of On-farm Experimentation and Mchine Learing in the Developmet of Intelligent Decision Systems in Agriculture

André F. Colaço (University of São Paulo, Brazil)
Rob Bramley (CSIRO, Waite Campus, Australia)
Brett Whelan (The University of Sydney, Australia)

Since the early development of Precision Agriculture (PA) in the 90's, decision tools used for site-specific nutrient management have largely relied on traditional agronomic recommendation frameworks to calculate fertilizer application rates. In turn, these have generally derived from small plot trials conducted at sites within widely ranging regions. For example, a common strategy – in academic research and commercial PA services – has been to input information from soil fertility maps into recommendation formulas based on generalized response functions to generate variable rate fertilizer recommendation maps (e.g. Colaço e Molin, 2017). This type of approach has been long criticized (Bullock et al., 2002 and Colaço et al., 2020) because it fails to consider local crop responsiveness to applied nutrient, which is a key element of site-specific management. Similarly, most sensor-based approaches for nitrogen (N) management have also relied on generalized agronomic approaches to calculate fertilizer rates (Colaço and Bramley, 2018). In this case, a common strategy is based on a nutrient mass balance (or 'nutrient budget') calculation in which sensor-based yield predictions are used as proxy to nutrient demand (Raun et al. 2005). However, aside from the generally weak yield prediction models generated from a single sensor input (Colaço and Bramley, 2019), other elements of the nutrient balance framework, such as the total available nutrient in the system or the fertilizer use efficiency are often not measured nor estimated, so fixed values are assumed. As a result, these factors combined can compromise the accuracy of the final recommendation (Colaço et al., 2021). Overall, the lack of adequate decision tools to make use of the spatial digital data provided by PA technology has been a critical barrier for the advance of site-specific management and of digital agriculture more broadly.

11:30

Prediction Software using OFPE and Machine Learning

Giorgio Morales (Montana State University, USA)

The increasing accessibility of precision sensors capable of consistently and continuously gathering data from agricultural fields provides an opportunity to develop models that predict critical response variables, including but not limited to crop yield and protein content. Leveraging various machine learning (ML) algorithms, these models are trained to integrate data from On-Farm Precision Experimentation (OFPE), generating site-specific insights into field management responses. In this training session, we will present the prediction tool we have developed as part of the Analytic Engine of the Data-Intensive Farm Management (DIFM) project. This tool incorporates recent and well-known ML algorithms, including Hyper3DNetAQD, convolutional neural networks with late fusion (CNN-LF), random forests, generalized additive models (GAMs), Bayesian linear regression, and standard linear regression. The session outlines the configuration, training, and storing of these models, along with the creation of prediction shapefile maps. Furthermore, we will discuss the quantification of prediction uncertainty through the generation of uncertainty maps based on estimated prediction intervals.

11:50

Utilizing UAV Imagery and Machine Learning techniques for Soil Nitrogen Measurement and Yield Estimation

Maria Villamil Mahecha (North Dakota State University, USA)
Xin Sun (North Dakota State University, USA)

Nitrogen mismanagement in the field is a driver of soil and crop health degradation, and therefore one of the factors that increases costs without crop yield benefits. Current Nitrogen management practices involve recording nitrogen concentrations at random points in the field, which can be labor intensive and ineffective in large agricultural fields. Unmanned aerial vehicles (UAV) enable the collection of high-resolution images over a large area. In this study, UAV was used to collect multispectral images in a Data intensive farm management (DIFM) field at a high resolution of 1.9 cm per pixel, and a height of 120 ft which enabled large area coverage. Three orthomosaics were generated based on the acquired images. ArcGIS Pro software was employed to analyze the orthomosaics, calculate vegetation indices, and measure variables from the prediction maps of the DIFM field. Vegetative indices with potential to quantify soil nitrogen content were selected. These indices were then preprocessed as features for the developed machine learning (ML) models. Three ML models, i.e., multiple linear regression, random forest, and convolutional neural networks were trained to predict nitrogen concentrations in soil. These model predictions were then correlated to find the crop yield. Prediction of nitrogen concentration in soil would optimize the use of nitrogen fertilizers, maximizing crop yield and reducing the environmental footprint associated with nitrogen use in agriculture.

12:10

Analyzing the Performance of Machine Learning Models for Sub-field Maize Yield Precision Agriculture

Simphiwe Maseko (University of Pretoria, South Africa)
Mark van der Laan (University of Pretoria, South Africa & Agricultural Research Council, South Africa)
Eyob H. Tesfamariam (University of Pretoria, South Africa)
Marion Delport (Bureau for Agricultural and Food Policy (BFAP), South Africa)
Helga Ottermann (Bureau for Agricultural and Food Policy (BFAP), South Africa)

Understanding the relationships between crop yields, soil properties, weather patterns, and input application is crucial for optimizing agricultural production. Data variation analysis using statistical and machine learning approaches can help identify and understand the practices that optimize yields. The study aimed to evaluate the predictive accuracy of selected ML models for estimating grain yields in on-farm maize trials with different combinations of seeding and fertilizer rates, and to investigate the ability of ML models to assist in identifying yield-limiting factors. Four ML models, MLR, MLP, DT, and RF, were trained and tested for maize yield prediction using crop management, soil, and remotely sensed data. The RF had the best combination of high correlation and low error compared to other models. Feature importance analysis revealed that urea application was the most critical variable explaining yield variations to the greatest extent, while soil P, plant population, and sodium were the most influential factors for explaining yields in the respective seasons. This study found that the RF model was best for predicting spatial yield using Data Intensive Farm Management (DIFM) trials datasets. There was also seasonal variability in factors that could limit yield due to temporal variation. Machine learning models in agricultural systems require the consideration of variations in weather, soil types, and other environmental factors that can vary in space and time. The DIFM trials combined with ML can provide valuable insights into crop-soil-management interactions and identify opportunities for improving yields and sustainability.

12:30 – 13:10
Lunch (on your own)
Room: Great White

13:10 - 14:30
Session 11D: Breakout Groups: Planning for 2024
Room: Great White

Analytical Engine
John Sheppard (Montana State University, USA)

13:10 - 14:30
Session 11D: Breakout Groups: Planning for 2024
Room: Tarpon

Trial Implementation
Robert Dunker (University of Illinois, USA)

13:10 - 14:30
Session 11D: Breakout Groups: Planning for 2024
Room: Marlin

Extension
Haiying Tao (University of Connecticut, USA)

14:30 – 14:40
Break

14:40 – 15:30
Session 11E: Wrap-Up Discussion
Moderator: David Bullock, *University of Illinois, USA*
Room: Great White

15:30 – 17:00
DIFM Project Management Committee Meeting
Room: Great White