NC1201 ACCOMPLISHMENTS REPORT

Project Number: NC1201
Project Title: Methods to Increase Reproductive Efficiency in Cattle
Period Covered: 08/05/2024 to 03/16/2025
Date of Report: 09/03/2025
Annual Meeting Dates: 06/05/2025 to 06/06/2025

MEETING PARTICIPANTS: Carl Dahlen (Carl.Dahlen@ndsu.edu) – North Dakota State; Roberta Dahlen (Carl.Dahlen@ndsu.edu) – North Dakota State George Smith (smithge7@msu.edu) -Administrative Advisor; Jordan Thomas (ThomasJor@missouri.edu) – University of Missouri; Michelle Rhoads (rhodesm@vt.edu) – Virginia Tech; Nicholas Dias (diasnw@ksu.edu) – Kansas State University; Pedro Fontes (pedrofontes@uga.edu) – University of Georgia; Richard Pursley (pursleyr@msu.edu) – Michigan State University; Rick Funston (rfunston2@unl.edu) –University of Nebraska; Saulo Zoca (szoca@utk.edu) – University of Tennessee; Victor Gomez-Leon (vgomezleon@ksu.edu) – Kansas State University.

BRIEF SUMMARY OF MINUTES OF ANNUAL MEETING:

Welcome and introductions: The 2025 Annual Meeting was held at Kansas State University in Manhattan (KSU), Kansas. The meeting started with a general welcome from Victor Gomez-Leon and Mike Day (head of the Department of Animal Sciences & Industry at KSU).
Business meeting and general updates: Victor Gomez-Leon (chair of the 2025 meeting) opened the floor to discuss next year's meeting details. The group approved:

- Nicholas Dias and Jordan Thomas as the 2025 president and secretary, respectively.
- The 2026 annual meeting to be held in East Lansing at Michigan State University.
- Next year's annual meeting dates from 6/10/26 to 6/11/26. This date should avoid conflict with classes and major scientific meetings.
- Nicholas Dias will lead efforts to organize a multi-state graduate level class on bovine applied reproduction.

USDA update: Mark Mirando and Kamillah Grant shared updates on personnel change, information on NIFA budget and RFA opportunities, as well as the new 6-step review process of grant applications.
Other notes: The group was encouraged to invite new participants to join NC-1201

ACCOMPLISHMENTS:

Conducting timed insemination studies and fertility trials requires substantial time, which, in several cases, represents a challenge for collaborations among research stations. Moreover, collective funding for multiple research stations and allocating those resources also represents a challenge for replicating studies among different states. Nonetheless, the results from individual and collaborate studies collectively advance the body of knowledge, contributing to improvements in reproductive strategies or advancing the understanding of the mechanisms

controlling reproduction, which are key objectives of the NC1201 project. Examples of such collaborative advancements are summarized for objectives 1 and 2 in the categories below. Finally, efforts to expand collaboration opportunities were discussed as part of the annual meeting.

Objective 1: Increase the efficiency and predictability of sustainable reproductive technologies and management programs for cattle:

Strategies to enhance reproductive efficiency of cattle submitted to TAI:

- Beef cows that expressed estrus (ESTRUS) in response to an estrous synchronization protocol prior to timed-artificial insemination tended to have greater pregnancy success than females that did not express estrus and had ovulation induced by GnRH (GNRH), while females that failed to express estrus and had ovulation induced by GnRH and Estradiol (GNRH+E2) were intermediate. Females in the GNRH group also tended to have greater concentrations of pregnancy associated glycoproteins on day 20 when compared to ESTRUS females, and heavier embryos on day 32 when compared to GNRH+E2 females. (**TX, NE**).
- Multi-sire pooled semen showed no difference in pregnancy success of beef heifers exposed to timed-artificial insemination but resulted in satisfactory pregnancy success when utilized for sexed-semen insemination in a split-timed artificial insemination approach (**NE, MO**).
- *Bos taurus* beef cows classified to be among the 25% shortest anogenital distances had improved conception rates to timed-artificial insemination when compared to the remaining 75%. Furthermore, *Bos indicus* beef heifers tended to have decreased probability of pregnancy to TAI as anogenital distances increased. No effects of anogenital distances were observed for fertility of *Bos taurus* beef or dairy heifers (**KS, TN, GA**).
- Reproductive tract scores had greater prediction of pregnancy success to timed-artificial insemination for Bos taurus beef heifers when compared to anogenital distances (**KS, TN**).
- Tandem administration of both GnRH and Prostaglandind-F2α at days 0 and 7 of the 7&7 synch protocol resulted in convergent ovarian response among anestrous and estrous cycling beef females and tended to result in increased pregnancy rates to timed-artificial insemination. (**MO, GA, TN**).
- Administration of hCG at the initiation of the 7&7 synch protocol with the inclusion of a CIDR (hCG+CIDR) or without (hCG) resulted in a greater proportion of treated beef cows with the presence of a corpus luteum in the ovary 3 days prior to timed-artificial insemination when compared to control females that received the standard 7&7 synch protocol. However, females that received a CIDR (7&7; hCG+CIDR) tended to have greater pregnancy rates to timed-artificial insemination when compared to females that received no CIDR. (**MO, TN**).
- Enrolling beef Bos taurus heifers into an acclimation protocol during the handling events of the 7-d CO-Synch + CIDR protocol resulted in improved temperament parameters by the day of timed-artificial insemination, and improved conception rates to timed-artificial insemination (**KS, NC**).

Interaction of nutrition and reproduction:

- Young bull overnutrition promoted an obese-like metabolic profile along with increased insulin resistance and systemic inflammation compared with the MG diet. (**GA, TN**).

- Young bull overnutrition negatively impacted semen quality, indicating that diet-induced over conditioning in young bulls resulted in subtle decreases key sperm functional traits. (**GA, TN**).
- Supplementation of omega-3 fatty acids during young bull development improved sperm motility and morphology and mitigated detrimental effects of overnutrition in the semen of obese bulls. (**KS, TN**).

Objective 2: Evaluate mechanisms that regulate reproductive processes impacting production efficiency in cattle

- Feeding a high-gain diet to young bulls results in semen that delays embryonic development and decreases embryo quality. (**GA, TN**)
- Beef females with abnormal reproductive cycles following vaccination with a modified live vaccine had increased concentrations of IL-1β from d0 to d4, increased concentrations of IFN-γ from d0 to d2, increased concentration of VEGF-A from d8 to d10 following vaccination, and overall increased concentrations of IL-4 when compared to females with normal reproductive cycles (**TX, TN**).
- Developing Bos taurus beef heifers in a stair-step nutritional program in native range setting resulted in increased surface antral follicle count when compared to heifers developed in constant gain at either drylot or native range settings and heifers developed at a stair-step approach at a drylot setting. However, no impact of feeding strategy were observed on number of ovarian primordial follicles, ovarian length, and ovarian height (**WY, NE, TX**).
- No differences in microbiome composition were observed between Bos taurus beef heifers that were classified at either low antral follicle count, or high antral follicle count. However, differences in microbiome composition were found between vaginal and uterine samples, regardless of antral follicle count classification (**WY, NE**).

Objective 3: Disseminate reproductive management information to stakeholders to improve sustainability of cattle enterprises

The members of the NC1201 continue to place themselves as scientists who provide unbiased information to the livestock industry based on research data. As an example of this achievement, over the last year, the members of the NC1201 participated in more than 5 workshops, 52 regional or national meetings, and over 40 scientific meetings, reaching several thousand people. The target audience of such efforts continues to be producers, veterinarians, technicians, and students involved in the National and International beef and dairy cattle industries.

PEER REVIEW PUBLICATIONS (SELECTED):

L.M. Goncalves, S. Burato, L. Neira, K. Harvey, **S.M. Zoca**, V.R.G. Mercadante, **P.L.P. Fontes**. 2025. Impact of late embryonic and early fetal mortality on productivity of beef cows. Trans. Anim. Sci. doi.org/10.1093/tas/txaf071. (In press). (**TN, GA**)

Smith, M. S., J. O. S. Aguilar, G. Nyhuis, F. M. Ciriaco, **S. M. Zoca**, L. Strickland, R. L. Stewart Jr., J. D. Duggin, and **P. L. P. Fontes**. 2025. Relationship between

phenotypic subcutaneous backfat thickness and spermiogram outcomes in young beef bulls. 2025. Trans. Anim. Sci. 9: txaf039. doi:10.1093/tas/txaf039. (**TN, GA**)

S. Burato, M. B. Walker, L. M. Goncalves, N. Oosthuizen, **S. M. Zoca**, D. D. Henry, F. M. Ciriaco, J. Ranches, **P. L. P. Fontes**. 2024. Influence of early progesterone removal on follicular development, expression of estrus, and pregnancy rates in presynchronized postpartum beef cows. Anim. Reprod. Sci. 267:107541 doi.org/10.1016/j.anireprosci.2024.107541. (**TN, GA**)

Binelli, M., M. C. Lopez-Duarte, A. Gonella-Diaza, **F. A. Silva**, G. Pugliesi, **T. Martins**, and C. C. Rocha. 2025. Effectors and predictors of conceptus survival in cattle: What is next? Domestic Animal Endocrinology 92:106939. (**NC, MO**)

Cushman, R. A., **S. L. Rosasco**, K. L. McCarthy, A. P. Snider, **G. A. Perry**, and C. A. Lents. 2025. Advances in our understanding of the estrous cycle and applications for improving targeted reproductive management in livestock. Domest. Anim. Endocrinol. 91:106912. doi.org/10.1016/j.domaniend.2025.106912 (**NE, WY, TX**)

Kaps, M., L. K. Quail, **S. L. Rosasco**, A. P. Snider, **S. M. Zoca**, K. M. Epperson, J. J. J. Rich, J. R. Miles, M. S. Crouse, B. N. Keel, A. F. Summers, **G. A. Perry**, C. A. Lents, **and R. A. Cushman**. 2025. Extended window of maternal recognition as a potential factor for improved reproductive performance in Angus beef heifers with high antral follicle counts. Biol. Reprod. 112:130-139. doi.org/10.1093/biolre/ioae146 (**WY, TN, TX, NE**)

Kilama, J., **C.R. Dahlen**, M. Abbasi, X. Shi, T.G. Nagaraja, M.S. Crouse, **R.A. Cushman**, A.P. Snider, K.L. McCarthy, J.S. Caton and S. Amat. 2025. Characterizing the prevalence of *Fusobacterium necrophorum subsp. necrophorum, Fusobacterum necrophorum subsp. funduliforme* and *Fusobacterium varium* in bovine and ovine semen, bovine gut, vagino-uterine and fetal microbiota using targeted culturing and qPCR. Microbiol. Spectrum. 13(5): e0314524. DOI: 10.1128/spectrum.03145-24 (**ND, NE**)

Crouse, M.S., R.J. Trotta, H.C. Freetly, A.K. Lindholm-Perry, B.W. Neville, W.T. Oliver, C.J. Hammer, J.G. Syring, L.E. King, T.L. Neville, L.P. Reynolds, **C.R. Dahlen**, J.S. Caton, A.K. Ward, and **R.A. Cushman**. 2023. Disrupted one-carbon metabolism in heifers negatively impacts their health and physiology. J. Anim. Sci. 102, skae144. https://doi.org/10.1093/jas/skae144 (**ND, NE**)

Andrews, T. N., K. M. Epperson, J. J. J. Rich, **S. Menegatti Zoca**, A. C. Kline, L. K. Quail, S. R. McCoski, C. D. Sanford, A. L. Zezeski, T. W. Geary, J. A. Walker, **G. A. Perry**. 2025. The interactions of change in nutrition prior to and after artificial insemination on plasma non-esterified fatty acids, plasma mineral concentrations, and uterine histotroph in beef heifers. Applied Animal Sci. In press. (**TN, TX**)

Harl, A.W., V.M. Negrón-Pérez, J.W. Stewart, **G.A. Perry**, A.D. Ealy, and **M.L. Rhoads**. 2025. Maturation of bovine cumulus oocyte complexes in follicular fluid with or without estradiol,

progesterone or the combination affects cumulus cell expansion and blastocyst development. PLOS one https://doi.org/10.1371/journal.pone.0321266. (**TX, VA**)

Negrón-Pérez, V.M., A. Al Naib, A.L. Zezeski, V.L. McCracken, **G.A. Perry**, A.D. Ealy, and **M.L. Rhoads**. 2024. Cumulus cell expansion, nuclear maturation and embryonic development of bovine cumulus-oocyte complexes matured in varying concentrations of follicular fluid. PLOS one 2025 Feb 7;20(2):e0318376. doi: 10.1371/journal.pone.0318376. (**TX, VA**)

Epperson, J. J. J. Rich, **S. Menegatti Zoca**, L. K. Quail, T. N. Andrews, A. C. Kline, F. J. White, R. F. Daly, **R. A. Cushman**, A. P. Snider, and **G. A. Perry**. 2024. Influence of commercial inactivated or modified-live virus vaccination at time of AI on corpus luteum development and function in beef cattle. Animal Reproduction Science. doi: 10.1016/j.anireprosci.2024.107594 (**TN, NE**)

Kaps, M., L K. Quail, S. L. Rosasco, A. P. Snider, **S. M. Zoca**, K. M. Epperson, J. J.J. Rich, J. R. Miles, M. S. Crouse, B. N. Keel, A. F. Summers, **G. A. Perry**, C. A. Lents, **and R. A. Cushman**. 2024. Delayed endometrial preparation for the induction of luteolysis as a potential factor for improved reproductive performance in Angus beef heifers with high antral follicle counts. Biology of Reproduction. doi: 10.1093/biolre/ioae146 (**TN, TX, NE**)

Kaps, M., A. P. Snider, L K. Quail, J. R. Miles, **G. A. Perry**, and **R. A. Cushman**. 2024. Transcriptomic analysis of luteal tissue supports the earlier onset of luteolysis in heifers with diminished ovarian reserve. Repro Fertil Dev. doi: 10.1071/RD24130 (**TX, NE**)

Kline, A. C., **S. Menegatti Zoca**, K. M. Epperson, L. K. Quail, J. N. Ketchum, T. N. Andrews, J. J. J. Rich, J. R. Rhoades, J. A. Walker, and **G. A. Perry**. 2024. Evaluation of pregnancy associated glycoproteins assays for on farm determination of pregnancy status in beef cattle. PLOS ONE. Jul 25;19(7):e0306325. doi: 10.1371/journal.pone.0306325. eCollection 2024. (**TN, TX**)

Palcheff LJ, VanWye GM, Ricardo KR, Green K, Even F, Roberts S, Lonas A, Spinka CM, Poock SE, **Zoca S**, Drum J, and **Thomas JM**. Tandem administration of prostaglandin F2 α and gonadotropin-releasing hormone in beef heifers and cows as a convergent presynchronization method in the 7 & 7 Synch protocol. Animals. 2025;15(9):1329. https://doi.org/10.3390/ani15091329 (**TN, MO**)

Arneson, A. G., J. W. Stewart, M. H. Byrd, **G. A. Perry**, and **M. L. Rhodes**. 2024. Plasma γ-Aminobutyric Acid (GABA) Concentrations in Lactating Holstein Cows during Thermoneutral and Heat Stress Conditions and Their Relationships with Circulating Glucose, Insulin and Progesterone Levels. Veterinary Sciences. Mar 21;11(3):137. doi: 10.3390/vetsci11030137. (**TX, VA**)

Cushman, R. A., V. Akbarinejad, **G. A. Perry**, and C. A. Lents. 2024. Developmental programming of the ovarian reserve in livestock. Animal Reproduction Science. 265:107458. https://doi.org/10.1016/j.anireprosci.2024.107458 (**NE, TX**)

OTHER PUBLICATION AND OUTREACH EFFORTS: The members of the NC1201 published over 80 documents in the last year, either in popular press, extension publications, or peer review abstracts. The most relevant are shared below. Other efforts include digital outreach, such as webinars and podcasts and conference proceedings.

Hauxwell, K.M., **R.A. Cushman**, J.S. Caton, W.J.S. Diniz, B.N. Keel, A.K. Ward, A.K. Lindholm-Perry, A.P. Snider, H.C. Freetly, **C.R. Dahlen**, S. Amat, B.W. Neville, J.F. Thorson, W.T. Oliver, J.R. Miles, and M.S. Crouse. 2024. Altering methyl donors to beef heifers during the periconceptual period impacts fetal muscle transcript abundance. J. Anim. Sci. 102 (Suppl 3):205-206. https://doi.org/10.1093/jas/skae234.240. (**ND, NE**)

Crouse, M.S., **R.A. Cushman**, C.A. Redifer, B.W. Neville, A.K. Ward, **C.R. Dahlen**, K.M. Hauxwell, W.J.S. Diniz, and J.S. Caton. 2024. One-carbon metabolism in beef cattle throughout the production cycle. 2024 International Symposium on Ruminant Physiology. Invited Abstract. (**NE, ND**)

Kathlyn M. Hauxwell. K.M., **R.A. Cushman**, J.S. Caton, W.J.S. Diniz, A.K. Ward, A.K. Lindholm-Perry, A.P. Snider, H.C. Freetly, **C.R. Dahlen**, S. Amat, B.W. Neville, J.F. Thorson, W.T. Oliver, J.R. Miles, and M.S. Crouse. 2024. Methionine and guanidinoacetic acid supplementation of beef heifers during the periconceptual period impacts fetal hepatic transcriptome. 2024 International Symposium on Ruminant Physiology Abstract. (**NE, ND**)

Allen Schwartz, Brandon Fraser, Danielle Stock, Jordana Zimmermann, Eduarda Bortoluzzi, Adam Bassett, **Saulo Zoca**, **Nicholas Dias**, Jason Warner. Effects of dietary inclusion of omega-3 fatty acid-based supplement on biological parameters and sperm motility and morphology of developing beef bulls. 2025. J. Anim. Sci. (**TN, KS**)

Allen Schwartz, Danielle Stock, Sydney Tastad, **Saulo Zoca**, Sandy Johnson, **Nicholas W. Dias**. Evaluating the relationship between anogenital distance, reproductive tract score, and fertility to timed-artificial insemination in commercial *Bos taurus* beef heifers. 2025. J. Anim. Sci. (**TN, KS**)

Allen Schwartz, Danielle Stock, Sydney Tastad, Trinity Vidlund, Lucas M. Goncalves, Alvaro F. F. Sales, Renato C. Furquim, Paulo H. Yamada, Vitor R. G. Mercadante, **Pedro L. P. Fontes**, Sandy Johnson, **Nicholas W. Dias**. Evaluating the relationship between anogenital distance and fertility in beef females. 2025. J. Anim. Sci. (**GA, KS**)

Sydney Tastad, Danielle Stock, Allen Schwartz, Jack Lemmon, Joao V. C. Silva, Santiago P. Hurtado, Andreia F. Machado, **Victor E. Gomez-Leon**, John R. Jaeger, Nicola Oosthuizen, K.C. Olson, **Felipe Silva**, Sandy Johnson, **Nicholas W. Dias**. Effects of an acclimation protocol during the handling events of the 7 d CO-synch + CIDR protocol on temperament and reproductive performance of *Bos taurus* beef heifers. 2025. J. Anim. Sci. (**NC, KS**)

Wiltbank MC, Andrade JP, **Gomez-Leon VE*****, Garcia-Guerra A, Monteiro PLJ, Domingues RR, **Fricke PM**, Sartori R. The dichotomy between pregnancy survival and loss: Challenging

"post" -conceived notions. Oral presentation. June 16-June 19, 2024. Proceedings from American Dairy Science Association annual meeting West Palm Beach, FL, Abstract 1619 (**KS, NE**)

Christenson, D., **J. Thomas**, D. Kelly, J. Maddux and **R. Funston**. 2024 Multi-sire artificial insemination of beef heifers effect on pregnancy rate compared to single-sire insemination. J. *Anim. Sci.102:3:499-500* (e-Suppl.). (**MO, NE**)

A. M. Aizpuru, T. N. Andrews, C. D. Bedke, J. A. Cooper, K. J. Richardson, R. L. Dunlap, S. H. Cox, **R. A. Cushman**, A. P. Snider, **P. L. P. Fontes**, M. S. Smith, E. Mesen, A. F. Summers, and E. J. Scholljegerdes. 2025. Influence of source and level of ruminal undegradable protein on antral follicle count and circulating concentrations of urea, glucose, and insulin in beef heifers grazing native rangelands. 2025. J. Anim. Sci. (Accepted) (**NE, GA**)

A.R. Henington, T.N. Andrews, C.D. Bedke, J.A. Cooper, K.J. Richardson, **R.A. Cushman**, A.P. Snider, **P.L.P. Fontes**, M.S. Smith , A.F. Summers, and E.J. Scholljegerdes. 2025. Effects of source and level of ruminal undegradable protein on serum glucose, insulin, and urea nitrogen in developing beef heifers fed in a dry-lot. J. Anim. Sci. (Accepted). (**NE, GA**)

FUNDING

Collaborative Funding:
Fontes, P. L. P. and G. A. Perry. USDA – AFRI 2021-2026 $650,000. Paternal origins of offspring fetal and postnatal development **(GA, TX)**

Perry, G. A. and P. L. P. Fontes. USDA – AFRI 2022-2027 $650,000. Unraveling the benefits of omega-6 fatty acids to pregnancy establishment and maintenance in beef females **(GA, TX)**

McLean, K. J., A. P. Snider, and C. R. Dahlen. Value = $299,884.00. The effects of nutritional plane in bulls on female response to seminal plasma, spermatozoa, or the entire ejaculate. Grant to USDA-NIFAAFRI. 2022 **(TN, ND)**

Wiltbank M. C. and V. E. Gomez-Leon. USDA – AFRI 2021-2025 $649,966. Role of LH/FSH pulses and transcriptomics for a new model of follicle selection in cattle **(KS, WI)**

Other Funding:
Other reported funding within this group that was acquired on a more individual basis but will still be utilized to progress the objectives of the group is over $39 million.