NCCC-170
Research Advances in Agricultural Statistics
Annual meeting held at University of Illinois
Champaign, Illinois
June 20-21, 2019

Members and Participants Present: Nora Bello (KS), Deborah Boykin (USDA-ARS), Bruce Craig (IN, Admin.), Xin Dai (UT), Philip Dixon (IA), Sara Duke (USDA-ARS), Susan Durham (UT), Ed Gbur (AR), Carla Goad (OK), Kathryn Goode (IA), Kathy Hanford (NE), Nick Keuler (WI), Matt Kramer (USDA-ARS), Alex Lipka (IL), Larry Madden (OH), Neil Paton (Cargill), Guilherme Rosa (WI), John Stevens (UT), Rob Tempelman (MI), Edzard van Santen (FL), Kathy Yeater (USDA-ARS), Linda Young (USDA-NASS), Bruce Mackey (USDA-ARS), Debra Palmquist (USDA-ARS), Bryan Vinyard (USDA-ARS)

Others Present: Matthew Murphy (IL), Brian Rice (IL), Marcus Olatoye (IL)

2019 Officers: Ed Gbur, Chair; Susan Durham, Secretary; Larry Madden, Program Chair; Alex Lipka, Local Arrangements

NCCC-170 Website: sites.uark.edu/ncr170/
NIMSS Website: www.nmiss.org

Minutes:
Technical program: The meeting began at 8:30 a.m. on Thursday, June 20 with opening remarks by Dr. Chris Harbourt, CEO, Air Scout, Inc. Presentations ended at approximately 4:15 p.m. and was followed by a group discussion (details below) that ended at 5:00 p.m. The Friday, June 21 session began at 8:30 am with the last technical presentation followed by a second group discussion (details below). After a short break the business meeting was held. The meeting ended at 10:30 am.

The technical program consisted of the following presentations:

K. Chitakasempornkul[1], G.J.M. Rosa[2], A. Jager[1], and **N.M. Bello**[1] [1]*Kansas State University and* [2]*University of Wisconsin-Madison*	Hierarchical modeling of structural coefficients for heterogeneous networks with an application to animal production systems
Guilherme J.M. Rosa *University of Wisconsin-Madison*	Generalized additive mixed modeling of total transport losses of market-weight pigs
Kathleen Yeater[1], George Yocum[2], Joseph Rinehart[2], Arun Rajamohan[2], Julia Bowsher[3], Kendra Greenlee[3] [1]*USDA-ARS Plains Area Office of the Director,* [2]*USDA-ARS-Insect Genetics and Biochemistry Research Unit,* [3]*North Dakota State University*	Generalized linear mixed model approach to time-to-event data with censored observations
John R. Stevens and Richard M. Lambert *Utah State University*	Evaluating the comparative performance of popular gene set test methods

Brian Rice and Alex Lipka *University of Illinois*	Pleiotropy in principal components
Marcus O. Olatoye and Alex Lipka *University of Illinois*	Training population optimization for genomic selection in *Miscanthus*
Philip Dixon *Iowa State University*	Using the binomial GLMM for partially paired categorical data
Larry Madden *Ohio State University*	The all-zero treatment problem with conditional binomial data and GLMMs
Susan Durham[1], Leila Shultz[1], James Long[1], Wanda Lindquist[1], and Douglas Johnson[2] [1]*Utah State University and* [2]*Utah National Guard*	Exploring longitudinal data with historical random forests
Katherine Goode *Iowa State University*	A review and discussion of residuals for mixed models
Philip Dixon *Iowa State University*	Ordination plots for model-based analysis of species composition data: connecting two very different sets of methods

The Thursday group discussion considered potential replacement of the now defunct Kansas State University Conference on Applied Statistics in Agriculture and its associated workshop. There was discussion about whether a replacement was feasible, logistics, programming, workshop offering, location, timing, continuity, etc. The discussion continued at the Friday morning business meeting. Edzard van Santen will investigate the possibility of a organizing a conference at the University of Florida in Gainesville in May 2020 and report back to the group.

The discussion on Friday morning considered whether the group would write a book on Bayesian data analysis similar to the book by group members on generalized linear mixed models in the agricultural sciences that was published in 2012 by the American Society of Agronomy, Crop Science Society of America, and Soil Science Society of America. It was decided that the need to disseminate this methodology to agricultural scientists would be better addressed by one or two papers rather than by a book. The timing of the papers depends upon when participants have access to new SAS software for Bayesian analysis of generalized linear mixed models. The possibility of working with the SAS Institute for software access and educational webinars was considered.

Business meeting: The business meeting began at about 10:00 am. Ed Gbur presided. Carla Goad and Linda Young participated remotely via Zoom software. The following items were discussed:

(1) The organizers were thanked for a productive and enjoyable meeting.

(2) Presenters who wish to post their talk on the project website should send a pdf of the talk to Ed.

(3) The annual report and impact statements are due this Fall. Participants need to send Ed Gbur (egbur@uark.edu) accountings of all activities (workshops, papers, presentations, grants, awards, teaching related items, etc.) from October 1, 2018 to September 30, 2019 (or since last year's report)

that are related to or inspired by their participation in NCCC-170 as soon as possible. (See the email from Ed soliciting contributions, sent June 26, 2019, and posted on the NCCC-170 website.)

(4) The group considered the updated USDA guidelines for "impactful" final reports and discussed how improvements might be achieved, including documented collaborations among group members.

(5) The 2020 meeting will be held at the Oklahoma State University with Carla Goad as the local host. Tentative dates are June 25-26, 2020. Nora Bello will serve as program chair. The 2021 meeting is tentatively planned for Colorado State University with Julia Sharp as the local host. Utah State University was suggested as an alternative site for 2021 if necessary.

(6) Discussion of the replacement for the Kansas State University Conference was continued. Linda Young volunteered to set up a conference call to continue discussions on Edzard van Santen's offer to host such a meeting in 2020.

(7) 2018-2019 is the third year of the current project that is scheduled to end in 2021. Progress toward those objectives as they relate to the expected outcomes and impacts, especially providing continuing education and statistical support to the scientific community in the review and editorial process have become more important than ever.

(8) Ed noted that the same state and institution can be represented by multiple people, but only one of whom may be designated as a voting member. This question arose because several individuals who participate in the annual meetings are not official participants according to NIMSS.

The business meeting adjourned at approximately 10:30 a.m.

Some group members visited the Morrow Plots on the University of Illinois campus after the meeting adjourned. This field, established in 1876, is the oldest experimental agricultural field in the United States.

Accomplishments: Statisticians who consult and do research in an Agricultural Experiment Station environment enable land grant institutions to perform their agricultural research missions more effectively and efficiently than would otherwise be possible. However, most stations have at most one or two professional statisticians who are not, and cannot be expected to be, experts in every area of statistics. This multi-state committee brings together statisticians to work cooperatively to determine the best current approaches to common statistical problems and to help guide future directions of sound statistical practice. In addition to producing group outputs such as workshops, the committee serves as a resource for its members and a sounding board for new ideas in their applied statistical research. As a result, all members are able to provide more effective assistance to agricultural researchers addressing national research priorities than they would without NCCC-170.

Outputs:

Workshops:
Nora Bello presented a short course entitled "Modern Statistics for Agricultural Research" at the College of Agriculture, Royal University of Agriculture, Phnom Penh, Cambodia. August 11-15, 2019.

Nora Bello, Bruce Craig and Rob Tempelman were a presentera at a short course on general and generalized linear mixed models in conjunction with the American Dairy Science Association. Cincinnati, Ohio. June 26-27, 2019.

Nora Bello presented a short course entitled “Hierarchical Structural Equation Models” as part of the Graduate Program in Applied Statistics at National University of Cordoba (Universidad Nacional de Cordoba), Argentina. December 19, 2018.

Nora Bello presented a short course entitled on “Applied Bayesian Modeling” for the Association of Veterinary Epidemiology and Preventive Veterinary Medicine (AVEPM) at the 2018 Conference of Research Workers in Animal Disease (CRWAD). December 1-2, 2018.

Nora Bello presented a short course on generalized linear mixed models at the XXIII Meeting of the International Biometrics Society Argentinean Chapter (Grupo Argentino de Biometria) and the II Argentinean-Chilean Biometrical Meeting. Neuquen, Argentina. October 10-12, 2018.

Nora Bello presented a two day workshop entitled “Summer Workshop on Mixed Models” sponsored by Shell, Inc. US at Kansas State University in Manhattan, Kansas. 2018.

Larry Madden taught a workshop on “Mixed models in plant pathology” at the annual meeting of the American Phytopathological Society (APS). Cleveland, Ohio. August 3, 2019.

Larry Madden taught a series of six lectures on “Plant disease prediction: Concepts, examples, model development and testing, cost functions, and Bayesian decisions” in a plant pathology short course in Honne, Norway. May 6-11, 2019.

Kathy Yeater taught a training seminar on survival analysis methods to the USDA Biosciences Research Laboratory, Insect Genetics and Biochemistry Research Unit, Fargo, ND. June 12, 2019.

Raul Macchiavelli and A. Pimentel taught a short course entitled “Mixed Models for Data Analysis” at the Universidad Autónoma de Santo Domingo, May 20-24, 2019.

Raul Macchiavelli and E. Jiménez Cabán taught a workshop entitled “Introduction to SAS University Edition” organized by CEP, Mayaguez, PR, March 12, 2019.

Raul Macchiavelli taught a short course entitled “Spatial and Spatio-temporal Models with R-INLA” at the *Congreso Escuela de Estadística Espacial*, Córdoba (Argentina). December 10-14, 2018.

J. Di Rienzo and Raul Macchiavelli taught a short course entitled “Linear Mixed Models” at the at Universidad Nacional del Comahue during the Reunión Científica Anual Grupo Argentino de Biometría, Neuquén, Argentina. October 2018

J Di Rienzo, Raul Macchiavelli and F. Casanoves, taught a short cousre entitled “Advanced Linear Mixed Models” at CATIE (Tropical Agronomic Center for Research and Teaching), Turrialba, Costa Rica, August-September 2018.

Raul Macchiavelli and P. Torres taught a short course entitled “Advanced Statistical Models Applied in Health and Environmental Sciences” at CELFI (National University of Buenos Aires. August 6-15, 2018.

Guilherme Rosa taught a short on “Graphical Models and the Analysis of Observational Data” at the 64th Annual Meeting of the Brazilian Region of the International Biometric Society (RBRAS – IBS), Cuiaba – Brazil. July 29 – Aug 2, 2019.

Guilherme Rosa taught a short course on “Quantitative Genetics” (co-taught with Dr. Bruce Walsh) at the 24th Summer Institute in Statistical Genetics, University of Washington, Seattle, WA. July 15-17, 2019.

Guilherme Rosa taught a short course on "Mixed Models in Quantitative Genetics" (co-taught with Dr. Bruce Walsh) at the 24th Summer Institute in Statistical Genetics, University of Washington, Seattle – WA. July 17-19, 2019.

Guilherme Rosa taught a short course on "Selection and Breeding" (co-taught with Dr. Bruce Walsh) at the Technical University of Munich, Herrsching, Germany. June 24 – July 2, 2019.

Guilherme Rosa taught a short course on "Introduction to Graphical Models with Applications to Quantitative Genetics and Genomics" (co-taught with Dr. Francisco Penagaricano) at the University of Padova, Padova, Italy. June 3-7, 2019.

Guilherme Rosa taught a short course on "Introduction to Graphical Models with Applications to Quantitative Genetics and Genomics" (co-taught with Dr. Francisco Penagaricano) at the University of New England, Armidale, Australia. January 28-February 1, 2019.

Guilherme Rosa taught a short course on Statistical Modeling in Animal Breeding and Genetics, at the Sao Paulo State University (UNESP), Jaboticabal, Brazil. November 10-14, 2018.

Alex Lipka presented workshop at the II International Meeting on Plant Breeding, University of Sao Paulo, ESALQ, Piracicaba, Brazil entitled "Statistical mechanisms and practical applications of genome-wide association studies, genomic selection, and related analyses." October 5, 2018.

Alex Lipka presented workshop at the 10th Congresso Brasileiro de Melhoramento de Plantas, Aguas de Lindoia, Brazil entitled "Implementing genomic selection and comparing it to marker-assisted selection." July 28, 2019.

Edzard van Santen taught a one-day workshop at the 2018 International Meetings of the Tri-Societies (ASA-CSSA-SSA) in Baltimore, MD on basic data handling techniques in SAS. November 4, 2018.

Presentations:

Bello, N.M. Dynamic crop modeling: A hierarchical Bayesian specification and extensions for genomic prediction. AgMiP Global Workshop. Oklahoma State University. May 29, 2019 (Invited).

Bello, N.M. Systems modeling: Interdisciplinary opportunities in animal agriculture. Department of Pathobiology, College of Veterinary Medicine, University of Illinois. March 29, 2019 (Invited).

Bello, N.M. Systems modeling: a case study in animal production agriculture. Department of Pathobiology, College of Veterinary Medicine, University of Illinois, March 28, 2019 (Invited).

Bello, N.M. Causality networks and experimental data: a swine application. XXIII Meeting of the International Biometric Society Argentinean-Chilean Chapter (Grupo Argentino de Biometria). Neuquen, Argentina. October 13, 2018 (Invited).

Lipka, A.E. Quantification of the genomic contribution towards food and energy-related crop traits. Hokkaido University, Sapporo, Japan. August 22, 2018 (Invited).

Lipka, A.E. Quantification of the genomic contribution towards food and energy-related crop traits. Chinese Academy of Sciences, Beijing, China. August 27, 2018 (Invited).

Lipka, A.E. Quantification of the genomic contribution towards food and energy-related crop traits. Tokyo University, Tokyo, Japan. August 30, 2018 (Invited).

Lipka, A.E. Quantification of the genomic contribution towards food and energy-related crop traits. II International Meeting on Plant Breeding, University of Sao Paulo, ESALQ, Piracicaba, Brazil. October 3, 2018 (Invited).

Lipka, A.E. Exploration of the performance of GWAS models quantifying epistasis and genomic selection models that include peak-associated markers as fixed-effect covariates. Plant and Animal Genome (PAG) Genomic Selection and Genome-wide Association Studies Workshop, San Diego, CA. January 12, 2019 (Invited).

Lipka, A.E. Quantification of the genomic contribution towards food and energy-related crop traits. Georg-August-Universität Göttingen, Göttingen, Germany. February 7, 2019 (Invited).

Lipka, A.E. Quantification of the genomic contribution towards food and energy-related crop traits. KWS SAAT SE Company Headquarters, Einbeck, Germany. February 8, 2019 (Invited).

Lipka, A.E. Exploration of the impact of genetic architecture on the performance of GWAS and GS models. National Association of Plant Breeders Webinar Series (Online). May 29, 2019 (Invited).

Lipka, A.E. Exploration of the Impact of Genetic Architecture on the Performance of GWAS Models Quantifying Epistasis and Genomic Selection Models that Include Peak-Associated Markers as Fixed-Effect Covariates. 10th Congresso Brasileiro de Melhoramento de Plantas. Aguas de Lindoia, Brazil. July 31, 2019 (Invited).

Johnson, L., M. Galliart, N.M. Bello, S. Baer, B. Maricle, J. Poland. Experimental selection of big bluestem grass ecotypes across the Great Plains climate gradient. Joint Annual Conference of the American Society of Naturalists, the Society for the Study of Evolution and the Society of Systematic Biologists. Providence, RI. June 21-25, 2019 (Invited).

Renter, D.G., N.M. Bello, N. Cernicchiaro, R.L. Larson, M.W. Sanderson, T.C. Schroeder, B.J. White. Risk management strategies to reduce the impacts of bovine respiratory disease complex I commercial feedlot cattle. Conference of Research Workers in Animal Disease (CRWAD). Chicago, IL. December 1-4, 2018 (Invited).

Albin, N., P. Alderman, N.M. Bello, C. Chen, L. Duke, D. Flippo, F. Fondjo-Fotou, A. Fritz, G. Hettiarachchi, C. Howard, K. Jagadish, J. Poland, E. Santos, J. Snow, S. Welch, L. Yan. Building field-based ecophysiological genome-to-phenome prediction. Kansas State University Global Food Systems Focus Day. Manhattan, KS. March 7, 2019.

Welch, S. M., P.D. Alderman, F. Fondjo, C. Leuschen, A. Lamsal, D. Gomez-Garcia, M. Guttieri, A. Fritz, A. Asebedo, N.M. Bello, S. Kulesza, B. Washburn, E. Santos, K. Corwin. Co-design of Gene-Based Ecophysiological Crop Models for Breeding and Management. 2018 International Annual Meeting of the American Society of Agronomy, the Crop Science Society of America and the Canadian Society of Agronomy. Baltimore, MD. November 4-7, 2018.

Johnson, L., S. Sharpe, N.M. Bello, M. Galliart and O. Parrish. Rapid adaptation in a contaminated environment: Evolutionary adaptive response of old field grass Andropogon virginicus to heavy metals in an abandoned mine site. Annual meeting of the Botanical Society of America. Rochester, MN. July 21-25, 2018,

Chitakasempornkul, K., A. Jager, N.M. Bello. Hierarchical Bayesian structural equation modeling of heterogeneous relationships between performance outcomes in animal production systems. International Biometrics Conference. Barcelona, Spain. July 8-13, 2018.

De Jesús, A., R. Macchiavelli. Application of meta-analysis in nitrogen fertilizer studies in Puerto Rico. XVII Conferencia Española de Biometría y VII Encuentro Iberoamericano de Biometría. Valencia, Spain. June 21-23, 2019.

Di Rienzo, J., R. Macchiavelli, Casanoves, F., Balzarini, M. Non-linear mixed model implementation in InfoStat and Interface with the nmle and lme4 Libraries in R. XVII Conferencia Española de Biometría y VII Encuentro Iberoamericano de Biometría. Valencia, Spain. June 21-23, 2019.

Madden, L.V. Meta-analysis for the synthesis of evidence in plant pathology. Ohio State University. August 2018.

Madden, L.V. The cost of plant disease prediction: A case study with Fusarium head blight of wheat. Colorado State University. September 2018.

Publications:

Chitakasempornku, K., M.B. Menegat, G.J.M. Rosa, F.B. Lopes, A. Jager, M.A.D. Goncalves, S.S. Dritz, M.D. Tokach, R.D. Goodband, N.M. Bello (2019). Investigating causal biological relationships between reproductive traits in high-performing gilts and sows. Journal of Animal Science 97(6): 2385-2401. DOI: 10.1093/jas/skz1

Li, Y., R.A. Cloyd and N.M. Bello (2019). Effect of integrating the entomopathogenic fungus, *Beauveria bassiana* and the rove beetle *Dalotia coriaria* in suppressing western flower thrips, *Frankliniella occidentalis* populations under greenhouse conditions. Journal of Economic Entomology. Doi.org/10.1093/jee/toz132

Li, Y., R.A. Cloyd and N.M. Bello (2019). Effect of insecticide drench applications on western flower thrips, Frankliniella occidentalis, pupae in the growing medium. HortScience 54(5): 890-895. Doi.org/10.21273/HORTSCI13892-19

Passafaro, T., D. Van de Stroet, N.M. Bello and G.J.M. Rosa (2019). Generalized additive mixed modeling of total transport losses of market-weight pigs. Journal of Animal Science 97(5): 2025-2034. Doi.org/10.1093/jas/skz087

Oliveira, R.C., K.J. Sailer, H.T. Holdorf, C.R. Seely, R.S. Pralle, M.B. Hall, N.M. Bello and H.M.White (2019). The effect of fermented ammoniated condensed whey supplementation on lactation performance and metabolic health in transition dairy cows. Journal of Dairy Science 102(3): 2283-2297. Doi.org/10.3168/jds.2018-15519.
***Selected as Editor's choice for the March Issue of the Journal of Dairy Science

Wu, F., M.D. Tokach, J.M. DeRouchey, S.S. Dritz, J.C. Woodworth, R.D. Goodband, K. Capps, S. Remfry, K. Chitakasempornkul, N.M. Bello, T.G. Nagaraja and R.G. Amachawadi (2019). Effects of tylosin administration routes on the prevalence of antimicrobial resistance among fecal enterococci of finishing swine. Foodborne Pathogens and Disease. Doi.org/10.1089/fpd.2018.2551.

Galliart, M., N.M. Bello, M. Knapp, J. Poland, P. St. Amand, S. Baer, B. Maricle, A.B. Smith and L. Johnson. (2019). Local adaptation, genetic divergence, and experimental selection in a foundation grass

across the US Great Plains' climate gradient. Global Change Biology 25: 850-868. Doi.org/10.1111/gcb.14534

Chen, R.; N.M. Bello; M.W. Becker and L. Bix. (2018). Chasing red herrings: Can visual distracters extend the time children take to open child resistant vials? PLOS ONE 13(12): e0207738. doi.org/10.1371/journal.pone.0207738

Chitakasempornkul, K., E. Cha, D. Renter, M. Sanderson, A. Jager, and N.M. Bello (2018). Accounting for data architecture in structural equation modeling of feedlot performance outcomes. Journal of Agricultural, Biological and Environmental Statistics 23(4): 529-549. https://doi.org/10.1007/s13253-018-0336-7.

Ekong, P.S., M.W. Sanderson, P.B. Shridhar, N. Cernicchiaro, D.G. Renter, N.M. Bello, J. Bai and T.G. Nagaraja (2018). Bayesian estimation of sensitivity and specificity of culture- and PCR-based methods for the detection of the six major non-O157 Escherichia coli serogroups in cattle feces. Preventive Veterinary Medicine 161: 90-99. doi: 10.1016/j.prevetmed.2018.10.012

Bello, N.M., V.C. Ferreira, D. Gianola and G. J. M. Rosa (2018). Invited review: Conceptual framework for investigating causal effects from observational data in livestock. Journal of Animal Science 96(10): 4045-4062. doi: 10.1093/jas/sky277.

Bello, N.M. and D. Renter (2018). Invited review: Reproducible research from noisy data - revisiting key statistical principles for the animal sciences. Journal of Dairy Science 101(7):1-23. doi: 10.3168/jds.2017-13978.

Lamsal, A., S. Welch, J. White, K. Thorp and N.M. Bello (2018). Estimating Parametric Phenotypes that Determine Anthesis Date in *Zea mays:* Challenges in Combining Ecophysiological Models with Genetics. PLoS One 13(4): e0195841.

Murphy, M.L., D.S. Hodgson and N.M. Bello (2018). On accuracy and precision of oxygen therapy flowmeters in a veterinary teaching hospital. Veterinary Anaesthesia and Analgesia 45(1): 41-47.

Goncalves, M.A.D., M.D. Tokach, S.S. Dritz, N.M. Bello, K. J. Touchette, R. D. Goodband, J. M. DeRouchey and J. C. Woodworth (2018). Standardized ideal digestible valine:lysine dose-response effects in 25- to 45- kg pigs under commercial conditions. Journal of Animal Science 96(2): 591-599. doi: 10.1093/jas/skx059.

Williams, H.E., M.D. Tokach, S.S. Dritz, J.C. Woodworth, J.M. DeRouchey, T.G. Nagaraja, R.D. Goodband, K. Chitakasempornkul, N.M. Bello and R.G. Amachawadi (2018). Effects of chlortetracycline alone or in combination with probiotics on nursery pig growth performance and antimicrobial susceptibility of fecal Escherichia coli. Journal of Animal Science. doi: 10.1093/jas/sky370.

Goncalves, M.A.D., M.D. Tokach, N.M. Bello, K.J. Touchette, R.D. Goodband, J.M. DeRouchey, J.C. Woodworth and S.S. Dritz (2018). Dose-response evaluation of the standardized ideal digestible tryptophan:lysine ratio to maximize growth performance of growing-finishing gilts under commercial conditions. Animal 12(7):1380-1387. doi: 10.1017/S1751731117002968.

Delph, K., E.G. Davis, N.M. Bello, K. Hankins, M.J. Wilkerson, C. Ewen (2018). Comparison of immunologic responses following intranasal and oral administration of a USDA-approved, live-attenuated *Streptococcus equi* vaccine. Journal of Equine Veterinary Science 60:29-34. doi: 10.1016/j.jevs.2016.08.015

Lalman, D. L., C. E. Andresen, C. L. Goad, L. Kriese-Anderson, M. E. King, K. G. Odde (2019). Weaning weight trends in the US beef cattle industry. Applied Animal Science 35(1): 57-65.

Akehi K, BC Long, C Goad, and A Cody (2018). Pulsed shortwave diathermy and moist heat pack application on musculotendinous stiffness and hysteresis during passive ankle motion. Athl Train Sports Health Care 10(1):31-40.

Cobb, Adam B., Gail W. T. Wilson, Carla Goad, Michael A. Grusak (2018). Influence of alternative soil amendments on mycorrhizal fungi and cowpea production. Heliyon 4(7):e00704. DOI: 10.1016/j.heliyon.2018.e00704

Dunn, Bruce, Hardeep Singh, Carla Goad, (2018). Relationship between chlorophyll meter readings and nitrogen in poinsettia leaves, Journal of Plant Nutrition 41(12): 1-10. DOI: 10.1080/01904167.2018.1459697

Haviland, C. L., Chris J. Richards, J. A. Reed, M. E. Youngers, S. T. Quanz, C. G. Lockard, M. A. Woolsoncroft, T. C. Husz, Carla Goad, T. A. Jackson, D. L. Step, M. Corbin, Clint R. Krehbiel (2018). Growth, performance, and carcass characteristics of feedlot Holstein steers fed ractopamine hydrochloride. Journal of Animal Science 96 (suppl_2): 80-81.

Swearengin, Lance, Bruce Dunn, Hardeep Singh, Carla Goad (2018). Evaluation of a mobile phone plant nitrogen recommendation application in the greenhouse, Journal of Plant Nutrition, DOI: 10.1080/01904167.2018.1510519.

Panthi, R., Kelly, A., McMahon, D.J., Dai, X., Vollmer, A., and Sheehan, J. (2019). Response surface methodology modeling of protein concentration, coagulum cut size, and set temperature on curd moisture loss kinetics during curd stirring. Journal of Dairy Science, 102 (6): 4989-5004.

Wang, Y. X., Li, L. Q., Sun, Y. P., and Dai, X. (2019). Relative salt tolerance ofsSeven Japanese Spirea cultivars. HortTechnology, 29 (3): 367–373.

Stewart, E. K., Beauchemin, K. A., Dai, X., MacAdam, J.W., and Villalba, J. J. (2019). Effect of tannin-containing hays on enteric methane emissions and nitrogen partitioning in beef cattle. Journal of Animal Science, 97(8): 3286-3299.

Krombeen, S. K., Shankar, V., Noorai, R. E., Saski, C. A., Sharp, J. L., Wilson, M. E. (2019). The identification of differentially expressed genes between extremes of placental efficiency in maternal line gilts on day 95 of gestations. BMC Genomics, 20 (1): 254-269.

Gredell, D., Schroeder, A. R., Belk, K., Broeckling, C., Heuberger, A., Kim, S.Y., King, D. A., Shackelford, S. D., Sharp, J. L., Wheeler, T. L., Woerner, D. R., and Prenni, J. (2019). Comparison of machine learning algorithms for predictive modeling of beef attributes using Rapid Evaporative Ionization Mass Spectrometry (REIMS) data. Scientific Reports, 9: 5721.

Krombeen, S. K., Shankar, V., Noorai, R. E., Saski, C. A., Sharp, J. L., Wilson, M. E. (2019). The identification of differentially expressed genes between extremes of placental efficiency in maternal line gilts on day 95 of gestations. BMC Genomics, 20 (1): 254-269.

Funk, P.A., A.A. Terrazas, K.M. Yeater, R.G. Hardin IV, C.B. Armijo, D.Pl. Whitelock, M.G. Pelletier, J.D. Wanjura, G.A. Holt, and C.D. Delhom (2018). Procedures for Moisture Analytical Tests Used in

Cotton Ginning Research. Transactions of the ASABE. 61(6): 1985-1995. https://doi.org/10.13031/trans.12980

Halvorson, J.J., D.W. Archer, M.A. Liebig, K.M. Yeater, and D.L. Tanaka (2019). Impacts of intensified cropping systems on soil water use by spring wheat. Soil Sci. Soc. Am. J. doi:10.2136/sssaj2018.09.0349

Mehus, A.A., A.M. Dickey, T.P.L. Smith, K.M. Yeater, and M.J. Picklo (2019). Next-Generation Sequencing Identifies Polyunsaturated Fatty Acid Responsive Genes in the Juvenile Rat Cerebellum. Nutrients 11(2), 407; https://doi.org/10.3390/nu11020407

Yocum, G., J. Rinehart, A. Rajamohan, J. Bowsher, K. Yeater, and K. Greenlee (2019). Thermoprofile parameters affect survival of *Megachile rotundata* during exposure to low-temperatures. Integrative & Comparative Biology, doi.org/10.1093/icb/icz126.

Wolfe, B., R. Macchiavelli, S. Van Bloem (2019). Seed rain along a gradient of degradation in Caribbean dry forest: Effect of dispersal limitation on the trajectory of forest recovery. Applied Vegetation Science DOI: 10.1111/avsc.1244

Kaler, A.S., J.D. Ray, W.T. Schapaugh, A.R. Asebedo, C.A. King, E.E. Gbur and L.C. Purcell (2018). Association mapping identifies loci for canopy temperature under drought in diverse soybean genotypes. Euphytica, 214, 135-152. doi.org/10.1007/s10681-018-2215-2.

Rector, C., K.R. Brye, R.J. Norman, J. Humphreys, E.E. Gbur, C. Willett, M.A. Evans-White and J. Hardke (2018). NO2 emmisions and global warming potential as affected by water management and rice cultivar on an Alfisol in Arkansas, USA. Geoderma Regional, 14, Article e00170.

Humphreys, J., K.R. Brye, C. Rector, R.J. Norman, E.E. Gbur and J. Hardke (2018). Water management and cultivar effects on methane emissions from direct-seeded, delayed-flood rice production in Arkansas. Journal of Rice Research and Developments, 1, 14-24.

Rector, C., K.R. Brye, J. Humphreys, R.J. Norman, N.A. Slaton, E.E. Gbur, C. Willett and M.A. Evans-White (2018). Tillage and coated-urea effects on nitrous oxide emissions from direct-seeded, delayed-flood rice production in Arkansas. Journal of Rice Research and Developments, 1, 25-37.

Greub, C.E., T.L. Roberts, N.A. Slaton, J.P. Kelly and E.E. Gbur (2018). Evaluating late-season tissue tests to improve nitrogen management in furrow irrigated mid-south corn production. Agronomy Journal, 110, 1580-1588.

Suhartono, M.C. Savin and E.E. Gbur (2018). Transmissible plasmids and integrons shift Escherichia coli population towards larger multiple drug resistance numbers. Microbial Drug Resistance, 24, 244-252.

Martin, S.M., J.K. Norsworthy, R.C. Scott, J. Hardke, G.M. Lorenz and E.Gbur (2019). Influence of a thiamethoxam seed treatment on acetolactate synthase-inhibiting herbicide induced injury to inbred and hybrid imidazolinone-resistant rice. Weed Technology, 33, 253-257.

Desrochers, J., K.R. Brye, E. Gbur, M. Savin, and E. Pollock (2019). Long term residue and water management practice effects on particulate organic matter in a loessial soil in eastern Arkansas. Geoderma, 337, 792-804. doi.org/10.1016/j.geoderma.2018.10.027.

da Silva, M.P., M. Klepadlo, E.E. Gbur, A. Pereira, R.E. Mason, J.R. Rupe, B.H. Bluhm, L. Wood, L.A. Mozzoni and P. Chen (2019). QTL mapping of charcoal rot resistance in PI 567562A soybean accession. Crop Science, 59(2). doi:10.2135/cropsci2018.02.0145.

Desrochers, J., K.R. Brye, E. Gbur, and E. Mason (2019). Long term residue and water management effects on infiltration in a wheat-soybean system on a loessial soil in eastern Arkansas. Geoderma Regional, doi.org/10.1016/j.geodrs.2019.e00203.

da Silva, M., A. Pereira, J. Rupe, B. Bluhm, E. Gbur, L. Wood, L. Mazzoni, and P. Chen (2019). Effectiveness of a seed plate assay for evaluating charcoal rot resistance in soybean and relationship to field performance. Plant Disease. doi.org/10.1094/PDIS-10-18-19-RE.

Fournier, A.M.V., D.C. Mengel, E. Gbur, A. Raedeke and D.G. Krementz (2019). Evaluating tradeoffs in the response of Sora (*Porzana carolina*) and waterfowl to the timing of early autumn wetland inundation. Waterbirds, 42, 168-178.

Folgelman, M., J.K. Norsworthy, T. Barber and E. Gbur (2019). Influence of formulation and rate on rice tolerance to early season applications of Acethlor. Weed Technology, 33, 239-245..

Jones, G.T., J.K. Norsworthy, T. Barber, E. Gbur and G.R. Kruger (2019). Off-target movement of DGA and BAPMA dicamba to sensitive soybean. Weed Technology, 33, 51-65.

Jones, G.T., J.K. Norsworthy, T. Barber, E. Gbur and G.R. Kruger (2019). Effect of low doses of dicamb alone and in combination with glyphosate on parent soybean and offspring. Weed Technology, 33, 17-23.

Norsworthy, J.K., M. Fogelman, T. Barber and E. Gbur (2019). Evaluation of acetochlor-containing herbicide programs in imidazolinone- and quizalofol-resistant rece. Crop Protection, 122, 98-105.

Duree, T.J., K.R. Brye, L.S. Wood, D.M. Miller and E.E. Gbur (2019). Soil moisture regime and mound position effects on soil profile properties in a native tallgrass prairie in northwest Arkansas, USA. Geoderma, 352, 49-60.

Cordova L.G., Ellis, M.A., Wilson, L.L., Madden, L.V., and Peres, N.A. (2018). Evaluation of the Florida strawberry advisory system for control of Botrytis and anthracnose fruit rots in Ohio. Plant Health Progress 19: 182-187.

Paul, P.A., Bradley, C.A., Madden, L.V., Dalla Lana, F., Bergstrom, G.C, Dill-Macky, R., Esker, P.D., Wise, K.A., McMullen, M., Grybauskas, A., Kirk, W.W., Milus, E., and Ruden, K. (2018). Meta-analysis of the effects of QoI and DMI fungicide combinations on Fusarium head blight and deoxynivalenol in wheat. Plant Disease 102: 2602-2615.

Paul, P.A., Bradley, C.A., Madden, L.V., Dalla Lana, F., Bergstrom, G.C, Dill-Macky, R., Wise, K.A., Esker, P.D., McMullen, M., Grybauskas, A., Kirk, W.W., Milus, E., and Ruden, K. (2018). Effects of pre- and post-anthesis applications of demethylation inhibitor fungicides on Fusarium head blight and deoxynivalenol in spring and winter wheat. Plant Disease 102: 2500-2510.

Piepho, H.-P., Madden, L.V., and Williams, E.R. (2018). Contribution to the discussion of the paper by Jackson and White: Using general-purpose GLMM software for meta-analysis. Biometrical Journal 60: 1059-1061.

Shah, D.A., De Wolf, E.D., Paul, P.A., and Madden, L.V. (2019). Functional data analysis of weather

variables linked to Fusarium head blight epidemics in the United States. Phytopathology 109: 96-110.

Paul, P.A., Salgado, J.D., Bergstrom, G.C., Bradley, C., Byamukama, E., Byrne, A.M., Chapara, V., Cummings, J.A., Chilvers, M.I., Dill-Macky, R., Friskop, A.J. Kleczewski, N.M., Madden, L.V., Nagelkirk, M., Stevens, J., Smith, M., Wegulo, S.N., Wise, K.A., Yabwalo, D. (2019). Integrated effects of genetic resistance and prothioconazole + tebuconazole application timing on Fusarium head blight in wheat. Plant Disease 103: 223-237.

Shah, D.A., Paul, P.A., De Wolf, E.D., and Madden, L.V. (2018). Predicting plant disease epidemics from functionally-represented weather series. Philosophical Transactions of the Royal Society B 374: 20180273.

Kramer M. (2019). Stats: How useful is the treatment? Nature 569, 192.

Kesoju S.R., Greene S.L., Martin R.C., Kramer M., Walsh D.B. and Boydston R.A. (2019). Isolation distances for transgenic alfalfa seed production in the Pacific Northwest. Crop Science 59: 1701-1708.

Kramer, M. (2018). Using the posterior predictive distribution as a diagnostic tool for mixed models. Proceedings from Joint Statistics Meeting, Biometrics Section 448-466.

Ebbets, A., Lane, D., Dixon, P.M., Hollweg, T., Huisenga, M., and Gurevitch, J. (2019). Using meta-analysis to develop evidence-based recovery trajectories of vegetation and soils in restored wetlands in the Northern Gulf of Mexico. Estuaries and Coasts. doi.org/10.1007/s12237-019-00536-y

Griebel, S., Webb, M.W., Campaneela, O.H., Craig, B.A., Weil, C.F., and Tuinstra, M.R. (2019). The alkali spreading phenotype in Sorghum bicolor and its relationship to starch gelatinization, Journal of Cereal Science, 86, 41–47.

Aiken, V, C.F., Dórea, J.R.R., Acedo, J.S., Sousa, F.G., Dias, F.G. and Rosa, G.J.M. (2019). Record linkage for farm-level data analytics: Comparison of deterministic, stochastic and machine learning methods. Computers and Electronics in Agriculture 163: 104857.

Goto, T., Fernandes, A.F.A., Tsudzuki, M., Rosa, G.J.M. (2019). Causal phenotypic networks for egg traits in an F_2 chicken population. Molecular Genetics and Genomics. doi.org/10.1007/s00438-019-01588-2

Fernandes, A.F.A., Dorea, J.R.R., Fitzgerald, R., Herring, W. and Rosa, G.J.M. (2019). A novel automated system to acquire biometric and morphological measurements, and predict body weight of pigs via 3D computer vision. Journal of Animal Science 97: 496-508.

Abdalla, E.A., Lopes, F.B., Byrem, T.M., Weigel, K.A. and Rosa, G.J.M. (2019). Genomic prediction of bovine leukosis incidence in a US Holstein population. Livestock Science 225: 73–77.

Bresolin, T., Rosa, G.J.M., Valente, B.D., Espigolan, R., Gordo, D.G.M., Braz, C.U., Fernandes, G.A., Magalhães, A.F.B., Garcia, D.A., Frezarim, G.B., Leão, G.F.C., Carvalheiro, R., Baldi, F., Oliveira H.N. and Albuquerque, L.G. (2019). Effect of quality control, density and allele frequency of markers on the accuracy of genomic prediction for complex traits in Nellore cattle. Animal Production Science 59(1): 48-54.

Momen, M., Mehrgardi, A.A., Sheikhi, A., Kranis, A., Tusell, L., Morota, G., Rosa, G.J.M. and Gianola, D. (2018). Predictive ability of genome-assisted statistical models under various forms of gene action. Scientific Reports 8:12309.

Baker, L.A., Rosa, G.J.M., Hao, Z., Piazza, A., Hoffman, C., Binversie, E.E., Sample, S.J. and Muir, P. (2018). Multivariate genome-wide association analysis identifies novel and relevant variants associated with anterior cruciate ligament rupture risk in the dog model. BMC Genetics 19:39.

Momen, M., Mehrgardi, A.A., Amiri Roudbar, M., Kranis, A., Pinto, R.M., Valente, B.D., Morota, G., Rosa, G.J.M. and Gianola, D. (2018). Including phenotypic causal networks in genome-wide association studies using mixed effects structural equation models. Frontiers in Genetics, 9:455.

Diers, B.W., Specht, J., Rainey, K.M., Cregan, P., Song, Q., Ramasubramanian, V., Graef, G., Nelson, R., Schapaugh, W., Wang, D., Shannon, G., McHale, L., Kantartzi. S., Xavier, A., Mian, R., Stupar, R.M., Michno, J.M., An, Y.Q.C., Goettel, W., Ward, R., Fox, C., Lipka, A.E., Hyten, H., Cary, T. and Beavis, W.D. (2018). Genetic architecture of soybean yield and agronomic traits. G3: Genes, Genomes, Genetics 8: 3367-3375.

Shenstone, E., Cooper, J., Rice, B., Bohn, M., Jamann, T.M., and Lipka, A.E. (2018). An assessment of the performance of the logistic mixed model for analyzing binary traits in maize and sorghum diversity panels. PLoS ONE 13: e0207752.

Dong, H., Liu. S., Clark, L.V., Sharma, S., Gifford, J.M., Juvik,.J.A., Lipka, A.E., and Sacks, E.J. (2018). Winter hardiness of miscanthus (II): genetic mapping for overwintering ability and adaptation traits in three interconnected Miscanthus populations. GCB Bioenergy. DOI: 10.1111/gcbb.12587.

Mastrodomenico, A.T., Bohn, M.O., Lipka, A.E.**,** and Below, F.E (2019). Genomic selection using maize ex-plant variety protection germplasm for the prediction of nitrogen-use traits. Crop Science 58: 1-19.

Chen, A.H., Ge, W., Metcalf, W., Jakobsson, E., Mainzer, L.S., and Lipka, A.E. (2019). An assessment of true and false positive detection rates of stepwise epistatic model selection as a function of sample size and number of markers. Heredity 122: 660-671.

Clark, L.V., Lipka, A.E.**,** and Sacks, E.J. (2019). polyRAD: genotype calling with uncertainty from sequencing data in polyploids and diploids. G3: Genes, Genomes, Genetics 9: 663-673.

Rice, B., and Lipka, A.E. (2019). Evaluation of RR-BLUP genomic selection models that incorporate peak genome-wide association study signals in maize and sorghum. The Plant Genome 12.

Cooper, J., Rice, B., Shenstone, E., Lipka, A.E.**,** and Jamann, T.M. (2019). Genome-wide analysis and prediction of resistance to Goss' wilt in maize. The Plant Genome. DOI: 10.3835/plantgenome 2018.06.0045.

Clark, L.V., Dwiyanti, M.S., Anzoua, K.G., Brummer, J.E., Ghimire, B.K., Głowacka, K., Hall, M., Heo, K., Jin, X., Lipka, A.E., Peng, J., Yamada, T., Yoo, J.H., Yu, Cy Zhao, H., Long, S.P., and Sacks, E.J. (2019). Biomass yield in a genetically diverse Miscanthus sinensis germplasm panel evaluated at five locations revealed individuals with exceptional potential. GCB Bioenergy. DOI: 10.1111/gcbb.12606.

Clavijo-Herrera, J., Edzard van Santen, and Celina Gómez (2018). Growth, Water-Use Efficiency, Stomatal Conductance, and Nitrogen Uptake of Two Lettuce Cultivars Grown under Different Percentages of Blue and Red Light. Horticulturae 2018, 4, 16; doi: 10.3390/horticulturae4030016.

Chinchilla, S. Luigi G. Izzo, Edzard van Santen, and Celina Gómez (2018). Growth and Physiological Responses of Lettuce Grown under Pre-Dawn or End-of-Day Sole-Source Light-Quality Treatments. Horticulturae 2018, 4, 8; doi: 10.3390/horticulturae4020008

Wang, L.P., D. Rowland, X.P. Yang, Edzard van Santen, B. Tillman and J.P. Wang (2018). Mild Water Deficit in the Field Down Regulated Drought Responsive Genes in Peanut Leaf Tissues. International Journal of Agriculture and Biology 20: 1152-1160. doi:10.17957/ijab/15.0633.

Rouquette, F.M., Edzard van Santen and G.R. Smith (2018). Long-Term Forage and Cow-Calf Relationships for Bermudagrass Overseeded with Arrowleaf Clover or Annual Ryegrass Managed at Different Stocking Rates. Crop Science 58: 1426-1439. doi: 10.2135/cropsci2017.12.0736.

Lin, Y., D.B. Watts, Edzard van Santen, and G. Cao (2018). Influence of Poultry Litter on Crop Productivity under Different Field Conditions: A Meta-Analysis. Agronomy J. 110:807-818. doi:10.2134/agronj2017.09.0513

Rovere, G., G. de los Campos, R.J. Tempelman, A.I. Vazquez, F. Miglior, F. Schenkel, A. Cecchinato, G. Bittante, H. Toledo-Alvarado, and A. Fleming (2018). A landscape of the heritability of Fourier-Transform infrared spectral wavelengths of milk samples by parity and lactation stage in Holstein cows. Journal of Dairy Science 102:1354-1363.

Channaiah, Lakshmikantha H., Minto Michael, Jennifer C. Acuff, Randall K. Phebus, Harshavardhan Thippareddi, and George Milliken (2019). Evaluation of thermal inactivation parameters of Salmonella in whole wheat multigrain bread. Food Microbiology 82: 334-341.

Other project related activities:
Nora Bello is an Associate Editor for the Journal of Agricultural, Biological and Environmental Statistics (JABES).

Nora Bello is a reviewer for Federal Grant Review Panels in the USDA–AFRI–NIFA Exploratory Research Program.

Larry Madden maintains a website with statistical software code (SAS) and PowerPoint presentations on a range of data-analytic subjects. Material based heavily on previously presented workshops. u.osu.edu/agstatworkshops/

Current specific goals for the 2016-2021 project:
(1) To identify, foster and coordinate cooperative research efforts in statistics among statisticians serving food and agriculture research programs.

(2) To provide continuing education and statistical support to the scientific community in the review and editorial process.

(3) To address the statistical design and analysis issues associated with studies involving technologies that typically produce a large number of spatially and/or temporally correlated variables per observations but small sample sizes (e.g.,-omics, informatics, and -metrics).

(4) To address concerns associated with the development and implementation of generalized linear mixed model techniques and software used by statisticians and researchers.

(5) To address meta-analysis issues associated with multi-location, multi-investigator projects including those in which study treatments and/or designs may differ by location.

Impacts:

(1) Education of members leading to cooperative research efforts and improved consulting and teaching by individual members. Specific examples that span a wide range of subject matter disciplines may be found in the Outputs section of this report under the Publications subsection.

(2) Cooperative research efforts among some members and information exchange on new developments among all members in the areas of generalized linear mixed models and the analysis of high dimensional, large volume data.

(3) Members continuing to offer workshops and, where appropriate, alternative means of continuing education and support for subject matter scientists, reviewers, and technical editors on valid design and statistical analysis of studies. Specific examples may be found in the Outputs section of this report under the Workshops and Presentations subsections.