

## Multistate Research Activity Accomplishments Report

Project Number: NC-1201

Project Title: Methods to Increase Reproductive Efficiency in Cattle

Period Covered: July 25, 2020 to July 20, 2021

Date of This Report: September 20, 2021

Annual Meeting Dates: July 21 and 23, 2021 (meeting was held virtually)

Meeting Participants: Cushman, Bob ([bob.cushman@usda.gov](mailto:bob.cushman@usda.gov)) - USDA Meat Animal Research Center; Fontes, Padro ([pedrofontes@uga.edu](mailto:pedrofontes@uga.edu)) - University of Georgia; Fricke, Paul ([pmfricke@wisc.edu](mailto:pmfricke@wisc.edu)) - University of Wisconsin; Larson, Jamie ([JLarson@ads.msstate.edu](mailto:JLarson@ads.msstate.edu)) - Mississippi State University; McLean, Kyle ([kmclea10@utk.edu](mailto:kmclea10@utk.edu)) - University of Tennessee; Mercadante, Vitor ([vrgm@vt.edu](mailto:vrgm@vt.edu)) - Virginia Tech; Perry, George ([george.perry@ag.tamu.edu](mailto:george.perry@ag.tamu.edu)) - Texas A&M University; Richard Pursley ([pursleyr@msu.edu](mailto:pursleyr@msu.edu)) - Michigan State University; Rhodes, Shelly ([rhodesm@vt.edu](mailto:rhodesm@vt.edu)) - Virginia Tech; Smith, George ([smithge7@msu.edu](mailto:smithge7@msu.edu)) - Administrative Advisor; Stevenson, Jeff ([jss@k-state.edu](mailto:jss@k-state.edu)) - Kansas State University; Summers, Adam ([asummers@nmsu.edu](mailto:asummers@nmsu.edu)) - New Mexico State University; Lima, Fabio ([Falima@ucdavis.edu](mailto:Falima@ucdavis.edu)) - UC Davis; Rosasco, Shelby ([srosasco@wyo.edu](mailto:srosasco@wyo.edu)) - University of Wyoming; Thomas, Jordan ([ThomasJor@missouri.edu](mailto:ThomasJor@missouri.edu)) - University of Missouri; Funston, Rick ([rfunston2@unl.edu](mailto:rfunston2@unl.edu)) - University of Nebraska; Christensen, Dempster - University of Nebraska.

### Brief summary of minutes of annual meeting:

Due to the issues with COVID-19 and limited travel authorization by some institutions the annual meeting was held on July 21<sup>st</sup> and 23<sup>rd</sup>, 2021 virtually. The meeting was called to order over Zoom by Adam Summers. The meeting began with everyone discussing how their respective university was handling COVID-19 and what impact it was having on research and extension. Additionally, updates to university facilities or positions at different institutions was discussed. Members Bob Cushman (USMARC), Padro Fontes (UG), Paul Fricke (WI), Jamie Larson (UM), Kyle McLean (UT), Vitor Mercadante (VA), George Perry (TX), Richard Pursley (MI), Shelly Rhodes (VA), George Smith (Administrative Advisor), Jeff Stevenson (KS), Adam Summers (NM), Fabio Lima (CA), Shelby Rosasco (WY), Jordan Thomas (MO), and Rick Funston (NE) were in attendance. Dempster Christensen (NE) research technician at the University of Nebraska, working with Rick Funston, was also in attendance. Kyle McLean was nominated and elected secretary. The group had a discussion on timing and venue for next year's meeting. We discussed the hopes of changing the venue next year and several different times were suggested. The group discussed and agreed to have the annual meeting next year in Starkville, MS at Mississippi State University, with Jaime Larson hosting. The meeting will be held on July 12<sup>th</sup> and 13<sup>th</sup>. George Smith gave an administrative update. The meeting on July 23<sup>rd</sup> focused on discussing the project renewal due later in the year. Groups were formed and discussion for objectives and goals initiated. Members were encouraged to join subcommittees for beef or dairy, based on research focus and objectives

to help with the re-write process. Next year's officers at the annual meeting of the NC-1201 multistate research project will be Pedro Fontes (Chairperson) and Kyle McLean (Secretary).

### **Accomplishments (research; objectives 1 and 2):**

Short Term Outcomes of Research from NC-1201 participants:

#### Dairy cattle

- Replacing GnRH with hCG at G1 of a DO protocol decreased fertility to TAI but did not affect the rate or completeness of luteolysis despite the ~2 h longer interval from treatment to ovulation. (Wisconsin)
- We do not recommend replacing G1 with hCG as a practical means to increase fertility to TAI in lactating Holstein cows. (Wisconsin)
- Although SC cows had greater circulating PGFM concentrations 15 to 90 min after treatment than IM cows, the decrease in circulating P4 concentrations during induced luteolysis did not differ based on route of dinoprost tromethamine administration. (Wisconsin)
- The effects of GnRH 7 days before PG+G presynchronization lead to positive and negative tendencies, respectively, in multiparous and primiparous cows for P/AI at day 67 post-AI and needs further investigation. (California)
- The use of GnRH at estrus detection to improve ovulatory response, progesterone one-week post-AI, and P/AI. More research is needed to investigate the relationship between GnRH at the time of AI and activity level in herds using AAM. (California)
- Gaining a greater understanding of how and why pregnancy losses occur in lactating dairy cows can translate into significant changes in reproductive management strategies for lactating dairy cows that can increase dairy farm profit. (Michigan)

#### Beef cattle

- Results of this experiment indicate that delaying the injection of PGF and TAI in the 14-day CIDR-PG protocol had no effect on PR/AI in beef heifers. (Georgia and Texas A&M)
- These results suggest that the ovarian follicular reserve, AFC, and potential fertility of cows may not be impacted by exposure to prenatal transportation stress. (Texas A&M)
- Using a blood pregnancy test prior to d 50 post-partum would increase the likelihood of false positive readings due to residual PAG concentrations from the previous pregnancy. (Texas A & M)
- Trace mineral source had no impact on heifer ADG, AI or overall pregnancy rates. (Nebraska)
- Altering the period of MGA feeding from 14 to 18 d did not improve estrous response, AI pregnancy rate, or final pregnancy rate in the present study. (Nebraska)
- Interactions observed suggest 7 & 7 Synch is most advantageous among cows that are likely to be cyclic rather than anestrous at treatment initiation, as would be hypothesized based on the PG-dependent presynchronization strategy employed. (Missouri)
- Vaginitis caused by the intravaginal progestin device (CIDR) changes vaginal pH. In addition, there is indication of an optimal vaginal pH range at the day of insemination for maximum pregnancy results. (Virginia)

- We determined that pregnant cows had decreased blood perfusion of the ovary during the 21 days post-AI compared to non-pregnant cows that did not receive AI. This did not support our hypothesis and we plan to continue this evaluation to determine when and why blood perfusion of the ovary changes as a result of pregnancy. (Mississippi)

**Outputs:** This group combined for 170 publications including 55 journal articles, and 5 book chapters. Of the journal articles published, 18 are collaborative projects from at least 2 institutions represented in NC1201. Additionally, several papers are from institutions with multiple investigators that are member of this group. Most of the non-journal articles focused on extending research findings to stakeholders through the U.S. and the world and contain numerous collaborations among the group that should progress to peer-reviewed publication status.

**Activities:**

- The Missouri Show-Me-Select™ Replacement Heifer Program continues to provide an educational conduit for beef producers and allied industry in Missouri, resulting in the enhanced adoption of reproductive and genetic/genomic technologies across the state.
- The FB Miller Internship at the University of Missouri was successful in training students in reproductive management by providing the knowledge, tools, and competency for them to become future leaders in the genetic improvement of beef and dairy herds.
- The University of Missouri dual DVM-MS program provided further training and expertise in the area of beef cattle reproduction to veterinary students that intended to offer specialized reproductive services as part of a food animal practice.

**Milestones:** This group of reproductive biologists and reproductive management specialists have now become the leaders in the creation of new knowledge relating to the manipulation of ovarian development to enhance fertility and reproductive management of cattle and the translation of that information to key stakeholders in the U.S. This is evident in the combination of the numbers of publications, presentations, and grants funded in this report. While the overarching goal of multistate research is collaboration across stations, projects conducted independently at various stations also contribute collectively to the body of knowledge driving development of new reproductive management programs applied within beef and dairy industries.

**Impacts:**

Key grants funded during the reporting period:

<b>Years of funding</b>	<b>Value</b>	<b>Funding Agency</b>	<b>States Included</b>
2021	\$500,000	USDA-AFRI	TX
2018-2021	\$150,000	USDA-AFRI	TX
2019-2022	\$500,000	USDA-AFRI	TX
2021	\$500,000	USDA-AFRI	TX

### **Accomplishments (long term industry impacts and communication of results; Objective 3)**

**Activities:** This group combined for more than 70 presentations of those data at either industry or academia events during the reporting period. The audiences included academicians, veterinarians, farm consultants and of course producers and their management teams. Additionally, three member of this group (V. Mercadante, Virginia Tech; A. Summers, New Mexico State; G. Perry, Texas A&M) serve as members of the Beef Reproduction Task Force. This 9 member group serves to promote and disseminate information to beef cattle producers, academics, and veterinarians to improve cattle reproduction. Along with a yearling meeting, monthly webinars and sponsoring a session at the Cattlemen's College at the National Cattlemen's Beef Association Annual Convention allowed members of this group to share new findings and technologies with interested audiences from around the world.

#### **Milestones:**

- University of Missouri web platforms have 2,845 followers (Mizzou Repro Facebook Page) and 1,000 subscribers with over 112,000 total views (Mizzou Repro YouTube Channel) which provides producers with pertinent information regarding reproductive management in their operations.
- Members of the Beef Reproduction Task Force participated in a virtual Applied Reproductive Strategies in Beef Cattle meeting in November 2020. This meeting had 2,107 total registrations from around the world. Recordings for this meeting have over 6,000 views online. Additionally, monthly webinars by this group have reached over 5,500 viewers.

#### **Indicators:**

- Dairy cow milk production per cow continues to increase across the United States. Efforts of NC-1201 participants efforts, for example in the state of Michigan, has led to the greatest average milk production per cow ever recorded in the United States at 26,340 lbs. per year in one state.
- Reproductive efficiencies have a much greater impact on average milk production per cow than any other management area. Fertility programs developed by members increased the percent of cows that became pregnant at the ideal time in lactation so low or no milk production in late gestation was minimized.

#### **Publications:**

##### *Refereed Journal Articles*

1. **Fontes P. L. P.**, N. Oosthuizen, F. M. Ciriaco, C. D. Sanford, L.B. Canal, K. G. Pohler, D. D. Henry, **V. R. G. Mercadante**, A. D. Ealy, S. E. Johnson, N. DiLorenzo, and **G. C. Lamb**. 2021. Effects of nutrient restriction on the metabolic profile of Bos indicus-influenced and B. taurus suckled beef cows. *Animal*. 15:100166. doi:10.1016/j.animal.2020.100166. **(Georgia, Virginia Tech and Texas A&M)**

2. N. Oosthuizen, G. D. Melo, G. E. Seidel, R. L. Stewart, L. Rowden, **G. C. Lamb, P. L. P. Fontes**. 2021. Effects of prolonging the interval from progestin removal to prostaglandin F2 $\alpha$  injection from 16 to 17 days in a long-term estrus synchronization protocol in beef heifers. *Translational Animal Science*. txab062. doi:10.1093/tas/txab062 (**Texas A&M and Georgia**)
3. Sanford C. D., M. P. T. Owen, N. Oosthuizen, **P. L. P. Fontes**, K. A. Vonnahme, M. Nelson, A. Reyaz, C. O. Lemley, N. DiLorenzo, **G. C. Lamb**. 2021. Effects of administering exogenous bovine somatotropin to beef heifers during the first trimester on conceptus development as well as steroid- and eicosanoid-metabolizing enzymes. *J. Anim. Sci.* 99: skab050. doi:10.1093/jas/skab050 (**Georgia and Texas A&M**)
4. N. Oosthuizen, **P. L. P. Fontes**, R. V. Oliveira Filho, C. R. Dahlen, D. M. Grieger, J. B. Hall, S. Lake, C. R. Looney, **V. R. G. Mercadante**, B.W. Neville, **G. A. Perry**, J. G. Powell, L. D. Prezotto, G. E. Seidel, R. S. Walker, R. C. Cardoso, K. G. Pohler, and **G. C. Lamb**. 2020. Presynchronization and delayed fixed-time artificial insemination increases pregnancy rates with sex-sorted semen in replacement beef heifers. *Anim. Reprod. Sci.* 226:106699. doi:10.1016/j.anireprosci.2021.106699. (**Georgia, Virginia Tech and Texas A&M**)
5. L. B. Canal, **P. L. P. Fontes**, C. D. Sanford, **V. R. G. Mercadante**, N. DiLorenzo, **G. C. Lamb**, and N. Oosthuizen. 2020. Relationships between feed efficiency and puberty in *Bos taurus* and *Bos indicus*-influenced replacement beef heifers. *J. Anim. Sci.* 98: 1-9. doi:10.1093/jas/skaa319. (**Georgia, Virginia Tech and Texas A&M**)
6. D. D. Henry, F. M. Ciriaco, R. C. Araujo, **P. L. P. Fontes**, N. Oosthuizen, M. E. Garcia-Ascolani, L. Rostoll-Cangiano, T. M. Schulmeister, J. C. B. Dubeux Jr., (**Georgia, Virginia Tech and Texas A&M**), and N. DiLorenzo. 2020. Effects of bismuth subsalicylate and encapsulated calcium-ammonium nitrate on ruminal fermentation of beef cattle. *J. Anim. Sci.* 98: 1-13. doi 10.1093/jas/skaa199. (**Georgia and Texas A&M**)
7. N. Oosthuizen, **P. L. P. Fontes**, K. Porter, **G. C. Lamb**. 2020. Presynchronization with prostaglandin F2 $\alpha$  and prolonged exposure to exogenous progesterone impacts estrus expression and fertility in beef heifers. *Theriogenology*. 146: 88-93. doi:10.1016/j.theriogenology.2020.02.010. (**Georgia and Texas A&M**)
8. Cabrera, E. M., M. R. Lauber, T. Valdes, M. S. El Azzi, J. P. N. Martins, T. R. Bilby, and **P. M. Fricke**. 2021. Replacing the first gonadotropin-releasing hormone treatment of an Ovsynch protocol with human chorionic gonadotropin decreased pregnancies per AI in lactating dairy cows. *J. Dairy Sci.* 104:8290–8300. (**Wisconsin**)
9. Lauber, M. R., B. McMullen, J. J. Parrish, and **P. M. Fricke**. 2020. Hot topic: Short Communication: Effect of timing of induction of ovulation relative to timed artificial insemination using sexed semen on pregnancy outcomes in primiparous Holstein cows. *J. Dairy Sci.* 103:10856-10861. (**Wisconsin**)
10. Ricci, A., M. Li, **P. M. Fricke**, and V. E. Cabrera. 2020. Short Communication: Economic impact among 7 reproductive programs for lactating dairy cows including a sensitivity analysis of the cost of hormonal treatments. *J. Dairy Sci.* 103:5654-5661. (**Wisconsin**)
11. Moriel, P., E. Palmer, M. Vedovatto, M. B. Piccolo, J. Ranches, H. M. Silva, **V. R. G. Mercadante**, **G. C. Lamb**, and J. M. B. Vendramini. 2020. Supplementation frequency and amount modulate postweaning growth and reproductive performance of *Bos indicus*-

- influenced beef heifers. *J. Anim. Sci.* 98(8):1-11 doi: [org/10.1093/jas/skaa236](https://doi.org/10.1093/jas/skaa236). (**Virginia Tech and Texas A&M**)
12. **McLean, M. K.**, T.W. Geary, A.L. Zezeski, M.F. Smith, T.E. Spencer, K.G. Pohler, S.T. Reese, and **G.A. Perry**. 2021. Effect of preovulatory estradiol on subsequent luteal progesterone secretion in beef cows. *Systems Biology in Reproductive Medicine* Submitted. (**Tennessee and Texas A&M**)
  13. Northrop, E. J. J. J. J. Rich, **R. A. Cushman**, R. Yao, X. Ge, and **G. A. Perry**. 2021. Influence of estradiol on bovine trophoblast and uterine gene transcripts around maternal recognition of pregnancy. *Biology of Reproduction* DOI: 10.1093/biolre/iaob091 (**USMARC and Texas A&M**)
  14. **Perry, G. A.**, S.D. Perkins, E.J. Northrop, J.J.J. Rich, K.M. Epperson, T.N. Andrews, A. C. Kline, L. K. Quail, J. A. Walker, C. L. Wright, and J. R. Russell. 2021. Impact of trace mineral source on beef replacement heifer growth, reproductive development, and biomarkers of maternal recognition of pregnancy and embryo survival. *Journal of Animal Science*. 99(7):1-8. DOI: 10.1093/jas/skab160 (**Texas A&M**)
  15. Afedi, P. A., E. L. Larimore, **R. A. Cushman**, D. E. Raynie, and **G. A. Perry**. 2021. iTRAQ-Based proteomic dataset for bovine pre-ovulatory plasma and follicular fluid containing high and low estradiol. *Data in Brief* 36:106998 DOI: 10.1016/j.dib.2021.106998 (**USMARC and Texas A&M**)
  16. Afedi, P. A., E. L. Larimore, **R. A. Cushman**, D. E. Raynie, and **G. A. Perry**. 2021. iTRAQ-Based proteomic analysis of bovine pre-ovulatory plasma and follicular fluid. *Domestic Animal Endo.* 76: 106606 DOI: 10.1016/j.domaniend.2021.106606 (**USMARC and Texas A&M**)
  17. Epperson, K. M., J. J. J. Rich, S. Menegatti Zoca, S. D. Perkins, E. J. Northrop, R. F. Daly, J. A. Walker, J. R. Rhoades, and **G. A. Perry**. 2021. Influence of BVDV infection on AI conception and breeding season pregnancy success in vaccinated beef herds. *Bovine Practitioners* 54:120-125. (**Texas A&M**)
  18. Cernia, L. A., **G. A. Perry**, M. F. Smith, J. J. Rich, E. J. Northrop, S. D. Perkins, J. A. Green, A. L. Zezeski, T. W. Geary. 2021. Effect of estradiol preceding and progesterone subsequent to ovulation on proportion of 1 postpartum beef cows pregnant. *Anim Reprod* 227: 106723 DOI: 10.1016/j.anireprosci.2021.106723 (**Texas A&M**)
  19. Kelly, A.K., C. Byrne, M. McGee, **G.A. Perry**, M.A. Crowe, H. Sauerwein and D.A. Kenny. 2020. Effect of calfhood nutrition on metabolic hormones, gonadotropins and estradiol concentrations, and on reproductive organ development in beef heifer calves. *J Animal Sci* 98 (10): skaa310, <https://doi.org/10.1093/jas/skaa310> (**Texas A&M**)
  20. Epperson, K. M., J. J. J. Rich, S. Menegatti Zoca, S. D. Perkins, E. J. Northrop, R. F. Daly, J. A. Walker, J. R. Rhoades, and **G. A. Perry**. 2020. Effect of progesterone supplementation in a resynchronization protocol on follicular dynamics and pregnancy success. *Theriogenology* 157:121-129 (**Texas A&M**)
  21. Brandão, A.P. **R. F. Cooke**, K. M. Schubach, B. Rett, O. A. Souza, C. L. Schachtschneider, **G. A. Perry**, S. A. Arispe, D. B. Jump. K.G. Pohler, D. W. Bohnert, and R. S. Marques. 2020. Supplementing Ca salts of soybean oil to late-gestating beef cows: Impacts on performance and physiological responses of the offspring. *J anim Sci* 98(8): <https://doi.org/10.1093/jas/skaa247>. (**Texas A&M**)

22. King, T.M. J.A. Musgrave, **R.N. Funston**, J.T. Mulliniks. 2020. Impact of cow milk production on cow-calf performance in the Nebraska Sandhills. *Transl. Anim. Sci.* 2020.4:S145–S148 doi: 10.1093/tas/txaa123 (**Nebraska**)
23. Ziegler, R.L., J.A. Musgrave, **R.N. Funston**, K.J. Hanford, J.T. Mulliniks. 2020. The impact of cow size on cow-calf performance and post-weaning progeny performance in the Nebraska Sandhills. *Transl. Anim. Sci.* 2020.4:1-11doi: 10.1093/tas/txaa194. (**Nebraska**)
24. Webb, M.J., J. J. Block, A.A. Harty, R.R. Salverson, R.F. Daly, J.R. Jaeger, K.R. Underwood, **R.N. Funston**, D.P. Pendell, C.A. Rotz, K.C. Olson, and A.D. Blair. 2020. Cattle and carcass performance, and life cycle assessment of production systems utilizing additive combinations of growth promotant technologies. *Transl. Anim. Sci.* 2020.4:1-15doi: 10.1093/tas/txaa216 (**Nebraska**)
25. Springman, S.A., M.E. Drewnoski, and **R.N. Funston**. 2020. Effects of hydroxyl trace mineral supplementation on gain and reproductive performance in beef heifers. *Lvstk. Sci.* 245 (2021) 104425. (**Nebraska**)
26. Ketchum JN, Bonacker RC, Andersen CM, Smith EG, Stoecklein KS, Spinka CM, and **Thomas JM**. Evaluation of later timepoints for split-time artificial insemination when using sex-sorted semen among beef heifers following the 14-d CIDR®-PG protocol. *Animal Reproduction Science* 2021;224:106649. <https://doi.org/10.1016/j.anireprosci.2020.106649>. (**Nebraska**)
27. Bonacker RC, Gray KR, Breiner CA, Anderson JM, Patterson DJ, Spinka CM, and **Thomas JM**. Comparison of the 7 & 7 Synch protocol and the 7-day CO-Synch + CIDR protocol among recipient beef cows in an embryo transfer program. *Theriogenology* 2020;158:490–6. <https://doi.org/10.1016/j.theriogenology.2020.09.033>. (**Missouri**)
28. Bonacker RC, Stoecklein KS, Locke JWC, Ketchum JN, Knickmeyer ER, Spinka CM, and **Thomas JM**. Treatment with prostaglandin F2 $\alpha$  and an intravaginal progesterone insert promotes follicular maturity in advance of gonadotropin-releasing hormone among postpartum beef cows. *Theriogenology* 2020;157:350–9. <https://doi.org/10.1016/j.theriogenology.2020.08.018>. (**Missouri**)
29. Timlin, C.L., A. Lynn, L. K. Wooldridge, K. Uh, A. D. Ealy, R. R. White, K. Lee, **V. R. G. Mercadante**. 2021. Physical parameters of bovine activated oocytes and zygotes as predictors of development success. *Zygote*. Accepted Jan 2021. (**Virginia Tech**)
30. Carrell, R.C., W.B. Smith, L.A. Kinman, **V.R.G. Mercadante**, N.W. Dias, D.A. Roper. 2021. Cattle stress and pregnancy responses when imposing different restraint methods for conducting fixed time artificial insemination. *Anim. Repro. Science.* 225:106672. ISSN 0378-4320. (**Virginia Tech**)
31. Stewart, J.L., S. Stella, L.L. Cunha, N.W. Dias, I.F. Canisso, **V.R.G. Mercadante**, R.C. Cardoso, G.L. Williams, K.G. Pohler, **F.S. Lima**. 2020. Administration of nerve growth factor- $\beta$  to heifers with a preovulatory follicle enhanced luteal formation and function and promoted LH release. *Theriogenology*. Volume 148. ISSN 0093-691X. (**Virginia Tech and California**)
32. Moriel, P., E. Palmer, M. Vedovatto, M.B. Piccolo, J. Ranches, H.M. Silva, **V.R.G. Mercadante**, **G.C. Lamb**, J.M.B. Vendramini. 2020. Supplementation frequency and amount modulate postweaning growth and reproductive performance of *Bos indicus*-influenced beef heifers. *J. of Anim. Sci.* Volume 98, Issue 8, 10.1093:236. (**Virginia Tech and Texas A&M**)

33. S. Pancini, **R. F. Cooke**, A. P. Brandão, N. W. Dias, C. Timlin, **P. L. P. Fontes**, A. Sales, J. Wicks, A. Murray, and **V. R. G. Mercadante**. 2020. Supplementing a yeast-derived product to feedlot cattle: Impacts on performance, physiological responses, and carcass characteristics. *Livestock Science* 232 (2020) 103907. (**Texas A&M, Georgia, and Virginia Tech**)
34. **Rhoads ML**. Effects of periconceptional heat stress on primiparous and multiparous daughters of Holstein dairy cows. *Theriogenology*. 2020 Mar 1 (**Virginia Tech**)
35. Oliveira EB, FC Ferreira, VY Jaesung, I Tagkopoulos, KN Galvão, N Silva-del-Rio, RVV Pereira, VS Machado, **FS Lima**. 2021. Integration of statistical inferences and machine learning algorithms improves prediction for metritis cure in dairy cows. *J Dairy Sci*. In review (**California**)
36. Hubner A, IF Canisso, PGM Peixoto, AJ Conley, **FS Lima**. 2021. Effect of GnRH administered at the time of AI for cows detected in estrus by conventional estrus detection or an automated activity monitoring system. *J Dairy Sci*. In Review (**California**)
37. Silva-Del Rio N, A Valdecabres, A Espadamala, P Pallares, A Lago RV Pereira, **FS Lima**. 2021. Treatment practices after calving-related disorders in 45 dairy farms in California. *J. Dairy Sci*. Accepted (**California**)
38. Bisinotto RS, ES Ribeiro, LF Greco, D Taylor-Rodriguez, H Ayres, **FS Lima**, N Martinez-Patino, WW Thatcher, JEP Santos. 2021. Effects of progesterone concentrations and follicular wave during growth of the ovulatory follicle on conceptus and endometrial transcriptome in dairy cows. *J. Dairy Sci*. Accepted (**California**)
39. Ferraz PA, CAS Godoy Filho, CC Rocha, AL Neto, GA Bruni, TSI Oshiro, PS Baruselli, **FS Lima**, G Pugliesi. 2021. Feasibility and accuracy of using different methods to detect pregnancy by conceptus-stimulated genes in dairy cattle. *JDS Communications*. 2:153-158. (**California**)
40. Figueiredo C, VR Merenda, EB Oliveira, **FS Lima**, RC Chebel, KN Galvao, JE Santos, RS Bisinotto. 2021. Failure of clinical cure in dairy cows treated for metritis is associated with reduced productive and reproductive performance. *J Dairy Sci*. 104:7056-7070. (**California**)
41. Perez J, T Silva, CA Risco, RC Chebel, F Cunha, A DeVries, JEP Santos, **FS Lima**, P Pinedo, Schuenemann G, Bicalho RC, Gilbert RO, Rodriguez-Zas S, Seabury C, Rosa G, Thatcher WW, Galvao KN. 2021. The economic cost of metritis. 2020. *J. Dairy Sci*. Accepted (**California**)
42. Silva T, EB Oliveira, J Perez, RC Risco, RC Chebel, F Cunha, R Daetz, JEP Santos, **FS Lima**, KC Jeong, KN Galvao. 2021. Economic comparison between ceftiofur-treated and non-treated dairy cows with metritis. *J Dairy Sci*. 104:8918-8930 (**California**)
43. Peixoto PMG, AM Hubner, LL Cunha, WC Meireles Filho, KG Pohler, NW Dias, **VRG Mercadante**, IF Canisso, **FS Lima**. 2021. Characterization of pregnancy-associated glycoproteins and progesterone as predictors of twins and conceptus loss in high-risk pregnancy Holstein cows. *J. Dairy Sci*. 104:5034-5046 (**Virginia Tech and California**)
44. **Lima FS**, Stewart JS, Canisso IF. 2020. Insights into Nerve Growth Factor- $\beta$  role in bovine reproduction – Review. *Theriogenology* doi.org/10.1016/j.theriogenology.2020.01.076. (**California**)



45. **Lima FS**, FT Silvestre, FN Penagaricano, WW Thatcher. 2020. Early genomic prediction of daughter pregnancy rate is associated with improved fertility outcomes in Holstein dairy cows. *J Dairy Sci* <https://doi.org/10.3168/jds.2019-17488> (**California**)
46. Stewart JL, S Stella, L Cunha, **VRG Mercadante**, NW Dias, R Cardoso, G Williams, K Pohler, IF Canisso, **FS Lima**. 2020. Administration of nerve growth factor- $\beta$  to heifers with a pre-ovulatory follicle enhanced luteal formation and function and promoted LH release. *Theriogenology* 148:37-47. (**Virginia Tech and California**)
47. Hubner AM, PMG Peixoto, LL Cunha, WC Meireles Filho, J Hillehiem, IF Canisso, **FS Lima**. 2020. Effect of GnRH seven days before pre-synchronization with simultaneous PGF2 $\alpha$  and GnRH on reproductive outcomes in Holstein dairy cows. *Frontiers Vet. Sci.* 7:574516. doi: 10.3389/fvets.2020.574516. (**California**)
48. **Lima FS**. 2020. Recent advances and future directions for uterine diseases diagnosis, pathogenesis, and management in dairy cows. *An Reprod.* 17(3):e20200063. <https://doi.org/10.1590/1984-3143-AR2020-0063> (**California**)
49. Machado VS, Celestino ML, Oliveira EB, **Lima FS**, Ballou MA, Galvão KN. 2020. The association of cow related factors assessed at metritis diagnosis with metritis cure risk, fertility, milk yield, and culling for untreated and ceftiofur-treated dairy cows. *J Dairy Sci.* 103:9261-9276. (**California**)
50. T. Minela, A. Santos, E. J. Schuurmans, E. L. Middleton, and **J. R. Pursley**. 2021. The effect of a double dose of cloprostenol sodium on luteal blood flow and pregnancy rates per AI in lactating dairy cows. *J. Dairy Sci.* Accepted June 30, 2021. (**Michigan State**)
51. Martins, J. P. N., M. J. T. Acevedo, C. Piterini, T. O. Cunha and **J. R. Pursley**. 2021. Effect of PGF2 $\alpha$  treatments during early corpus luteum development on circulating concentrations of progesterone and ovulation in breeding age Holstein heifers. *Theriogenology.* Jun 5;173:12-18. doi: 10.1016/j.theriogenology.2021.06.002. (**Michigan State**)
52. Minela, T, and **J. R. Pursley**. 2021. Effect of cloprostenol sodium dose on luteal blood flow and volume measurements in Holstein heifers that had both early- and mid-cycle corpora lutea. *J. Dairy Sci.* Aug;104(8):9327-9339. doi: 10.3168/jds.2020-19933. Epub 2021 May 21. (**Michigan State**)
53. **Pursley, J. R.** and E. L. Middleton. 2020. Getting Your Herd into a High Fertility Cycle. Dairy Cattle Reproduction Council Conference. Electronic proceedings P. 75. <https://www.dcrcouncil.org/wp-content/uploads/2020/11/2020-DCRC-Annual-Meeting-Proceedings.pdf>. (**Michigan State**)
54. **Fricke, Paul M.**, Milo C. Wiltbank, and **J. Richard Pursley**. 2020. The high fertility cycle. American Association of Bovine Practitioners Annual Meeting. Proceedings. Vol. 53 No. 2 P. 85-88. (**Wisconsin and Michigan State**)
55. Dysart, L. M., R. D. Messman, A. A. Crouse, C. O. Lemley, and **J. E. Larson**. 2020. Effects of administration of exogenous estradiol benzoate on follicular, luteal, and uterine hemodynamics in beef cows. *Anim. Reprod. Sci.* (under first revision: ANIREP-D-21-00012). (**Mississippi State**)

### *Abstracts*

1. D. B. Davis, Z. K. Seekford, M. J. Dickson, L. Goncalves, S. Burato, M. P. Holton, J. Gordon, K. G. Pohler, J. J. Bromfield, G. C. Lamb, R. L. Stewart, Jr., G.C. Lamb, M.

- Ferrer, and P. L. P. Fontes. 2021. Effects of paternal high energy diet on blastocyst development during in vitro embryo production in the bovine. *J. Anim. Sci.* (In press)
2. M. P. Holton, N. Oosthuizen, G. D. de Melo, D.B. Davis, R. L. Stewart, Jr., K. G. Pohler, G.C. Lamb and P. L. P. Fontes. 2021. Color Doppler ultrasonography for early pregnancy diagnosis in postpartum *Bos taurus* beef cows. *J. Anim. Sci.* (In press)
  3. M. P. Holton, N. Oosthuizen, G. D. de Melo, D.B. Davis, R. L. Stewart, Jr., K. G. Pohler, G.C. Lamb and P. L. P. Fontes. 2021. Pregnancy associated glycoproteins for pregnancy diagnosis on day 25 of gestation. *J. Anim. Sci.* (In press)
  4. D. B. Davis, A. L. Jones, S. R. Hernandez, C. B. Welsh, J. J. Tucker, P. L. P. Fontes, M. P. Holton, R. L. Stewart. 2021. The Effects of Whole Cottonseed Supplementation on Performance, Breeding Soundness Exams, and Manganese Superoxide Dismutase Concentrations in the Blood and Semen of Beef Bulls. *J. Anim. Sci.* (In press).
  5. V. R. G. Mercadante, G. C. Lamb, N. Oosthuizen, N. W. Dias, S. Pancini, H. Haines, J. Currin, S. Clark, J. L. Stewart, G. J. Pent, M. P. Holton, D. D. Davis, S. R. Hernandez, R. L. Stewart, P. L. P. Fontes. 2021. Estrus Response and Pregnancy Rates of Beef Replacement Heifers Enrolled in Two Fixed-time Artificial Insemination Protocols, with or Without Pre-synchronization. *J. Anim. Sci.* (In press).
  6. C. M. Andersen, M. P. Holton, J. M. Thomas, L. Goncalves, S. Burato. 2021. Evaluation of the 7 & 7 Synch and Bee Synch II protocols for control of the estrous cycle among cows of varying percentage *Bos indicus* influence. *J. Anim. Sci.* (In press).
  7. N. Oosthuizen, G. Melo, L. Stewart, G. Seidel, G. C. Lamb, P. L. P. Fontes. 2020. Effects of delayed injection of prostaglandin F<sub>2</sub> $\alpha$  and TAI in the 14-d CIDR-PG & TAI protocol in replacement beef heifers, *J. Anim. Sci.* Volume 98, Suppl. 4, 375–376.
  8. N. Oosthuizen, P. L. P. Fontes, G. C. Lamb. 2020. Presynchronization with prostaglandin F<sub>2</sub> $\alpha$  and prolonged exposure to exogenous progesterone impacts estrus expression and alters fertility in beef heifers. *J. Anim. Sci.* Volume 98. Suppl. 2 : 19–20. doi:10.1093/jas/skz397.043.
  9. N. Oosthuizen, P. L. P. Fontes, R. O. Filho, C. R. Dahlen, D. M. Grieger, J. B. Hall, S. Lake, C. Looney, V. R. G. Mercadante, B. W. Neville, G. A. Perry, J. G. Powell, L. Prezotto, G. Seidel, R. Walker, R. C. Cardoso, K. G. Pohler, G. C. Lamb. 2020. Presynchronization and delayed fixed-time artificial insemination increases pregnancy rates with sex-sorted semen in replacement beef heifers. *J. Anim. Sci.* Volume 98, Suppl. 4 : 115–116. doi :10.1093/jas/skaa278.211.
  10. Fricke, P. M. and M. C. Wiltbank. 2021. The implications of spontaneous versus synchronized ovulations on the reproductive performance of high-producing dairy cows. *J. Dairy Sci* 104(Suppl 1):363.
  11. Lauber, M. R., E. M. Cabrera, J. J. Parrish, and P. M. Fricke. 2021. Pregnancy outcomes of nulliparous Holstein heifers inseminated with sexed semen after submission to 5-d or 6-d CIDR protocols and timed AI or once-daily detection of estrus and AI after treatment with prostaglandin F<sub>2</sub> $\alpha$ . *J. Dairy Sci.* 104(Suppl 1):95.
  12. Lauber, M. R., V. E. Cabrera, and P. M. Fricke. 2021. An economic analysis of three strategies for reproductive management of nulliparous Holstein heifers inseminated using sexed semen. *J. Dairy Sci.* 104(Suppl 1):140.
  13. Lauber, M. R., M. S. Akins, P. D. Carvalho, and P. M. Fricke. 2021. Weight at calving relative to mature body weight rather than age at first calving affects milk production in primiparous Holstein cows. *J. Dairy Sci.* 104(Suppl 1):270.

14. Ketchum, J. N., G. A. Perry, K. M. Epperson, L. K. Quail, M. A. Ogg, A. L. Zezeski, J. J. Rich, S. Menegatti Zoca, A. C. Kline, T. N. Andrews, M. S. Ortega, M.F. Smith, T. W. Geary. 2021. Increased Preovulatory Estradiol Improves Pregnancy Success of Embryo Transfer in Beef Cows. American Society of Animal Science
15. Guy, C.P., L. Wesolowski, D. Law, D. Neuendorff, C. R. Long, G. Perry, R. D. Randel, T. H. Welsh, Jr., and S.H. White-Springer. 2021. Skeletal muscle mitochondrial capacities are impacted by breed and temperament in young Angus and Brahman steers. American Society of Animal Science
16. Tolleson, D. R., R. D. Randel, G. A. Perry, J. M. Diaz, H. D. Starns, C. W. Knight, N. E. Garza, S. L. Beall, D. A. Neuendorff, and T. H. Welsh, Jr. 2021. Nutritional monitoring of prenatally stressed and translocated Brahman heifers. American Society of Animal Science
17. Walker, J.A., J. J. J. Rich, W. C. Rusche, and G. A. Perry. 2021. Influence of reproductive technologies on post weaning calf performance and carcass characteristics. American Society of Animal Science
18. Walker, J.A., J. J. J. Rich, and G. A. Perry. 2021. Effect of Estrous Synchronization with Natural Service or Fixed-Timed Artificial Insemination with Conventional or Gender-Skewed Semen in Beef Females. American Society of Animal Science
19. Snider, A.P, M. S. Crouse, S.L. Rosasco, K. M. Epperson, E. J. Northrop-Albrecht, J. J. J. Rich, C. C. Chase Jr., J. R. Miles, G. A. Perry, A. F. Summers, R.A. Cushman. 2021. Beef heifers with increased number of follicles have greater uterine luminal glucose concentrations. American Society of Animal Science
20. Cushman, R.A., S.L. Rosasco, K.M. Epperson, E.J. Northrop-Albrecht, J.J. J. Rich, C.C. Chase Jr., M.S. Crouse, J.R. Miles, G.A. Perry, A.F. Summers, A.P. Snider. 2021. Uterine function during maternal recognition of pregnancy differs due to size of the ovarian reserve in beef heifers. American Society of Animal Science
21. Oliveira Filho, R., R. Paiva, G. Dalmaso, G.A. Perry, R. Cardoso, C.Lamb, K. Pohler. 2021. Ovarian dynamics of Brahman cows submitted to five-day or twelve-day progesterone-based estrus synchronization protocol. American Society of Animal Science
22. Menegatti Zoca, S., J.A. Walker, T.N. Andrews, A.C. Kline, J.J.J. Rich, K.M. Epperson, J. N. Drum, M. S. Ortega, G. A. Perry. 2021. Relationship Between Sire Conception Rate, Sperm Motility, Sperm SERPINA5 relative concentration, and in vitro Produced Embryos in Dairy Bulls. American Society of Animal Science
23. Quail, L.K., R.D. Randel, T.H. Welsh, Jr., R.A. d'Orey Branco, D.A. Neuendor , R.A. Cushman, H.K. Yake, G.A. Perry. 2021. Prenatal transportation stress does not impact ovarian follicle count in Brahman offspring. American Society of Animal Science
24. Kline, A.C., J.A. Walker, T.N. Andrews, S. Menegatti Zoca, K.M. Epperson, L.K. Quail, J.J.J. Rich, J.R. Rhoades, G.A. Perry. 2021. Factors Influencing Clearance of Pregnancy-Associated Glycoproteins in Postpartum Beef Cattle. American Society of Animal Science
25. Epperson, K.E., J.J.J. Rich, A.L. Zezeski, S. Menegatti Zoca, J.A. Walker, T.W. Geary, and G.A. Perry. 2021. Effect of Pre and Post-AI Nutrition on Ovarian Dynamics, Steroidogenesis, and Estrus Expression in Beef Heifers. American Society of Animal Science
26. Rich, J.J.J., E.J. Northrop, K.M. Epperson, S. Menegatti Zoca, S.D. Perkins, R.F. Daly, R.A. Cushman, G.A. Perry. 2021. Relationship among granulosa cell GnRH-I, GnRHII, and GnRH-R mRNA abundance and follicular fluid steroid hormone concentrations of

bovine antral follicles at specific stages of follicular development. American Society of Animal Science

27. Andrews, T.N., J.A. Walker, K.M. Epperson, J.J.J. Rich, S. Menegatti Zoca, A.C. Kline, L.K. Quail, S.R. McCoski, C. Sanford, A.L. Zezeski, T.W. Geary, and G.A. Perry. 2021. The interactions of change in nutrition after AI on plasma metabolites, steroid hormones, and uterine histotroph in beef heifers. American Society of Animal Science
28. Menegatti Zoca, S., X Ge, S. Perkins, R. Cushman, T. McDanel, B. Keel, and G. Perry. 2020. Comparison of microRNA between ejaculated and epididymal semen. Applied Animal Andrology
29. King, T.M. J.A. Musgrave, R.N. Funston, J.T. Mulliniks. 2020. Impact of cow milk production on cow-calf performance in the Nebraska Sandhills. <https://doi.org/10.1093/jas/skaa278.352>
30. Ziegler, R.L., J.A. Musgrave, R.N. Funston, K.J. Hanford, J.T. Mulliniks. 2020. The impact of cow size on cow-calf performance and post-weaning progeny performance in the Nebraska Sandhills. <https://doi.org/10.1093/jas/skaa278.370>.
31. Smith EG, Spinka CM, and Thomas JM. Incidence and implications of disparate uterine and ovarian development observed among heifers evaluated during the peripubertal period. American Society of Animal Sciences. 2021.
32. Andersen CM Holton MP, Goncalves L, Burato S, Fontes P, and Thomas JM. 2021. Evaluation of the 7 & 7 Synch and Bee Synch II protocols for control of the estrous cycle among cows of varying percentage *Bos indicus* influence. American Society of Animal Sciences. 2021.
33. Andersen CM, Bonacker RC, Smith EG, Spinka CM, Poock SE, Thomas JM. Evaluation of the 7 & 7 Synch and 7-day CO-Synch + CIDR ® protocols for estrus synchronization of beef cows prior to fixed-time artificial insemination with conventional or sex-sorted semen. Society for the Study of Reproduction. 2020.
34. Ketchum JN, Bonacker RC, Andersen CM, Smith EG, Stoecklein KS, Spinka CM, and Thomas JM. Should heifers receive timed AI later if using sex-sorted semen? Society for the Study of Reproduction. 2020.
35. Mercadante, V.R.G., N.W. Dias, S. Pancini, N. Oosthuizen, P. L. Fontes, G. C. Lamb. 2021. Estrus response and pregnancy rates of beef replacement heifers enrolled in two fixed-time artificial insemination protocols, with or without pre-synchronization. ASAS Annual Meeting Proceedings.
36. Dias, N.W., H. Haines, S. Pancini, Mercadante, V.R.G. 2021. The effects of vaginal pH on fertility of cows and heifers enrolled in the 7-d CO-Synch + controlled internal drug release (CIDR) protocol. ASAS Annual Meeting Proceedings.
37. H. Haines, N.W. Dias, S. Pancini, J. Stewart, S. Clark, C. Leeth, J. Lysiak, V.R.G. Mercadante. 2021. Estimation of phosphatidylserine positive sperm in fresh bull semen. ASAS Annual Meeting Proceedings.
38. A. G. Arneson, J. W. Stewart, M. K. Harrod, H. M. Newberne, M. K. Burgess, J. A. Jordan, R. R. White, A. D. Ealy, S. W. El-Kadi, R. P. Rhoads, and M. L. Rhoads. 2021. Impact of heat stress and glycemic state on plasma  $\gamma$ -aminobutyric acid (GABA) in lactating Holstein cows. *J. Dairy Sci.* Vol. 104, Suppl. 1. 173.
39. J. W. Stewart, H. M. Newberne, M. K. Harrod, A. G. Arneson, V. M. Negron-Perez, R. R. White, S. W. El-Kadi, A. D. Ealy, R. P. Rhoads, and M. L. Rhoads. 2021. Heat stress and

- glycemic state alter milk production and composition in Holstein dairy cows. *J. Dairy Sci.* Vol. 104, Suppl. 1. 173.
40. Mercadante, V.R.G., N.W. Dias, C.L. Timlin, S. Pancini. 2020. Economic Consequences of Pregnancy Loss in Beef Cattle. *Journal of Animal Science*, Volume 98, Issue Supplement\_4, November 2020, Page 124.
  41. Pancini, S., J.F. Currin, J.L. Stewart, S. Clark, T. Redifer, N.W. Dias, C.L. Timlin, A. Sales, V.R.G. Mercadante. 2020. Effect of injectable trace mineral supplementation on beef cows fertility and overall mineral status, *Journal of Animal Science*, Volume 98, Issue Supplement\_2, November 2020, Page 45.
  42. Dias, N.W., C.L. Timlin, S. Pancini, Z. Seekford, J. Gómez, V.R.G. Mercadante. 2020. Vaginal pH changes due to the use of a controlled internal drug release (CIDR) and its effects on fertility of beef cows. *Journal of Animal Science*, Volume 98, Issue Supplement\_4, November 2020, Pages 25–26.
  43. Timlin, C.L., A. Lynn, L.K. Wooldridge, K. Uh, A.D. Ealy, R.R. White, K. Lee, V.R.G. Mercadante. 2020. Using physical parameters of bovine zygotes to predict in vitro development success. International Embryo Technology Society. Annual Meeting Proceedings.
  44. Timlin, C.L., T. Parrish, N.W. Dias, F.V. Santili, S. Pancini, V.R.G. Mercadante. 2020. Uterine gene expression of beef cows in response to supplementation with calcium salts of soybean oil. ASASSouthern Section. Annual Meeting Proceedings.
  45. Stewart J, Newberne H, Arneson A, Harrod M, Negron-Perez V, Haines H, Jordan J, White R, Ealy A, El-Kadi S, Rhoads R and Rhoads M. Glucose infusion during heat stress restores normoglycemia but does not improve milk production. 2020. *J. Dairy Sci.* Vol. 103, Suppl. 1. 148.

### *Popular Press Articles*

1. Thomas JM. Busyness as Usual. *Drovers*. June 2021. Available at: <https://www.drovers.com/opinion/thomas-busyness-usual>
2. Thomas JM. Sweet Corn and Steer Calves: Part III. *Joplin Regional Stockyards Cattlemen’s News*. July 2021. Available at: [https://www.joplinstockyards.com/cattlemens\\_archive.php](https://www.joplinstockyards.com/cattlemens_archive.php)
3. Thomas JM. Sweet Corn and Steer Calves: Part II. *Joplin Regional Stockyards Cattlemen’s News*. June 2021. Available at: [https://www.joplinstockyards.com/cattlemens\\_archive.php](https://www.joplinstockyards.com/cattlemens_archive.php)
4. Thomas JM. Sweet Corn and Steer Calves. *Joplin Regional Stockyards Cattlemen’s News*. May 2021. Available at: [https://www.joplinstockyards.com/cattlemens\\_archive.php](https://www.joplinstockyards.com/cattlemens_archive.php)
5. Thomas JM. Should You “Hate” Your Cows? Flexible Stocking Rates (Cover Story). *Progressive Cattle*. April 2021. Available at: <https://www.progressivecattle.com/topics/grazing/should-you-hate-your-cows-flexiblestocking-rates> Thomas JM. Don’t Try to Pick Out the Good Ones. *Joplin Regional Stockyards Cattlemen’s News*. April 2021. Available at: [https://www.joplinstockyards.com/cattlemens\\_archive.php](https://www.joplinstockyards.com/cattlemens_archive.php)
6. Thomas JM. Rational Ranching: Make the Time to “Think Slow.” *BEEF Magazine*. March 2021. Available at: <https://www.beefmagazine.com/beef/rational-ranching-make-timethink-slow>

7. Thomas JM. Breeding Season Swing... and a Miss? Joplin Regional Stockyards Cattlemen's News. March 2021. Available at: [https://www.joplinstockyards.com/cattlemens\\_archive.php](https://www.joplinstockyards.com/cattlemens_archive.php)
8. Thomas JM. Short-Term Focus and Long-Term Problems. Progressive Cattle. March 2021. Available at: <https://www.progressivecattle.com/topics/reproduction/short-term-focusand-long-term-problems>
9. Shipman, M. Keep or Cull? Keeping That Cow Could Be Costing You. Missouri Beef Cattleman February 2021.
10. New Protocol Option: 7 & 7 Synch. Leachman 2021 Herd Sire Directory. Available at: [https://issuu.com/leachman/docs/2021\\_herd\\_sire\\_directory\\_final\\_for\\_web](https://issuu.com/leachman/docs/2021_herd_sire_directory_final_for_web)
11. 7 & 7 Synch: An Estrus Synchronization Protocol for Postpartum Beef Cows. Select Sires Spring 2021 Beef Directory. Available at: [https://issuu.com/selectsiresbeef/docs/2021springsiredirectory\\_webfinal](https://issuu.com/selectsiresbeef/docs/2021springsiredirectory_webfinal)
12. 7 & 7 Synch: An Estrus Synchronization Protocol for Postpartum Beef Cows. ABS Global 2021 Beef Sire Directory. Available at: [https://issuu.com/absglobalinc/docs/2021\\_beef\\_sd](https://issuu.com/absglobalinc/docs/2021_beef_sd)
13. 7 & 7 Synch: An Estrus Synchronization Protocol for Postpartum Beef Cows. Select Sires Fall 2020 Beef Directory. Available at: [https://issuu.com/selectsiresbeef/docs/2020falldirectory\\_web](https://issuu.com/selectsiresbeef/docs/2020falldirectory_web)
14. 7 & 7 Synch: An Estrus Synchronization Protocol for Postpartum Beef Cows. Beef 360 2021 Genetics Guide. Available at: <https://issuu.com/livestockdirect/docs/f49c94af>
15. Estrus Synchronization Protocols for Mature Cows and Heifers. Select Sires Fall 2020 Beef Directory. Available at: [https://issuu.com/selectsiresbeef/docs/2020falldirectory\\_web](https://issuu.com/selectsiresbeef/docs/2020falldirectory_web)
16. Thomas JM. To do or "To Don't." Joplin Regional Stockyards Cattlemen's News. February 2021. Available at: [https://www.joplinstockyards.com/cattlemens\\_archive.php](https://www.joplinstockyards.com/cattlemens_archive.php)
17. Thomas JM. Cut Seasons Short for More Profit. Joplin Regional Stockyards Cattlemen's News. February 2021. Available at: [https://www.joplinstockyards.com/cattlemens\\_archive.php](https://www.joplinstockyards.com/cattlemens_archive.php)
18. VanWye GM and Thomas JM. Cow Depreciation: The "Silent Killer" of Cow-Calf Profitability. Joplin Regional Stockyards Cattlemen's News. February 2021. Available at: [https://www.joplinstockyards.com/cattlemens\\_archive.php](https://www.joplinstockyards.com/cattlemens_archive.php)
19. Red Angus Association of America Commercial Marketing Team. White Paper: Why all the Fat Bulls? 2020. Available at: [https://redangus.org/wp-content/uploads/2020/11/WhitePaper---Why-All-the-Fat-Bulls\\_2020\\_web.pdf](https://redangus.org/wp-content/uploads/2020/11/WhitePaper---Why-All-the-Fat-Bulls_2020_web.pdf)
20. Thomas JM. Buy Quality, Buy Once. Buy Cheap, Buy Twice. Joplin Regional Stockyards Cattlemen's News. January 2021. Available at: [https://www.joplinstockyards.com/cattlemens\\_archive.php](https://www.joplinstockyards.com/cattlemens_archive.php)
21. Thomas JM. Practical Tips for Moving Pairs During the Calving Season. Stockman Grass Farmer. November 2020. Derksen B. Exploring the possibilities of cattle handling and facilities. Progressive Cattle. November 25, 2020. Available at: <https://www.progressivecattle.com/topics/facilitiesequipment/exploring-the-possibilities-of-cattle-handling-and-facilities>
22. Thomas JM. How Many of the Calves Were Born by When? Joplin Regional Stockyards Cattlemen's News. November 2020. Available at: [https://www.joplinstockyards.com/cattlemens\\_archive.php](https://www.joplinstockyards.com/cattlemens_archive.php)

23. Thomas-Smith, H. Heifer Fertility Research Lays Groundwork for DNA Genetic Test. Red Angus Magazine. October 2020. Available at: [https://issuu.com/redangusassociation/docs/201382\\_red\\_angus\\_oct20\\_complete\\_lr/40](https://issuu.com/redangusassociation/docs/201382_red_angus_oct20_complete_lr/40)
24. VanWye GM and Thomas JM. Breeding Soundness Exams: Every Bull, Every Breeding Season. Joplin Regional Stockyards Cattlemen's News. October 2020. Available at: [https://www.joplinstockyards.com/cattlemens\\_archive.php](https://www.joplinstockyards.com/cattlemens_archive.php)
25. Thomas-Smith, H. New Research Creates DNA tests for Heifer Fertility. BEEF Magazine. October 2020. Available at: <https://www.beefmagazine.com/beef/new-research-createsdna-tests-heifer-fertility>
26. Thomas JM and Andersen CM. Selecting Replacement Heifers: What Are the Criteria? (Cover Story). Progressive Cattle. September, 2020. Available at: <https://www.progressivecattle.com/topics/management/selecting-replacement-heiferswhat-are-the-criteria>
27. Thomas JM. Long Hay-Feeding Seasons and Long Calving Seasons: What's the Root Cause? BEEF Magazine. Published in Cow-Calf Weekly September 17, 2020 and in print January 2021. Available at: <https://www.beefmagazine.com/nutrition/long-hay-feedingseasons-and-long-calving-seasons-whats-root-cause>
28. Smith EG and Thomas JM. 'Crazy' Cows Can Affect Reproductive Performance. Progressive Cattle. September 10, 2020 Available at: <https://www.progressivecattle.com/topics/reproduction/crazy-cows-can-affectreproductive-performance>
29. Andersen CM and Thomas JM. Selection of Replacement Heifers Shouldn't Happen at Weaning. Progressive Cattle. August 25, 2020. Available at: <https://www.progressivecattle.com/topics/herd-health/selecting-replacement-heifersshouldn-t-happen-at-weaning>
30. Thomas JM. Feedback Loops and Your Cow Herd. BEEF Magazine Cow-Calf Weekly. August 13, 2020. Available at: <https://www.beefmagazine.com/cow-calf/feedback-loops-and-your-cow-herd>.
31. Mercadante, V.R.G., T.B. Wilson, S. Greiner. 2021. July Virginia Beef Herd Advisor. VA Cattlemen Association Newsletter.
32. Mercadante, V.R.G., T.B. Wilson, S. Greiner. 2021. June Virginia Beef Herd Advisor. VA Cattlemen Association Newsletter.
33. Mercadante, V.R.G., T.B. Wilson, S. Greiner. 2021. May Virginia Beef Herd Advisor. VA Cattlemen Association Newsletter.
34. Mercadante, V.R.G., T.B. Wilson, S. Greiner. 2021. April Virginia Beef Herd Advisor. VA Cattlemen Association Newsletter.
35. Mercadante, V.R.G., T.B. Wilson, S. Greiner. 2021. March Virginia Beef Herd Advisor. VA Cattlemen Association Newsletter.
36. Mercadante, V.R.G., T.B. Wilson, S. Greiner. 2021. February Virginia Beef Herd Advisor. VA Cattlemen Association Newsletter.
37. Mercadante, V.R.G., T.B. Wilson, S. Greiner. 2021. January Virginia Beef Herd Advisor. VA Cattlemen Association Newsletter.
38. Mercadante, V.R.G., T.B. Wilson, S. Greiner. 2020. December Virginia Beef Herd Advisor. VA Cattlemen Association Newsletter.
39. Mercadante, V.R.G., T.B. Wilson, S. Greiner. 2020. November Virginia Beef Herd Advisor. VA Cattlemen Association Newsletter.

40. Mercadante, V.R.G., T.B. Wilson, S. Greiner. 2020. October Virginia Beef Herd Advisor. VA Cattlemen Association Newsletter.
41. Mercadante, V.R.G., T.B. Wilson, S. Greiner. 2020. September Virginia Beef Herd Advisor. VA Cattlemen Association Newsletter.

### *Book Chapters*

1. Fricke, P. M. 2020. Chapter 15: Methods for pregnancy diagnosis. In: Dairy Cattle Fertility, W. D. Hoard and Sons Company, Fort Atkinson, WI, pp. 87-93.
2. Mercadante, V.R.G., P.L. Fontes, N. Oosthuizen, and G.C. Lamb. 2021. Selection and management of the embryo transfer recipient herd for embryo transfer. In: Richard M. Hopper, editor, Bovine reproduction, 2nd Edition. Willey Blacwell, Oxford, UK. Chapter 83. ISBN: 978-1-119-60236-1
3. Pursley, J. Richard. 2021. Reproduction Techniques. Essential Guides on Cattle Farming. Servet. Grupo Asís Biomedica, SL,50002 Zaragoza – Spain.
4. Pursley, J. Richard and Jose Cibelli. 2020. Reproductive technologies in cattle. Pages 1 – 12 in Reproductive Technologies in Animals. Giorgio A. Presicce DVM PhD, ed. Academic Press, London, UK.
5. Pursley, J. R. 2020. Fertility programs for 1st and subsequent AI. Chapter for Hoard's Dairyman magazine's Fertility of Dairy Cattle. Monograph.

### *Extension fact sheets*

1. Beard, J.K., J.A. Musgrave, K.J. Hanford, R.N. Funston, and J.T. Mulliniks. 2020. Effect of age of dam on heifer progeny performance. Nebraska Beef Cattle Report. Univ. Nebraska, Lincoln. MP 108:8-9.
2. Erickson, M.R., D. Kelly, D. O'Hare, T.L. Meyer, and R.N. Funston. 2020. Effect of GnRH injection at -72 h in MGA-PG estrus synchronization protocol. Nebraska Beef Cattle Report. Univ. Nebraska, Lincoln. MP 108:8-9.
3. Erickson, M.R., K.C. Ramsay, and R.N. Funston. 2020. Efficacy of a second injection of PG in yearling beef heifers following previous estrus synchronization. Nebraska Beef Cattle Report. Univ. Nebraska, Lincoln. MP 108:12-13.
4. Erickson, M.R., J.R. Tait, J.A. Musgrave, and R.N. Funston. 2020. Evaluation of commercial genomic tests for maternal traits in crossbred beef cattle. Nebraska Beef Cattle Report. Univ. Nebraska, Lincoln. MP 108:14-15.
5. Broadhead, D.L., K.J. Hanford, M.C. Stockton, J.A. Musgrave, and R.N. Funston. 2020. Combined analysis on the effects of late gestation supplementation in a spring calving beef herd. Nebraska Beef Cattle Report. Univ. Nebraska, Lincoln. MP 108:16-18.
6. Erickson, M.R., D.L. Broadhead, J.A. Musgrave, and R.N. Funston. 2020. Comparing March and May calving systems in the Nebraska Sandhills. Nebraska Beef Cattle Report. Univ. Nebraska, Lincoln. MP 108:19-20.
7. Ziegler, R.I., T.L. Meyer, J.A. Musgrave, J.C. MacDonald, J.T. Mulliniks, and R.N. Funston. 2020. Growth and performance of terminal sired calves grazing range or meadow pasture. Nebraska Beef Cattle Report. Univ. Nebraska, Lincoln. MP 108:27-30.



8. Decker JE and Thomas JM. Hair Shedding: A Tool to Select Heat Tolerant Cattle. University of Missouri Extension. 2021. Available at: <https://extension.missouri.edu/publications/g2014>
9. Lamberson WR and Thomas JM. Crossbreeding Systems for Small Herds of Beef Cattle. University of Missouri Extension. 2021. Available at: <https://extension.missouri.edu/publications/g2040>
10. Thomas JM and Smith EG. Managing the Effects of Stress and Temperament on Beef Cattle Reproduction. University of Missouri Extension. 2021. Available at: <https://extension.missouri.edu/publications/g2047>
11. Thomas JM and Andersen CM. Reproductive Management of Bos indicus-Influenced Beef Cattle. University of Missouri Extension. 2021. Available at: <https://extension.missouri.edu/publications/g2046> Payne C and Thomas JM. Production Records for Commercial Cow-Calf Operations. University of Missouri Extension. 2021. Available at: <https://extension.missouri.edu/publications/g2045>
12. Pooch SE, Thomas JM, and Smith EG. Herd Health and Reproductive Efficiency in Beef Cattle. University of Missouri Extension. 2021. Available at: <https://extension.missouri.edu/publications/g2044>
13. Thomas JM, Smith MF, and VanWye GM. Understanding and Minimizing Pregnancy Loss in Cattle. University of Missouri Extension. 2021. Available at: <https://extension.missouri.edu/publications/g2043>
14. Thomas JM, Pooch SE, and Smith EG. Determination of Pregnancy Status in Beef Cattle Herds. University of Missouri Extension. 2021. Available at: <https://extension.missouri.edu/publications/g2042>
15. Thomas JM. Calving Season Considerations for Commercial Beef Cattle Operations. University of Missouri Extension. 2021. Available at: <https://extension.missouri.edu/publications/g2029>
16. Thomas JM. Selection of Replacement Heifers for Commercial Beef Cattle Operations. University of Missouri Extension. 2021. Available at: <https://extension.missouri.edu/publications/g2028>
17. Thomas JM, Picking E, Ellis AM, and Smith EG. Facilities for Artificial Insemination. University of Missouri Extension. 2021. Available at: <https://extension.missouri.edu/publications/g2003>
18. Thomas JM and Andersen CM. Artificial Insemination of Cattle Step by Step. University of Missouri Extension. 2021. Available at: <https://extension.missouri.edu/publications/g2019>
19. Thomas JM and Andersen CM. Preparation and Handling of Catheters for Artificial Insemination. University of Missouri Extension. 2021. Available at: <https://extension.missouri.edu/publications/g2018>
20. Thomas JM, Andersen CM, and VanWye GM. Care and Maintenance of a Liquid Nitrogen Tank. University of Missouri Extension. 2021. Available at: <https://extension.missouri.edu/publications/g2002>
21. Thomas JM and Monnig J. Detection of Estrus in Beef Cattle. University of Missouri Extension. 2021. Available at: <https://extension.missouri.edu/publications/g2021>

22. Thomas JM and Ellis AM. Reproductive Anatomy and Physiology of the Cow. University of Missouri Extension. 2021. Available at: <https://extension.missouri.edu/publications/g2015>
23. Thomas JM, Bonacker RC, Andersen CM, Smith EG, and VanWye GM. Estrus Synchronization Recommendations for Artificial Insemination of Beef Cows. University of Missouri Extension. 2021. Available at: <https://extension.missouri.edu/publications/g2024>
24. Thomas JM, Bonacker RC, Andersen CM, Smith EG, and VanWye GM. Estrus Synchronization Recommendations for Artificial Insemination of Beef Heifers. University of Missouri Extension. 2021. Available at: <https://extension.missouri.edu/publications/g2025>
25. Thomas JM and Andersen CM. Sexed Semen for Artificial Insemination: Recommendations and AI Approaches. University of Missouri Extension. 2021. Available at: <https://extension.missouri.edu/publications/g2026>
26. Thomas JM and Smith EG. Estrus Synchronization Recommendations for Natural Service Bull Breeding. University of Missouri Extension. 2021. Available at: <https://extension.missouri.edu/publications/g2027>
27. Thomas JM, Bonacker RC, and Andersen CM. 7 & 7 Synch: An Estrus Synchronization Protocol for Postpartum Beef Cows. University of Missouri Extension. 2021. Available at: <https://extension.missouri.edu/g2023>

Authorization: