# NC1211 Activities Report 2025

**Basic Information**

- **Project No. and Title:** NC1211: Precision Management of Animals for Improved Care, Health, and Welfare of Livestock and Poultry
- **Duration:** 10/01/2021 – 09/30/2026
- **Administrative Advisor:** Hector Santiago
- **NIFA Reps:** Kamilah Grant, Angelica Van Goor
- **Regional System Administrator**: Christina Hamilton
- **Executive Committee**: Yang Zhao (Chair), Joao Costa (Secretary)
- **Reporting Period:** Sep 2024 – Jun 2025
- **Date of Report:** 07/30/2025
- **Report preparer:** Yang Zhao

**Annual Meeting**

- **Date:** June 2, 2025
- **Location:** Embassy Suites, Lincoln NE, USA
- **Format:** Hybrid (In-person and virtual)
- **Participants:**
  - Members
    - Yang Zhao, University of Tennessee, yzhao@utk.edu
    - Tami Brown-Brandl, University of Nebraska, tbrownbrandl2@unl.edu
    - Jeremiah Davis, Auburn University, Jeremiah.Davis@auburn.edu
    - Sushil Paudyal, Texas A&M University, sushilpaudyale@tamu.edu
    - Hector Santiago, University of Nebraska, hsandiago@unl.edu
    - Jianfeng Zhou, University of Missouri, j.zhou@missouri.edu
    - Juan Steibel, Iowa State University, jsteibel@iastate.edu
    - Tiago Bresolin, UIUC, bresolin@illinois.edu
    - Haipeng Yu, University of Florida, haipengyu@ufl.edu
    - Hector Menendez, South Dakota State University, hector.menendez@sdstate.edu
    - Courtney Daigle, Texas A&M University, cdaigle@tamu.edu
    - Joao Dorea, UW-Madison, joao.dorea@wisc.edu
    - Enrico Casella, Penn State, casella@psu.edu
    - Tom Tabler, University of Tennessee, gtabler@utk.edu
    - Lingjuan Wang-Li, NC State University, lwang5@ncsu.edu
    - Madonna Benjamin, Michigan State University, gemus@msu.edu
    - Yijie Xiong, University of Nebraska, yijie.xiong@unl.edu
    - Marcia Endres, University of Minnesota, miendres@umn.edu
    - Prafulla Regmi, University of Georgia, pr01814@uga.edu
    - Edison Magalhaes, Iowa State University, edison@iastate.edu
    - Daniel Morris, Michigan State University, dmorris@msu.edu
    - Yuzhi Li, University of Minnesota, yuzhili@umn.edu

  - Non-members
    - Christina Hamilton, agInnovation North Central, christina.hamilton@wisc.edu

- Diego Xavier, Embrapa/UIUC, diegobx@illinois.edu
- Carson Edge, Auburn University, carson.edge@auburn.edu
- Xianghuan He, University of Missouri, xhh2c@umsystem.edu
- Shiva Paudel, University of Nebraska, spaudel@huskers.unl.edu
- Veronica Pacheco, University of Nebraska, veronica.pacheco@unl.edu
- Madison Bacon, Texas A&M University, mbacon@tamu.edu
- Raj Sharma, UNL, raj.sharma@unl.edu
- Maria Montes, UW-Madison, montesgonzal@wisc.edu
- Guilherme Menezes, UW-Madison, lobatomeneze@wisc.edu
- Gustavo Mazon, UV-Madison, gustavo.mazon@wisc.edu
- Tadeu Silva, University of Vermont, tadeu.da-silva@uvm.edu
- Luara Freitas, UW-Madison
- Diego Leal, University of Nebraska
- Raphael Mantovani, UW-Madison

- **Brief Summary of Minutes of Annual Meeting**
  The fourth formal meeting of NC1211 was held on Sunday, June 2, 2025, in Lincoln, Nebraska, USA, in conjunction with and preceding the 3rd U.S. Precision Livestock Farming Conference (USPLF2025). This hybrid meeting offered both in-person and virtual participation options to accommodate attendees. The meeting began at 8:00 am and concluded at 11:44 am. The objectives of the meeting included providing updates on the progress of the multistate project, sharing station-level progress updates, and facilitating project business discussions with plans for continued collaboration. A total of 22 project members and 15 non-members participated either in person or virtually. A list of participants is provided above.

- **Agenda and Minutes**
  - 8:00 - 8:10 AM | Introduction

    We started with a self-introduction of all participants

  - 8:10 - 8:15 AM | Welcome and Opening Remarks — Tami Brown-Brandl

  - 8:15 - 8:25 AM | NIMSS and Multistate Project

    Christina Hamilton provided an overview of multistate research projects, covering expectations for project participation, supporting federal legislation, research capacity at 1862 Land-Grant Universities, and FY2024 Hatch funding at both the national and North Central region levels. She also discussed project reporting requirements, the role of Regional Associations and SAES Directors in Hatch Multistate Research Funding, agInnovation North Central, hatch multistate research and committees, committee responsibilities, and ways to join multistate committee. Notably, she emphasized that the project's annual report must be submitted within 60 days following the annual meeting.

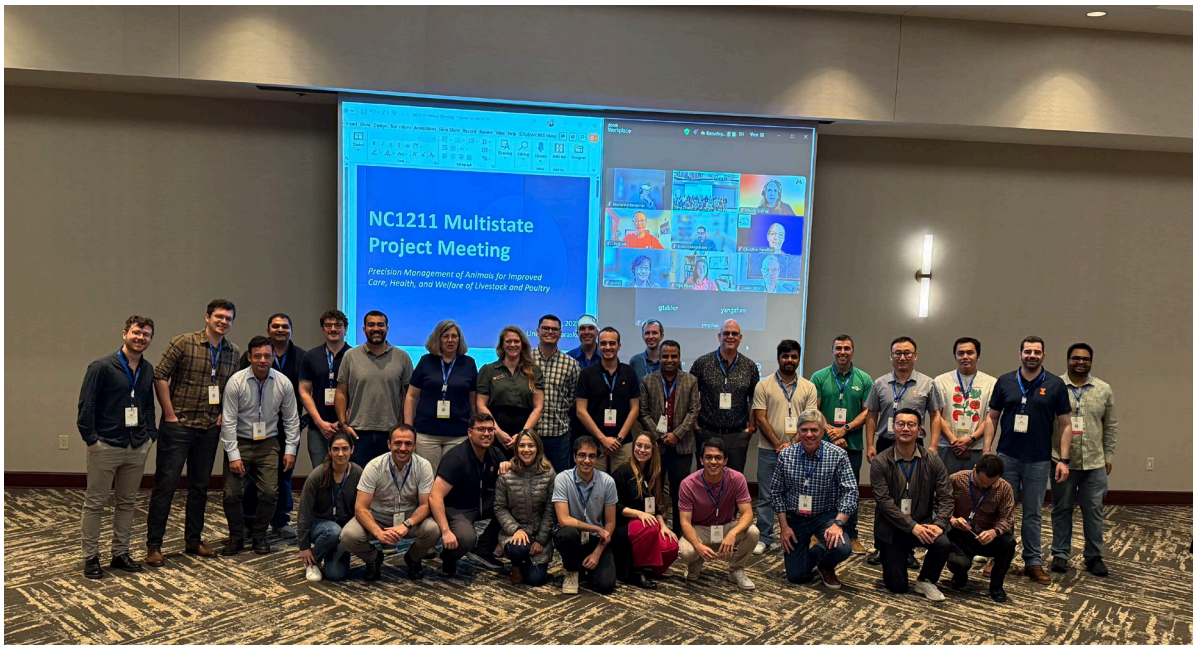
- 8:25 - 8:35 AM | Updates of NC1211

  Yang Zhao provided an overview and updates on NC1211. He reviewed the project's history, introduced its leadership, outlined the project objectives, and summarized participant distribution by region, domain, and role. He also highlighted the group's collaborative efforts on publications and joint projects. Additionally, he emphasized the importance of timely submission of station reports. To streamline the process and ensure consistency in content and format, a Google Form will be developed for station report submissions.

- 8:35 - 9:30 AM | Station Reports and Presentations — Project Participants

  - Jeremiah Davis – Updates from Auburn University
  - Tiago Bresolin – NC1211 Meeting 2025 Illinois Station Accomplishments
  - Juan Steibel – Iowa State University: NC1211 Precision Management of Animals Station Report

- 9:30 - 9:40 AM | Break & Group Photo




- 9:40 - 11:30 AM | Station Reports and Presentations — Project Participants
  - Hector Menendez - Updates from South Dakota State University
  - Sushil Paudyal & Courtney Daigle – Updates from Texas A&M
  - Jianfeng Zhou – Report from University of Missouri "Leveraging robotic imaging technology to improve swine reproduction and sustainability"
  - Tami Brown-Brandl – Updates from University of Nebraska
  - Joao Dorea & team – Updates from University of Wisconsin-Madison
  - Enrico Casella – Research and background – PennState
  - Haipeng Yu – Updates from University of Florida

- Madonna Benjamin & Daniel Morris – Updates from Michigan State University

- 11:30 - 11:45 AM | Roundtable Discussion — Project Participants
  - NC1211 Project rewriting
  - Collaboration opportunities

    Due to time constraints, the discussion on project rewriting and collaboration opportunities was rescheduled for the evening. Yang Zhao, Tami Brown-Brandl, Courtney Daigle, Jianfeng Zhou, John Linhoss, and Joao Dorea participated. The discussion focused on forming a project rewriting team, establishing a timeline for the rewrite, and creating a Google Form to facilitate and standardize station report submissions. A whole-day annual meeting, instead of half day, was also discussed to allow both station reports and group discussion.

  - Officer election

    Hector Menendez was elected as the incoming Secretary, and Joao Costa moved into the role of Chair.

  - Planning for the next meeting

    The next annual meeting is planned to be held in conjunction with ECPLF 2026 in Valencia, Spain.

  - Other business

    Marcia Endres announced Precision Dairy Conference scheduled in June 17-18, 2025 in Bloomington, MN.

- 11:45 AM | Adjourn

**Accomplishment**

Station reports were collected from 8 stations. The information from these reports was summarized into the accomplishments of the NC1211 multistate project during the reporting period, as listed below. These accomplishments reflect collaborative efforts and outcomes involving two or more participating stations.

**Station Name: Iowa State University**

**Station members**


- Brett Ramirez (bramirez@iastate.edu) (Head for the NC1211)
- Juan Steibel (jsteibel@iastate.edu)
- James Koltes (jekoltes@iastate.edu)
- Edison Magalhaes (edison@iastate.edu)


**Multistate Collaborative Research Publications**

| | Type of the Publication | Full Citation for the Publication | Status | Other Stations/ Institutions Involved |
|---|---|---|---|---|
| Pub. 1 | Peer-reviewed journal article | Grebey, T., Bongiorno, V., Han, J., Steibel, J., & Siegford, J. M. (2025). Maximum vertical height during wing flapping of laying hens captured with a depth camera. PloS one, 20(3), e0312656. | Published | Michigan State University |
| Pub. 2 | Peer-reviewed journal article | Kapoor, M., Ventura, E. S., Walsh, A., Sokolov, A., George, N., Kumari, S., ... & Tuggle, C. K. (2024). Building a FAIR data ecosystem for incorporating single-cell transcriptomics data into agricultural genome to phenome research. Frontiers in Genetics, 15, 1460351. | Published | University of Missouri, USDA, Lawrence Berkley National Lab |
| Pub. 3 | Peer-reviewed journal article | Cavani, L., Novo, L. C., Reyes, F. S., Nascimento, B. M., VandeHaar, M. J., Tempelman, R. J., ... & Peñagaricano, F. (2025). Associations between body temperature and feed efficiency traits in lactating Holstein cows. JDS communications, 6(2), 256-260. | Published | University of Wisconsin, University of Florida, Michigan State University |
| Pub. 4 | Peer-reviewed journal article | Suazo, I., Xiang, L., wang-li, L., Johnson, A. K., & Leonard, S. M. (2025). 201 Evaluating the impact of thermal conditions on behavior in feeder pigs. Journal of Animal Science, 103(Supplement_1), 37-38. | Published | North Carolina State University |

**Future Directions:** We have planned collaborations with several institutions including Michigan State, Wisconsin, Nebraska, and USDA. Some research initiatives include exploring machine visions systems for pig and cattle behavior monitoring, environmental monitoring inside livestock facilities, developing data science, data analytic, and other software techniques to big data.

## Station Name: Michigan State University

### Station members


- Madonna Benjamin (gemus@msu.edu) (Head for the NC1211)
- Janice Siegford (siegford@msu.edu)
- Daniel Morris (dmorris@msu.edu)


### Multistate Collaborative Research Publications

| | Type of the Publication | Full Citation for the Publication | Status | Other Stations/ Institutions Involved |
|---|---|---|---|---|
| Pub. 1 | Peer-reviewed journal article | Guest Editors: Zhao Y, Berckmans D, Gan H, Ramirez B, Siegford J, Wang-Li L, Burns R. 2024. Special Issue: 2nd U.S. Precision Livestock Farming Conference. Animals. https://www.mdpi.com/journal/animals/special_issues/4DMQ6B7A73. https://doi.org/10.3390/ani14071128 | Published | University of Tennessee, Iowa State University, North Carolina State University |
| Pub. 2 | Conference proceedings | Akinyemi BE, Turner SP, Akaichi F, Benjamin ME, Johnson, AK, Pairis-Garcia MD, Rozeboom DW, Steibel JP, Thompson DP, Zangaro C, Jessiman L, Siegford JM. 2024. Understanding the intention of US swine farmers to adopt, their actual adoption, and the intention of US veterinarians to recommend Precision Livestock Farming (PLF) technologies. Precision Livestock Farming 2024: Papers Presented at the 11th European Conference on Precision Livestock Farming, Bologna, Italy, 9-12 September 2024. 11:400-408. | Published | Iowa State University, Scotland's Rural College, North Carolina State University |
| Pub. 3 | Conference proceedings | Akinyemi BE, Siegford JM. 2024. United States public's attitudinal acceptance of precision livestock farming technologies in the swine industry. Precision Livestock Farming 2024: Papers Presented at the 11th European Conference on Precision Livestock Farming, Bologna, Italy, 9-12 September 2024. 11:409-417. | Published | None |

| | | | | |
|---|---|---|---|---|
| Pub. 4 | Conference proceedings | Morris D, Long Y, Ali A, Siegford J. 2024. LED Arrays to Reduce Poultry Piling. Precision Livestock Farming 2024: Papers Presented at the 11th European Conference on Precision Livestock Farming, Bologna, Italy9-12 September 2024. 11:374-381. | Published | Clemson |
| Pub. 5 | Extension publication | Siegford JM. 2024. Chapter 20: Precision livestock farming and technology in pig husbandry. In: Advances in Pig Welfare, 2nd Ed. (eds. I. Camerlink & E. Baxter). Woodhead Publishing. Pp. 449-469. doi:10.1016/B978-0-323-85676-8.00015-8. | Published | none |
| Pub. 6 | Abstract | Long Y, Siegford JM, Morris D. 2024. Automatic detection of piling in poultry. Proceedings of the 2024 ASABE Annual International Meeting, Anaheim, California. (poster) | Published | None |
| Pub. 7 | Abstract | Ma X, Siegford J, Jacobs J, Swanson J, Widowski T, Ali A. 2024. Using accelerometers to monitor laying hen activity at three different ages in two styles of multi-tiered aviaries. Proceedings of the 2024 Poultry Science Association Meeting, Lexington, KY. pp167-168. (poster) | Published | University of Guelph, Clemson University |
| Pub. 8 | Abstract | Petek M, Siegford J. 2024. Using a transect approach to assess behavior and welfare of laying hens in aviary tiers during peak lay. Proceedings of the 2024 International Poultry Scientific Forum, Atlanta, GA. (poster) | Published | Uludag University |
| Pub. 9 | Extension publication | Siegford J, Akinyemi BA. 2024. How do swine producers and veterinarians think precision livestock farming could help farms? ï, MSU Extension. https://www.canr.msu.edu/news/how-producers-vets-think-precision-livestock-farming-help-farms ï, Swineweb. https://www.swineweb.com/ag-tech/how-do-swine-producers-and-veterinarians-think-precision-livestock-farming-could-help-farms/ | Published | none |
| Pub. 10 | Extension publication | Siegford J, Akinyemi BA. 2024. What drives swine producers to buy into precision livestock farming technology? ï, MSU Extension. https://www.canr.msu.edu/news/what-drives-swine-producers-to-buy-into-precision-livestock-farming-technology | Published | none |

**Multistate Collaborative Research Grants**

| | Title/Official Name | Status | Other Stations/Institutions Involved |
|---|---|---|---|
| Gr. 1 | USDA NIFA AFRI—Social Implications of Food and Agricultural Technologies. Akinyemi BA, Siegford JM, Douglas H. Building trust in precision livestock farming using public engagement techniques. $650,000. | Pending | None |

| | | | |
|---|---|---|---|
| Gr. 2 | USDA NIFA AFRI—IDEAS. Benjamin M, Morris D, McLaughlin N, Manzanilla E, Kyriazakis I, Pairis-Garcia M, Brown-Brandl T, Knauer M, Muns R, Ferry E, Beltranena E, Hovey R, Farmer C, Boyle L. $1,000,000. Tripartite: Automated Piglet and Sow Monitoring for Early Detection of At-Risk Piglets. 09/2024-08/2028 | Ongoing | North Carolina State University, University of Nebraska Lincoln, UC Davis, Agriculture and Agri-Food Canada, Agri-Food and Biosciences Institute, Queens University, Animal and Grassland Research and Innovation Center. |
| Gr. 3 | USDA NIFA Agriculture and Food Research Initiative Competitive Grants Program—Food and Agriculture Cyberinformatics and Tools. Steibel JP, Brown-Brandl T, Rosa GJ, Siegford JM, Psota E, Dorea J, Benjamin M, Morris D, Norton T. $1,000,000. FACT-CIN: A Coordinated Innovation Network For Advancing Computer Vision In Precision Livestock Farming. 4/21-3/26. | Ongoing | Iowa State University, University of Nebraska-Lincoln, University of Wisconsin, PIC North America, PIC North America, M3-BIORES |
| Gr. 4 | Michigan Alliance for Animal Agriculture. Morris D, Siegford J, Ali A. $150,000. Automated targeted interventions to reduce eggs laid in the litter. 6/2022-12/2024. | Ongoing | Clemson University |
| Gr. 5 | Michigan Alliance for Animal Agriculture. Yang, X, Morris D, Siegford J, Ali A. $150,000. Encouraging and Directing Behavior Patterns of Cage-Free Poultry. 6/2024-5/2026. | Ongoing | Clemson University |
| Gr. 6 | USDA Agriculture & Food Research Initiative. D Morris, Brown-Brandl T., Benjamin M, Rohrer G. $590,000. An Automated Swine Phenotyping Tool to Advance Management, Research and Genetics. 8/2022-8/2026 | Ongoing | University of Nebraska-Lincoln |
| Gr. 7 | 2. PI - Michigan Alliance for Animal Agriculture. Benjamin M, Ferry E, Brown-Brandl T. $147,454. The Cost of Comfort - Establishing the Thermal Neutral Zone of Modern Hyperprolific Sows. 06/2024-05/2026 | Ongoing | University of Nebraska-Lincoln |

**Station Name: North Carolina State University**

**Station members**

- Lingjuan Li (lwang5@ncsu.edu) (Head for the NC1211)
- Suzanne Leonard (smleona4@ncsu.edu)
- Peter Ferket (pferket@ncsu.edu)

**Multistate Collaborative Research Projects**

| | Title/ Official Name | Status | Other Stations/ Institutions Involved | Description |
|---|---|---|---|---|
| Proj. 1 | Proactive Pig Production (P3): Animal-centric AI for Indoor Environmental Control to Optimize Productivity, Welfare, and Sustainability | Ongoing | Iowa State University | The project is to fill this gap and fundamentally change the existing swine production environmental control system from sensor-based reactive to animal-based and AI-powered proactive intervention system |

**Station Name: University of Illinois at Urbana-Champaign**

**Station members**

- Isabella Condotta (icfsc@illinois.edu) (Head for the NC1211)
- Tiago Bresolin (bresolin@illinois.edu)

**Multistate Collaborative Research Publications**

| | Type of the Publication | Full Citation for the Publication | Status | Other Stations/ Institutions Involved |
|---|---|---|---|---|
| Pub. 1 | Peer-reviewed journal article | Negreiro, A.; Bresolin, T.; Ferreira, R.; Dado-Senn, B.; Van Os, J.; Laporta, J.; Dorea, J. Leveraging Computer Vision Systems for Monitoring Hutch-housed Dairy Calves. Journal of Dairy Science, 2025. | Published | University of Wisconsin-Madison |
| Pub. 2 | Peer-reviewed journal article | Ribeiro, L.; Menezes, G.; Bresolin, T.; Arriola Apelo, S.; Dorea, J. Using Fourier-transform infrared spectroscopy to predict urinary allantoin in dairy cows. JDS Communications, v.6, p.212-216, 2025. | Published | University of Wisconsin-Madison |
| Pub. 3 | Peer-reviewed journal article | Ferreira, R.E.P.; Balaguer, M.A.L.; Bresolin, T.; Chandra, R.; Rosa, G.J.M.; White, H.M.; Dorea, J. Multi-modal machine learning for the early detection of metabolic disorder in dairy cows using a cloud computing framework. Computers and Electronics in Agriculture, v.227, p.1-15, 2024. | Published | University of Wisconsin-Madison |
| Pub. 4 | Peer-reviewed journal article | Vang, A.; Bresolin, T.; Waneska, F.; Compolina, J.; Menezes, G.; Rosa, G.; Dorea, J.; Hernandez, L. Monitoring mammary gland development in preweaned dairy heifers using ultrasound imaging. JDS Communications, v., p., 2024. | Published | University of Wisconsin-Madison |
| Pub. 5 | Peer-reviewed journal article | Oliveira, D.A.B.; Bresolin, T.; Coelho, S.G.; Campos, M.M.; Lage, C.F.A.; Leao, J.M.; Pereira, L.G.R.; Hernandez, L.; Dorea, J.R.R. A polar transformation augmentation approach for enhancing mammary | Published | University of Wisconsin-Madison |

| | | | | |
|---|---|---|---|---|
| | | gland segmentation in ultrasound images. Computers and Electronics in Agriculture, v.220, p.1-8, 2024. | | |
| Pub. 6 | Peer-reviewed journal article | Perttu, R.K.; Peiter, M.; Bresolin, T.; Dorea, J.R.R.; Endre, M.I. Predictive models for disease detection in group-housed preweaned dairy calves using data collected from automated milk feeders. Journal of Dairy Science, v.107, p.331-341, 2024. | Published | University of Wisconsin-Madison and University of Minnesota Twin Cities |
| Pub. 7 | Abstract | Elluru, V.; Sallam, A.M.; Alves, A.; Bresolin, T. Towards Unsupervised Latent Representations for Cattle Image Segmentation. Proceedings of the 3rd U.S. Precision Livestock Farming Conference, Lincoln, Nebraska, USA, 2025. | Published | University of Georgia |
| Pub. 8 | Abstract | Ferreira, R.; Bresolin, T.; Holdorf, H.T.; White, H.M.; Dorea, J.R.R. Early detection of subclinical ketosis in Holstein dairy cows using computer vision and recurrent neural networks. Proceedings of the American Dairy Science Association Meeting, West Palm Beach, Florida, USA, 2024. | Published | University of Wisconsin-Madison |
| Pub. 9 | Abstract | Negreiro, A.; Alves, A.A.C.; Ferreira, R.; Bresolin, T.; Rosa, G. J. M.; Dorea, J. R. R. Siamese Networks for open-set identification of Holstein cattle during growth and across different physiological stages. European Conference on Precision Livestock Farming Meeting, Bolagna, Italy, 2024. | Published | University of Wisconsin-Madison and University of Georgia |
| Pub. 10 | Peer-reviewed journal article | Rahman, M.; Souza, V. H. S.; Brown-Brandl, T. M.; Rohrer, G. A.; Shi, Y.; Condotta, I. C. F. S. Accelerating Sow Nursing Behavior and Activity Monitoring with Modified YOLO11n Architecture and TensorRT Integration. Porcine Health Management. 2025 | Under review | University of Nebraska-Lincoln |
| Pub. 11 | Abstract | Rahman, M.; Souza, V. H. S.; Brown-Brandl, T. M.; Rohrer, G.; Shi, Y.; Condotta, I.C. F. S. Automated Monitoring of Sow Nursing Behaviors in Farrowing Crates Through Computer Vision Techniques. Proceedings of the 3rd U.S. Precision Livestock Farming Conference, Lincoln, Nebraska, USA, 2025. | Published | University of Nebraska-Lincoln |

**Multistate Collaborative Research Product**

| | Title/Official Name | Status | Other Stations/ Institutions Involved | Description |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| Prod. 1 | Integrating Image-Based Social Behaviors And Genomic Data To Enhance Genetic Selection Decision Of Beef Cattle Production Efficiency Traits | Pending | Texas A&M University | Our goals it to: 1) Determine social behaviors in beef cattle using spatial and temporal location data generated by an automated vision-based monitoring system, 2) Train undergraduate students in precision livestock farming skills, preparing them to become the next generation of graduate students and industry leaders, and 3) Evaluate the contribution of social genetics effects to the total breeding values of efficiency and production traits in beef cattle. Collectively, these efforts will lead to more efficient, productive, and data-driven cattle management and breeding practices. |

**Future Directions:**

- Resubmit the research project if it is not funded in collaboration with the Texas A&M University station
- Publish ongoing research publication that involves the University of Georgia and the University of Wisconsin-Madison stations
- Publish peer-reviewed papers currently in preparation involving the University of Nebraska-Lincoln

## Station Name: University of Minnesota

**Station Members**

- Marcia Endres (miendres@umn.edu) (Head for the NC1211)
- Yuzhi Li (yuzhili@umn.edu)

**Multistate Collaborative Research Projects**

| | Title/ Official Name | Status | Other Stations/ Institutions Involved | Description |
|---|---|---|---|---|
| Proj. 1 | Computer Vision System Enables Continuous, Individual-Level Behavioral Monitoring in Swine Research Environments | Ongoing | University of Nebraska | NUtrack, developed by the University of Nebraska, was installed above pens to record and process posture (lying, sitting, standing), activity (walking distance), and resource use (feeder and drinker visits) for each individual pig in the pen. The system uses machine vision and deep learning to detect and track individual pigs in group housing. Data were collected continuously for the study period (12-14 weeks) across multiple experimental treatments, including group size and litter origin (social composition), to identify behavioral changes |

| | |
|---|---|
| | that precede tail-biting outbreaks. Manual video review and NUtrack behavioral data enabled researchers to identify pigs involved in tail-biting events (biters, victims, and controls). Tail biters were predominantly gilts and exhibited lower average daily gain and lighter final weights than non-biters. Biting events occurred most frequently in the morning and late afternoon. This project is the first to use continuous, individual-level behavioral tracking to characterize the onset and social dynamics of tail biting in growing-finishing pigs. Findings are being used to develop predictive algorithms that can detect early behavioral deviations associated with tail injury risk and will contribute to future automated alerts for producers, supporting non-invasive, data-driven welfare management in commercial swine systems. |

**Multistate Collaborative Research Publications**

| | Type of the Publication | Full Citation for the Publication | Status | Other Stations/ Institutions Involved |
|---|---|---|---|---|
| Pub. 1 | Abstract | Archer, C., Hilbrands, A., Mote, B. E., Schmidt, T. B., Johnston, L. J., & Li, Y. (2024). 209 Influence of litter origin on performance and tail biting in growing-finishing pigs. Journal of Animal Science, 102(Supplement_2), 5–6. | Published | University of Nebraska |
| Pub. 2 | Abstract | Li, Y., Archer, C., Hilbrands, A., Schmidt, T. B., Mote, B. E., & Johnston, L. J. (2024). PSIII-6 Tail damage caused by tail biting in growing-finishing pigs housed in two group sizes. Journal of Animal Science, 102(Supplement_2), 265–266. | Published | University of Nebraska |
| Pub. 3 | Abstract | Archer, C. A., Forster, S. L., Mote, B. E., Schmidt, T. B., Johnston, L. J., & Li, Y. (2025). 40 Identifying tail-biting pigs in small and large groups of growing-finishing pigs with intact tails. Journal of Animal Science, 103(Supplement_1), 5–6. | Published | University of Nebraska |
| Pub. 4 | Abstract | Forster, S. L., Archer, C. A., Li, Y., Johnston, L. J., Anderson, J., Mote, B. E., & Schmidt, T. B. (2025). 39 Use of the NU track System to evaluate behaviors of growing-finishing pigs with intact tails classified as tail biters or non-tail biters. Journal of Animal Science, 103(Supplement_1), 7–8. | Published | University of Nebraska |
| Pub. 5 | Abstract | Archer, C. A., Forster, S. L., Mote, B. E., Schmidt, T. B., Anderson, J., Johnston, L. J., & Li, Y. (2025). 213 Differences in growth, tail injury, and immune | Published | University of Nebraska |

| | |
|---|---|
| | markers among tail-biting, non-biting, and control pigs with intact tails. Journal of Animal Science, 103(Supplement_1), 40–41. |

**Future Directions:** Continue the collaboration with the University of Nebraska to complete analysis for this project.

## Station Name: University of Missouri

### Station members

- Jianfeng Zhou (j.zhou@missouri.edu) (Head for the NC1211)

### Multistate Collaborative Research Publications

| | Type of the Publication | Full Citation for the Publication | Status | Other Stations/ Institutions Involved |
|---|---|---|---|---|
| Pub. 1 | Peer-reviewed journal article | Xu, Z., J. Zhou, C. Bromfield, T. T. Lim, T. J. Safranski, Z. Yan and J. G. Wiegert. 2024. Automated estrus detection in sows using a robotic imaging system. Biosystems Engineering. 244(2024), 134-145. | Published | Texas A&M University |
| Pub. 2 | Peer-reviewed journal article | Xu, Z., J. Zhou,* C. Bromfield, T. T. Lim, T. J. Safranski, Z. Yan and P. Calyam. 2024. Developing a sow vulva volume estimation pipeline based on LiDAR imagery and deep learning. Journal of ASABE. 67(3), 649-661. | Published | Texas A&M University |

### Multistate Collaborative Research Presentations

| | Title | Status | Other Stations/ Institutions Involved |
|---|---|---|---|
| Pres. 1 | 11. Zhou, J., Z. Xu, T. Safranski, T. Lim. 2024. Automated sow estrus detection using machine vision technology. 16th International Conference on Precision Agriculture. International Society of Precision Agriculture (ISPA). Manhattan, KS, July 21 - 24, 2024. | Presented | Texas A&M University |

### Multistate Collaborative Book Chapter

| | Title | Status | Other Stations/ Institutions Involved | Description |
|---|---|---|---|---|
| Bk. Ch. 1 | Xu, Z., and J. Zhou. Chapter 7: Developments in automated technologies for early pregnancy diagnosis in pigs: Advances in precision pig farming | Ongoing | Texas A&M University | A book chapter can reach out international audiences and |

| | | |
|---|---|---|
| | technologies (ed. Prof. Lisa Collins). Burleigh Dodds Science Publishing. | provide education and technical reference for other researchers. |

**Future Directions:** Will continue the current collaborative work, and seek additional collaboration with researchers of other states.

## Station Name: University of Nebraska-Lincoln

### Station members

- Tami Brown-Brandl (tbrownbrandl2@unl.edu)
- Yijie Xiong (yijie.xiong@unl.edu)

### Multistate Collaborative Research Projects

| | Title/Official Name | Status | Other Stations/ Institutions Involved | Description |
|---|---|---|---|---|
| Proj. 1 | The Cost of Comfort — Establishing the Thermal Neutral Zone of Modern Hyperprolific Sows. | Ongoing | Michigan State University | The proposed study will use non-invasive methods to determine the thermal comfort zone of modern sows within a commercial gestation barn. This study will utilize thermal imaging and behavioral observations to reflect changes in the sows' behavior and surface blood flow, thereby assessing animal comfort and estimating the ideal temperatures for gestation barns. Adopting new standards will ensure optimal animal well-being and maximize on-farm energy efficiency. |
| Proj. 2 | Reducing lameness in commercial group-housed sows using rubber flooring | Ongoing | North Carolina State University and Michigan State University | Sow lameness is one of the primary causes of premature culling in the sow herd. This study will evaluate rubber mats as a strategy to reduce lameness and improve animal welfare through two objectives: 1) assess impacts on lameness, treatments, production, and mortality, and 2) quantify behavioral and physiological responses related to pain and welfare. Rubber mats may alter heat transfer, affecting sow comfort across seasons. Therefore, it is critical to assess seasonal thermal comfort in mat-equipped pens. Nebraska will lead the evaluation of |

| | | |
|---|---|---|
| | | thermal comfort associated with rubber mat use in Prop 12-compliant sow housing. |

**Multistate Collaborative Research Publications**

| | Type of the Publication | Full Citation for the Publication | Status | Other Stations/ Institutions Involved |
|---|---|---|---|---|
| Pub. 1 | Peer-reviewed journal article | Bery, S., Brown-Brandl, T. M., Rohrer, G. A., Sharma, S. R., & Leonard, S. M. (2024). Impacts of crate design, number of heat lamps and lying posture on the occurrence of shoulder lesions in sows. Biosystems Engineering, 247, 249-256. | Published | North Carolina State University |
| Pub. 2 | Peer-reviewed journal article | 118. Paudel, S., Brown-Brandl, T.*, Rohrer, G., & Sharma, S. R. (2025). Deep learning algorithms to identify individual finishing pigs using 3D data. Biosystems Engineering, 255, 104143. | Published | PIC and Iowa State University |
| Pub. 3 | Peer-reviewed journal article | Paudel, S., Rohrer, G., & Sharma, S. R., Brown-Brandl, T.* (2025) Identifying Individual Grow-Finish Pigs Using Point Cloud Data . | Under review | Iowa State University and Michigan State University |
| Pub. 4 | Conference proceedings | Rahman, M. T., Rohrer, G. A., Sharma, S. R., Shi, Y., Leonard, S. M., Brown-Brandl, T. M.* (2025). Behavioral insights impacting preweaning mortality. In 3rd U.S. Precision Livestock Farming Conference. In 3rd US Precision Livestock Farming Conference in Lincoln, NE June 2-5, 2025 | Accepted | North Carolina State University and University of Illinois |
| Pub. 5 | Conference proceedings | Poudel, A., Davis, J., Purswell, J., Sharma, S. R., & Brown-Brandl, T. (2025). Semi-automatic annotation system based on Segment Anything Model for large scale poultry data annotations. In 3rd US Precision Livestock Farming Conference in Lincoln, NE June 2-5, 2025 | Accepted | Auburn University and USDA ARS Poultry Research Unit |
| Pub. 6 | Conference proceedings | Akin, H., Akinyemi, B.E., McQuillan, J., Brown-Brandl, T. 2024. Studentsâ€™ knowledge of and attitudes toward dairy production. . In 11th European Conference on Precision Livestock Farming, ECPLF 2024 Bologna, Italy. | Published | Michigan State University |

**Future Directions:** Michigan State University and the University of Nebraska-Lincoln are currently working on two additional projects and completing one more.

**Station Name: University of Tennessee**

**Station members**

- Yang Zhao (yzhao@utk.edu) (Head for the NC1211)
- Tom Tabler (gtabler@utk.edu)
- Robert Burns (rburns@utk.edu)

**Multistate Collaborative Research Publications**

| | Type of the Publication | Full Citation for the Publication | Status | Other Stations/ Institutions Involved |
|---|---|---|---|---|
| Pub. 1 | Abstract | Burns, Robert. (2025, June 1-6). Transferring Smart Agriculture from the Lab to the Field. [Conference presentation abstract]. Proceedings of the Croatian SA2025 International Symposium on Agriculture. June 1-6, 2025. Bol, Brac Island. Page 21. | Published | |
| Pub. 2 | Peer-reviewed journal article | Zhang, B., S. Zhou, W. Zhai, Y. Zhao. 2025. Effects of Amino Acid and Energy Reduction on Processing, Internal Organs Developments, and Economic Returns of Cobb 700 and Ross 708 Broilers. Animals, 15(7), 1064 | Published | Mississippi State University |
| Pub. 3 | Peer-reviewed journal article | Zhang, B., S. Zhou, W. Zhai, Y. Zhao. 2025. Effect of Reduction in Dietary Amino Acid and Energy on Growth Performance and Economic Return of Cobb 700 and Ross 708 Broilers. Animals, 15(6), 890. | Published | Mississippi State University |
| Pub. 4 | Conference proceedings | Zhou, S., A. Nasiri, X. Yang, T. Thornton, H. Gan, T. Tabler, Y. Zhao. 2025. Evaluating Broiler Activity index, Stretching and Preening behaviors as Affected by Stocking Density. In: Proceedings of 3rd U.S. Precision Livestock Farming Conference (USPLF 2025), Lincoln, NE, USA. | Accepted | China Agriculture University |

| | | | | |
|---|---|---|---|---|
| Pub. 5 | Abstract | Jaihuni, M., Y. Zhao, H. Gan, J. Moyle. 2025. Developing deep learning models for automated mating-related behavior detection in broiler breeders in lab setting. In: Proceedings of 2025 International Symposium on Animal Environment and Welfare, October 20-23, 2025, Chongqing, China. | Accepted | University of Maryland |
| Pub. 6 | Extension publication | Tabler, T., Y. Liang, T. Thornton, J. Moon, and P. Maharjan. 2024. Winter ventilation challenges broiler growers. University of Tennessee Extension Publ. No. D 244. October. | Published | University of Arkansas, Mississippi State University<br><br>Tennessee State University |
| Pub. 7 | Extension publication | Tabler, T., S. Hawkins, Y. Liang, T. Thornton, and J. Moon. 2024. Poultry litter management (inside and outside the house). University of Tennessee Extension Publ. No. D 247. November. | Published | University of Arkansas, Mississippi State University |
| Pub. 8 | Extension publication | Tabler, T., T. Thornton, J. F. Chibanga, and P. Maharjan. 2025. Circular bioeconomy in sub-Saharan Africa: Transforming African food systems. University of Tennessee Extension Publ. No. W 1312. January. | Published | National Institute for Scientific and Industrial Research, Luska, Zambia, Tennessee State University |
| Pub. 9 | Extension publication | Tabler. T., Y. Liang, J. Moon, and T, Thornton. 2021. Sprinkler cooling of broilers highlights sustainability and water conservation potential. University of Tennessee Extension Publ. No. D 235. January. | Published | University of Arkansas, Mississippi State University |
| Pub. 10 | Extension publication | Tabler, T., S. Hawkins, Y. Liang, T. Thornton, and J. Moon. 2025. Proper maintenance of stand-by generators is critical on commercial poultry farms. University of Tennessee Extension Publ. No. D 257. April. | Published | University of Arkansas, Mississippi State University |
| Pub. 11 | Extension publication | Tabler, T., S. Hawkins, F. Walker, A. Rius, T, Thornton, Y. Liang, J. Moon, and J. Urrutia. 2025. Challenges and benefits of managing and utilizing poultry litter inside and outside the broiler house. University of Tennessee Extension Publ. No. W XXXX. July. | Accepted | University of Arkansas, Mississippi State University |
| Pub. 12 | Extension publication | Tabler, T., J. F. Chibanga, T. O. Rewe, P. Maharjan, L. Lweis, and T. Thornton. 2025. Agriculture and the circular bioeconomy across | Accepted | Pwani University |

| | | | | |
|---|---|---|---|---|
| | | Sub-Saharan Africa. University of Tennessee Extension Publ. No. W XXXX. July. | | Kilifi, Kenya, National Institute for Scientific and Industrial Research Lusaka, Zambia, Tennessee State University |
| Pub. 13 | Peer-reviewed journal article | Terrilyn Klingberg, Robert Burns, Shawn Hawkins, Yang Zhao, Tanner Thornton, Susan Schexnayder, A Producer Survey on Implementation of Precision Livestock Farming in the Broiler Industry, Journal of Applied Poultry Research, 2025, 100548, ISSN 1056-6171, https://doi.org/10.1016/j.japr.2025.100548 | Published | |
| Pub. 14 | Peer-reviewed journal article | Wang, Y., L. Yang, F. Chen, W. Liu, R. T. Burns, and J. Zhuang. 2024. Optimum thermal treatment for removing antibiotic resistance genes and retaining nutrients in poultry broiler manure. Environmental Technology & Innovation, 36, 103864. | Published | Chinese Academy of Sciences |
| Pub. 15 | Extension publication | Klingberg, T., R. T. Burns, G. T. Tabler, and S. A. Hawkins. 2024. Precision livestock farming in the broiler industry. UT Institute of Agriculture Publ No. W 1271. | Published | |

**Multistate Collaborative Research Presentations**

| | **Title** | **Status** | **Other Stations/ Institutions Involved** |
|---|---|---|---|
| Pres. 1 | Burns, Robert. (2025, June 1-6). *Transferring Smart Agriculture from the Lab to the Field.* [Conference presentation abstract]. Presentation at the Croatian SA2025 International Symposium on Agriculture. June 1-6, 2025. Bol, Brac Island. | Completed | |
| Pres. 2 | Zhou, S., A. Nasiri, X. Yang, T. Thornton, H. Gan, T. Tabler, Y. Zhao. 2025. Evaluating broiler activity index, stretching and preening behaviors as affected by stocking density. International Poultry Scientific Forum, Atlanta, GA, USA. | Presented | China Agricultural University |
| Pres. 3 | Tabler, T. 2025. Commercial poultry brooding and its importance to flock performance. University of Zambia School of Veterinary Medicine. Lusaka, Zambia. May 7. | Presented | University of Zambia |

| | | | |
|---|---|---|---|
| Pres. 4 | Tabler, T. 2025. Precision livestock farming technology and flock health: Challenges and opportunities. Poultry Extension Collaborative Symposium. May 20. | Presented | University of Arkansas |
| Pres. 5 | Tabler, T. 2025. Poultry lighting: Lamp and light dimmer issues. Egg Farmers of Alberta Lighting Webinar. May 28. | Presented | Egg Farmers of Alberta Calgary, Alberta, Canada |

**Multistate Collaborative Research Projects**

| | **Title/Official Name** | **Status** | **Other Stations/ Institutions Involved** |
|---|---|---|---|
| Proj. 1 | Improving health and well-being in broiler chickens through environmental management, *USDA Cooperative Agreemen*t, 2024-2025. | Ongoing | USDA-ARS PRU, Mississippi State University |
| Proj. 2 | Holistic performance, environment, and economics study of incorporating extruded-expelled soybean meal (EE-SBM) in poultry feed in Tennessee. *TN Soybean Association*, 2024-2025. | Ongoing | University of Arkansas |
| Proj. 3 | A vision-based precision livestock farming system for real-time detection of mating behaviors in broiler breeders. *Cobb Research Initiative*, 2023-2025. | Ongoing | University of Maryland |
| Proj. 4 | A holistic approach to improving keel bone health of breeders and commercial layer hens. *Foundation for Food and Agriculture Research*, 2023-2026. | Ongoing | University of California, Davis |
| Proj. 5 | Advancing environmental footprint assessment and safeguarding animal production: Developing low-cost diode-laser-based absorption sensors. *USDA SBIR*, 2024-2025. | Completed | Spectral Energies, Ohio |
| Proj. 6 | Empowering U.S. broiler production for transformation and sustainability. *USDA-NIFA*, 2019-2024. | Completed | USDA-NIFA University of Arkansas Mississippi State University |
| Proj. 7 | Novel non-antibiotic approaches for mitigation of antimicrobial resistance in poultry. *USDA-NIFA*, 2019-2024. | Completed | Mississippi State University |
| Proj. 8 | An approach to building a sustainable small flock poultry operation through improvement in nutrition, food safety, and marketing. *Southern SARE*, 2023-2026. | Ongoing | Tennessee State University |
| Proj. 9 | Sustaining small flock poultry producers utilizing a train-the-trainer model on identified poultry needs. *Southern SARE*, 2023-2025. | Ongoing | Tennessee State University |

| | | | |
|---|---|---|---|
| Proj. 10 | Small flock poultry drinking water sanitation practices on Tennessee farms: An approach to thriving small-scale poultry operations through improvement in poultry drinking water management. *USDA 1890 CBG program*, 2024-2027. | Ongoing | Tennessee State University |

**Multistate Collaborative Trainings**

| | **Title** | **Status** | **Other Stations/ Institutions Involved** |
|---|---|---|---|
| Trng. 1 | PLF use in poultry broiler Short-Course – February 11-13, 2025 | Completed | |