NC-1210: Frontiers in On-Farm Experimentation, Post Meeting Report 2024

**Project/Activity Number:** NC1210

**Project/Activity Title:** “Frontiers in On-Farm Experimentation”

**Period Covered:** January 5, 2023 – January 11, 2024

**Date of This Report:** January 23, 2024

**Annual Meeting Date:** January 10-11th, 2024

# Participants: (total of 20 NC1210 MEMBERS)

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# Brief summary of minutes of annual meeting:

The 2024 Annual Meeting was held on January 10-11th in South Padre Island, Texas at the Hilton Garden Inn & Suites Conference Center. See below for an overview of the meeting agenda or view a more detailed agenda at: [ICOFPE\_2024\_Program\_aa67d7eab0.pdf (s3.us-east-1.amazonaws.com)](https://confcats-siteplex.s3.us-east-1.amazonaws.com/ofpe24/ICOFPE_2024_Program_aa67d7eab0.pdf)



# Accomplishments:

**Outputs:** Viable Trial Design Software, Database Development, International Conference for On-Farm Precision Experimentation (ICOFPE 24’), Publications, Presentations.

**Activities:** The NC-1210 Group wrote a proposal and was awarded a $50,000 grant from the USDA National Institute of Food and Agriculture’s Agricultural and Food Research Initiative (NIFA-AFRI, award number 2023-67021-40615) to organize and hold an International Conference for On-Farm Precision Experimentation. The conference was largely successful, bringing together researchers, crop consultants, and farmers from across the world. More can be found about the ICOFPE 24’ at this website: <https://2024.ofpe.org/>.

**Total registered:** 115

**Virtual:** 15

**Students:** 19

**Countries:** 12

 - Brazil (2)

 - Canada (13)

 - China (1)

 - Colombia (1)

 - Germany (1)

 - Italy (1)

 - Japan (3)

 - Nigeria (2)

 - Korea (1)

 - South Africa (3)

 - Uruguay (1)

 - USA (86)

**Academia:** 63

**Industry:** 52.

# Impacts:

**Activities:** The trial design software of the DIFM cyber-infrastructure is up and running. Work is proceeding apace with the database development, data processing, reporting and analytical engine components.

### Milestones: Trial Design Integration

Recent improvements to the website include integrating trial design, data processing, and report generation into the single system. Users can now design trials with new software that is based on the excellent prior work from the DIFM team at Purdue. Tools are also now in place to upload and process the applied and yield data through the website. Users can upload the results of a trial, process their data, and get reports automatically. These reports are being constantly improved, and these updates will mean farmers and consultants can get detailed information on the outcomes of the trials without requiring manual creation of the reports. Development is also proceeding with integrating the feedback from ICOFPE to better support users.

## Indicators:

In preparation for the conference, resources for the servers were increased to help make sure they could handle many simultaneous users. Despite the increased costs in this period, there were still over $20,000 unused free credits at the end of the month. The following figure shows the daily cost to run the services in the Oracle for Research DIFM CIG tenancy. At its peak, the daily cost was $99.17 for this period.



To improve efficiency and security, data was transferred to a new tenancy. This allowed DIFM to archive older tools and data that was no longer in use. After transferring all of the data to the new tenancy, multiple cost-saving measures were taken to lower the cost of running the services. With the reduced compute, archived data, and additional adjustments the daily cost was significantly lowered to under $22 per day as seen in the following graph. The same period in January in 2023 had an average daily cost over $120. These savings will help ensure long-term viability of the project.



# Publications & Presentations:

**Publications**

Amanda Ashworth, Phillip Owens, Edwin Winzeler, Tulsi Kharel, Darya Abbasi, Ammar Abdul Motaleb, Yuan Zhou. Tentative title: Site-specific zone management using machine learning. Currently status: working on the analysis and draft. Plan to submit it in August 2024.

Amy Peerlinck and John Sheppard.  Addressing Sustainability in Precision Agriculture via Multi-Objective Factored Evolutionary Algorithms URL: https://www.cs.montana.edu/sheppard/pubs/mic-2022.pdf

Amy Peerlinck and John W. Sheppard. Influence of Variable Grouping on Large-Scale Multi- and Many-Objective Optimization. in preparation (submission by December 23).

Amy Peerlinck and John W. Sheppard. Managing Objective Archives for Solution Set Reduction in Many-Objective Optimization. to appear IEEE Symposium Series on Computational Intelligence, December 2023

Chishan Zhang, Chunyuan Diao, David Bullock, Xiaofei Li, Taro Mieno. Economic Evaluation of Site-specific Nitrogen Management using Extended Geographically Weighted Regression (GWR) Analysis. Status: In progress, with a focus on writing and revising the manuscript. Estimated Timeframe for Submission: Dec 2023

Du, Q., T. Mieno, and D.S. Bullock. Economically Optimal Nitrogen Side-Dressing Based on Vegetation Indices from Satellite Images through On-farm Experiments. Working Paper.

Duff, H., L. Carlisle, P.B. Hegedus, S. Loewen and B.D. Maxwell. 202\_. When less is more: A case for converting low-yielding areas to ecological refugia in crop fields. Nature Sustainability (In Review, submitted 4/6/2023)

Duff, H., D. Debinski and B.D. Maxwell. 202\_. Ecological refugia enhance biodiversity and crop production in dryland grain production systems URL: https://www.sciencedirect.com/science/article/pii/S0167880923004103?ssrnid=4325712&dgcid=SSRN\_redirect\_SD

Duff, H., D. Debinski and B.D. Maxwell. 202\_. Landscape context affects patch habitat contributions to biodiversity in agroecosystems. J. Applied Ecology (In review, submitted 4/3/2023)

Giorgio Morales and John Sheppard. Counterfactual Explanations of Neural Network-Generated Response Curves URL: https://arxiv.org/abs/2304.04063

Giorgio Morales and John W. Sheppard, ``Dual Accuracy-Quality-Driven Neural Network for Prediction Interval Generation,'' re-submitted to IEEE Transactions on Neural Networks and Learning Systems, March 2023.

Giorgio Morales and John W. Sheppard, ``Univariate Functional Form Identification in Multivariate Systems Using Transformers," in preparation (submission by January 24)

Giorgio Morales, John Sheppard, Paul Hegedus, and Bruce Maxwell. Improved Yield Prediction of Winter Wheat Using a Novel Two-Dimensional Deep Regression Neural Network Trained via Remote Sensing URL: https://www.mdpi.com/1424-8220/23/1/489

Hegedus, P.B., Maxwell, B.D., Ewing, S.E., & Bekkerman, A. (2023). Development and evaluation of site-specific optimized nitrogen fertilizer management based on maximized profit and minimization of pollution. Paper. Precision Agriculture, Submitted.

Hans Edwin Winzeler, Phillip R. Owens, Tulsi Kharel, Amanda Ashworth, and Zamir Libohova.  Identification and Delineation of Broad-Base Agricultural Terraces in Flat Landscapes in Northeastern Oklahoma, USA URL: https://www.mdpi.com/2073-445X/12/2/486

Jaeseok Hwang, David S Bullock, Taro Mieno. "What is the Value of On-Farm Precision Experiment Data as a Public.” Working paper, 2025.

Khanal, B., T. Mieno, K. Schoengold, and D.S. Bullock. 2023. Optimizing Precision Conservation with On-Farm Precision Experiment Data: The Role of Crop Insurance and Spatially Variable Profit.

Li, X., Mieno, T. & Bullock, D.S. The economic performances of different trial designs in on-farm precision experimentation: a Monte Carlo evaluation. Precision Agric (2023). https://doi.org/10.1007/s11119-023-10050-8

Loewen, S. and B.D. Maxwell. 202\_. Optimizing Cover crop seeding rates and following cash crops to maximize net return in organic grain farming. Ecosphere. In review Submitted 8/29/2023

Loewen, S. and B.D. Maxwell. 202\_. Optimizing Crop Seeding Rates On Organic Grain Farms Using On Farm Precision Experimentation. Field Crops Research. In Review. Submitted 9/17/2023

Mills, B.E., B.W. Brorsen, D. Poursina, and D.B. Arnall. Optimal grid size for site-specific nutrient application URL: https://doi.org/10.1111/agec.12802

Mieno, T., X. Li, and D.S. Bullock. 2023. Bias in Economic Evaluation of Variable Rate Application based on Geographically Weighted Regression Models with Mis-specified Functional Form.

Mieno, T., Li, X., and Bullock, D. S. “Economic Evaluation of Misspecified Geograph-ically Weighted Regression Models for Site-specific Nitrogen Management.” Journal of the Agricultural and Applied Economics Association. (Revise & Resubmit)

Nan Li, David Bullock, Carrie Butts‐Wilmsmeyer, Laura Gentry, Greg Goodwin, Jaeyeong Han, Nathan Kleczweski, Nicolas F. Martín, Patricia Paulausky, Pete Pistorius, Nicholas Seiter, Nathan Schroeder, and Andrew J. Margenot. Distinct soil health indicators are associated with variation in maize yield and tile drain nitrate losses URL: https://ui.adsabs.harvard.edu/abs/2023SSASJ..87.1332L/abstract

Negrini, R., Mizuta, K. Miao, Y., Stueve, K., Lacerda, L., Anthony, P., Coulter, J. Evaluating the potential of variable rate sulfur management for corn in Minnesota, in preparation, to be submitted in 2024.

Patterson, G. Cole. 2023. Using Informative Bayesian Priors and On-Farm Experimentation to Predict Optimal Site-Specific Nitrogen Rates URL: file:///C:/Users/jbruner9/Downloads/Poster\_Ngombe\_Brorsen.pdf

Paul Hegedus, Bruce Maxwell, John Sheppard, Sasha Loewen, Hannah Duff, Giorgio Morales-Luna, and Amy Peerlinck. Towards a Low-Cost Comprehensive Process for On-Farm Precision Experimentation and Analysis URL: https://www.mdpi.com/2077-0472/13/3/524

Paul Hegedus, Stephanie Ewing, Claim Jones, and Bruce Maxwell. Using spatially variable nitrogen application and crop responses to evaluate crop nitrogen use efficiency URL: https://ui.adsabs.harvard.edu/abs/2023NCyAg.126....1H/abstract

Poursina, D., and B.W. Brorsen. 2023. Fully Bayesian Economically Optimal Design for Spatially Varying Coefficient Linear Stochastic Plateau Model. Submitted to Stochastic Environmental Research and Risk Assessment. In second review

Poursina, D., and B.W. Brorsen. Site-Specific Nitrogen Recommendation: Fast, Accurate, and Feasible Bayesian Kriging. To be submitted to Precision Agriculture

Qeiroz, P.W., R.K. Perrin, L.E. Fulginiti, and D.S. Bullock. 2023. Expected Payoff from a Variable Rate Nitrogen Application: an Expect Value of Sample Information (ESVI) Approach. Submitted to the American Journal of Agricultural Economics.

Tanaka, T.S.T., G.B.M. Heufelink, T. Mieno, and D.S Bullock. 2023. Provide Accurate Fertilizer Recommendations.

Tibbs, R.G. and M.A. Boerngen. "Understanding Farmers’ Views of On-Farm Precision Experimentation Through Interviews” to be submitted to Agricultural & Environmental Letters, within the next month or so.

Tibbs, R.G., M.A. Boerngen, and N. Heller. "Farmers’ Perceptions of and Interest in Conducting On-Farm Precision Experimentation" to be submitted to Precision Agriculture in Spring 2024

Zhang, C., Li, X., Mieno, T., and Bullock, D. S. 2024. Performances of Quadratic-Plateau Geographically Weighted Regression Model in Site-specific Yield Response Estimation. Target Journal: Precision Agriculture.

Zhang, C., X. Li, T. Mieno, C. Diao, and D.S. Bullock. 2024. Use of a Quadratic-plateau Geographically Weighted Regression Model for Estimating Site-specific Economically Optimal Input Rates.

**Presentations**

Amanda Ashworth. Machine Learning for Site-Specific Management in Precision Agriculture, April 2023, Innovation Day, University of Text at Arlington. Video Link: https://uta.engineering/innovationday/project-2023.php?p=78&h=63201076a0a47964cfa8837f30a8805a.

Brorsen, B.W. 2023. Nitrogen Use Efficiency and Economic Hurdles. Nitrogen Use Efficiency Meeting 2023, Stillwater, OK. Poursina, D., and B.W. Brorsen. 2023.

Bullock, D.S., Conducting Field Trials with the Iowa Nitrogen Initiative and the Data-Intensive Farm Management Project. Iowa Nitrogen Initiative Farmers. Washington, Iowa. February 24 2023.

Bullock, D.S., The Data-Intensive Farm Management Project. Researchers and administrators at the Quebec Ministry of Agriculture and Fisheries. Quebec City Canada. March 29 2023.

Bullock, D.S., The Data-Intensive Farm Management Project. Quebec farmers, consultants and researchers, in cooperation with the Quebec Ministry of Agriculture and Fisheries. Trois Rivieres Quebec Canada. March 31 2023.

Bullock, D.S., The Data-Intensive Farm Management Project. Quebec farmers, consultants and researchers, in cooperation with the Quebec Ministry of Agriculture and Fisheries. St. Cesaire Quebec Canada. March 30 2023.

Bullock, D.S., The Data-Intensive Farm Management Project: Progress, Challenges, and Results in On-Farm Precision Experimentation. ACE Weekly Seminar Series. Urbana, Illinois. April 7 2023.

Bullock, D.S., Discussion: Agrithority and DIFM. Agrithority Virtual Presentation. January 16 2023.

Bullock, D.S., Discussion: Amplify-Brookside and DIFM. Amplify-Brookside Virtual Presentation. January 31 2023.

Bullock, D.S., Discussion: Minnesota Crop Production Retailers and DIFM. Minnesota Crop Production Retailers Association Virtual Presentation. February 13 2023.

Bullock, D.S., La Experimentación a de Precisión a Campo: Una Oportunidad de Colaboración entre el Proyecto DIFM y los Productores Uruguayos. Annual Meeting of ProNutrion Producers. Colonia del Sacramento Uruguay. September 1 2023.

Bullock, D.S., Improving Outcomes through On-farm Precision Experimentation" (\*Invited Speaker). KATCON 2023, sponsored by the Kansas Agricultural Research and Technology Association (KARTA). Junction City Kansas. January 19 2023.

Bullock, D.S., On-farm Precision Experimentation: An Opportunity for Collaboration between Brazilian Farmers and DIFM. Rumo Agro (25 Brazilian farmers visiting the U.S.). Urbana, Illinois. August 28 2023.

Bullock, D.S., On-farm Precision Experimentation with the Data-Intensive Farm Management Project. Presentation before Alberta and Saskatchewan commodity groups. Olds College Alberta. November 20 2023.

Bullock, D.S., On-farm Precision Experimentation with the Data-Intensive Farm Management Project. Presentation before the Ontario Ministry of Agriculture, Food and Rural Affairs (and various farmer and commodity groups). Virtual. November 30 2023.

Bullock, D.S., Progress and Status of the Data-Intensive Farm Management Project. Researchers in and Administrators of the NRCS-Conservation Innovation Grant Program. Des Moines Iowa. August 7 2023.

Bullock, D.S., Some Thoughts on On-farm Precision Experimentation with Cover Crops. Researchers and administrators at the Quebec Ministry of Agriculture and Fisheries. Quebec City Canada. March 20 2023.

Bullock, D.S., The State of the DIFM Project.” DIFM/NC-1210 Annual Meeting. Corpus Christi Texas, January 5 2023.

Bullock, D.S., Some Thoughts on On-farm Precision Experimentation with Cover Crops. Quebec farmers, consultants and researchers, in cooperation with the Quebec Ministry of Agriculture and Fisheries. Trois Rivieres Quebec Canada. March 31 2023.

Bullock, D.S., Une rencontre d’information sur les possibilités de démarrer des essais à la ferme en 2023, utilisant l’agriculture de précision (Bullock attended to answer audience questions.) Quebec farmers, consultants and researchers, in cooperation with the Quebec Ministry of Agriculture and Fisheries. Virtual. April 27 2023.

Bullock, D.S., Using the (free!) Data-Intensive Farm Managment Project’s Tools to Design and Analyze Your On-Farm Trials. Kansas Agricultual Technologies Conference. Manhattan Kansas. January 26 2024.

Bullock, D.S., Using On-farm Precision Experimentation for Improved Nitrogen Fertilizer Efficiency and Mitigation of Greenhouse Gas Emissions. Presentation at the Journée d´échanges Scientifiques: Utilisation déngrais azoté et réduction GES conference, sponsored by the Quebec Minsitry of Agriculture, Fisheries and Food. Virtual. Novemebr 28 2023.

Bullock, D.S., Why Agriculture Big Data Needs On-Farm Precision Experimentation (and Vice-Versa). International Conference for On-Farm Precision Experimentation. South Padre Island Texas. January 8 2024.

Bullock, D.S., Working with the Data-Intensive Farm Management Project to Conduct On-Farm Precision Experiments. Virtual Symposium: Harvesting Insights with Data-Driven On-Farm Precision Experimentation. February 13, 2024.

Bullock, D.S., You May Not Want to Use "Yield Potential" to Make Input Management Decisions. Instead: Conduct On-Farm Precision Experiments! Michigan State University Field Crops Webinar. February 27 2023.

Bullock, D.S., B. Edge, and T.Mieno. A Microeconomic Perspective on the Value of OFPE Data in Management Zone Delineation. 6th Symposium on Agri-Tech Economics for Sustainable Futures. Harper Adams University, England. September 18 2023.

Bullock, D.S., B. Edge, and T.Mieno. A Microeconomic Perspective on the Value of OFPE Data in Management Zone Delineation. Second International Conference on Farmer-centric On-farm Experimentation. Virtual. December 5 2023.

Brorsen, B.W. 2023. “Fully Bayesian Economically Optimal Design for Spatially Varying Coefficient Linear Stochastic Plateau Model.” Presentation. StanCon 2023, St. Louis, MO, June.

Du, Q. 6th Symposium on Agri-Tech Economics for Sustainable Futures. 18-19 September 2023, Harper Adams University, Newport, U.K.

Duff. H., PhD Dissertation Defense Presentation Talk 4/13/2023

Hwang. J., 6th Symposium on Agri-Tech Economics and Sustainable Future. https://store.harper-adams.ac.uk/product-catalogue/on-campus-events/on-campus-events/6th-giate-symposium

Li, X., Mieno, T., Bullock, D. S., Gong, A., Edge, B., Du, Q., and Hwang, J. “Economic Evaluation of Variable Rate Application using On-Farm Precision Experimentation Data.” AI in Agriculture: Innovation and Discovery to Equitably Meet Producer Needs and Per-ceptions, Orlando, FL, April 17-19, 2023

Loewen. S,- PhD Dissertation Defense Presentation 4/14/2023 talk begins at 12:08, it is labeled. Recording link: https://montana-student.webex.com/montana-student/ldr.php?RCID=4617a4980f06f032f3a8219991d8cb8f Password: Ye6rzm4Y

Loewen. S, LRES Seminar 2/27/2023 link: https://montana.webex.com/montana/ldr.php?RCID=c1e6e2f69d37cb50eaad671214db70d8

Morales. G., Counterfactual Explanations of Neural Network-Generated Response Curves, IEEE International Joint Conference on Neural Networks, July 2023.

Sheppard, J., Demystifying Machine Learning through eXplainable Artificial Intelligence (XAI). Optical Technology Center Colloquium, Montana State University, February 10, 202

Sheppard, J., Insurance Innovation, Artificial Intelligence, & What to Watch For In Montana. CSI Insurance Summit, Butte, MT, September 13, 2023 (included DIFM as a case study).

Tibbs. R, and M. Boerngen. Examining the Perceptions of Precision Agriculture Technologies and On-Farm Precision Experimentation - Rural Sociological Society Annual Meeting, August 1-6, 2023, Burlington, VT. https://www.dropbox.com/scl/fi/twyolv3gl654mlgozxgq9/Revised-Final-RSS-Program-2023.pdf

Vanerplas. S, "Redesigning Yield Maps for Comprehension and Usability". Symposium on Data Science and Statistics. https://ww3.aievolution.com/AMSTATevents/index.cfm?do=cnt.appLoader&routerAction=runCustomSearch#/searches/load/Sessions\_SDSS