Project Number: NC-1201
Project Title: Methods to Increase Reproductive Efficiency in Cattle

Period Covered: September 30, 2017 to March 14, 2018
Date of Annual Report: April 18, 2018
Annual Meeting Dates: March 14-15, 2018 (Omaha, NE)

Participant Attendance at Annual Meeting:
Adele Turzillo – USDA-NIFA
Carl Dahlen – North Dakota State Univ.
Dave Patterson – Univ. of Missouri
George Perry – South Dakota State Univ.
George Smith – Michigan State Univ. (project administrator)
Jeff Stevenson – Kansas State Univ.
Michelle Rhoads – Virginia Tech
Paul Fricke – Univ. of Wisconsin
Richard Pursley – Michigan State Univ. (secretary)
Rick Funston – Univ. of Nebraska
Robert Cushman – US MARC
Theresa Steckler – Univ. of Illinois
Vitor Mercadante – Virginia Tech (chair)

Absent from the meeting
Cliff Lamb – Texas A&M Univ.
Jamie Larson – Mississippi State Univ.
Reinaldo Cooke – Oregon State Univ.

Minutes of Annual Meeting
Please see the attached document of Annual Meeting Minutes.

Accomplishments
Objective 1: To determine mechanisms that regulate reproductive processes impacting production efficiency in cattle.

Kansas
- Feeding a ***Saccharomyces cerevisiae*** fermentation product known to increase immune function failed to influence cycling status of postpartum dairy cows and alter follicular fluid or serum concentrations of NEFA, BHB, or glucose.
- Feeding increasing doses of a rumen protected glucose product failed to increase concentrations of plasma glucose and serum insulin and did not affect progesterone concentrations on d 2 through 11 of a synchronized estrous cycle.

Michigan
- Fertility programs decrease double ovulation rate, pregnancy loss, and subsequent twinning in lactating dairy cows. Decreasing pregnancy loss reduces variation in herd calving interval.

Decreasing twinning increases milk production per cow and decreases involuntary culling and death.

Missouri

- Endocrine parameters, ovarian dynamics, and pregnancy rates to timed artificial insemination were evaluated following the 9-day CIDR-PG protocol in comparison to the 7-d CO-Synch + CIDR protocol in postpartum beef cows.
    a) Response following the 9-d CIDR-PG protocol differed ($P < 0.05$) from the 7-d CO-Synch + CIDR protocol with respect to mean interval from PG to estrus onset (71.2 ± 1.3 h versus 56.5 ± 1.6 h), variance in interval to estrus, ovulatory follicle size at AI (13.7 ± 0.2 mm versus 14.6 ± 0.2), and serum estradiol concentrations at AI (6.9 ± 0.3 pg/mL versus 6.0 ± 0.3 pg/mL).
    b) Similar pregnancy rates to AI were obtained among cows following the 7-d CO-Synch + CIDR (66%; 163/247) and 9-d CIDR-PG (70%; 163/233) treatments.
    c) The 9-day CIDR-PG protocol is an effective protocol for synchronization of estrus among mature beef cows.
- The Show-Me-Select^{TM} Replacement Heifer Program was designed to improve reproductive efficiency of beef herds in Missouri and increase individual farm income. Development and implementation of this program created an educational conduit for beef producers and allied industry in Missouri and enhanced the adoption of reproductive and genetic/genomic technologies across the state. The Missouri Show-Me-Select™ Replacement Heifer Program is the first statewide on-farm beef heifer development and marketing program of its kind in the U.S. To date 136,606 heifers were enrolled in the program from 857 farms in Missouri, while the marketing arm of the program reports sales of 34,239 heifers into 20 states nationwide with gross receipts of $50,051,200. Impact on Missouri's economy from the past 20 years of the Show-Me-Select™ program exceeds $150M.
- The reproductive management internship at MU is supported by the F. B. Miller Fund and co-sponsored by Select Sires, Inc. Specific objectives of the F. B. Miller Internship in Reproductive Management are to: 1) provide students with practical training in the development and execution of estrous synchronization and AI programs; and 2) provide extensive hands-on experience in estrous synchronization, estrus detection, semen handling, and AI. During the past 20 years, 226 students participated in the internship and have gained hands-on experience in reproductive management procedures. These students have been involved with breeding programs involving over 270,000 heifers and cows on farms and ranches in twelve states. Participation in the internship by these students has fostered a greater appreciation of beef cattle reproductive management, created links for students with allied industries, and expanded career opportunities following graduation.
- The University of Missouri dual DVM-MS program provides further training and expertise in the area of beef cattle reproduction to veterinary students that intend to enter a food animal practice. Students that have been or that are currently enrolled in the dual DVM-MS program gain extensive experience in an array of reproductive procedures, and in addition develop a sound appreciation and working understanding of the scientific method.

Mississippi

- We determined that supplementing progesterone via a CIDR device at the time of transfer for 12 days did not improve pregnancy rates in recipients of in vitro, frozen-thawed embryos.

North Dakota

- A method to monitor consumption of mineral supplement of cows grazing pastures was successfully tested.
- Reproductive behavior of beef heifers resulted in changes in eating patterns.

Nebraska

- Establishing synchronization and artificial insemination systems that require less labor will increase the adoption of such technologies. Incorporating an orally active progestin for synchronization decreases animal handling and this research has demonstrated similar pregnancy rates with no estrus detection.
- Administration of a second PGF injection to yearling beef heifers that didn't respond to an MGA-PG protocol did not improve pregnancy rates.

South Dakota

- Gender-skewed semen can successfully be used in fixed-time AI protocols among animals that exhibit estrus, but caution should be used among animals that do not exhibit estrus.

Texas

- Embryo breed is likely responsible for the previously observed differences in concentrations of PAG between *Bos indicus* and *Bos taurus* cattle. Differences in circulating PAG depend on the antibody used in the assay, indicating that the profile of PAG production differs between subspecies. These difference, however, may reflect an impact on embryo/fetal health and may be used as measures to determine embryo survival.

USDA-ARS USMARC

- We will be able to apply ultrasonography at weaning to determine the number of follicles in the ovaries of heifers, allowing plenty of time for making replacement decisions.
- Fewer preantral follicles in the ovaries of heifers born to heifers suggest that replacement heifers should be selected from those born to mature cows when possible.

Virginia

- We have indicated that there seems to be a role for propionate, volatile fatty acid supply and subsequent metabolism on increased magnitude of progesterone production following ovulation in dairy heifers.
- We determined that early weaning of beef heifers can have long-term effects on physiology. Some of these changes have implications for lifetime productivity and may be beneficial in some production systems.
- We investigated the effects of steroid content of follicle fluid on the cumulus-oocyte complex. Cumulus cell expansion and gene expression differed with estradiol and progesterone concentrations, but in vitro embryo development to the blastocyst stage did not.

Wisconsin

- Submission of lactating dairy cows to an Ovsynch protocol that included a second PGF treatment to induce complete luteal regression in a low P4 environment increased the

incidence of double ovulation at AI, twin pregnancies, PSPB concentrations, and relative expression of ISG15 at 18 and 20 d after TAI.

Objective 2: To increase the efficiency and predictability of sustainable reproductive management programs for cattle.

Kansas

- When corpus luteum status was accurately detected by progesterone concentration at a nonpregnant diagnosis, a short timed AI protocol (PGF2α-24 h-PGF2α-32 h-GnRH2-16 h-AI) produced pregnancy per AI similar to a standard Ovsynch program (GnRH-7 d-PGF2α-24 h- PGF2α-32 h-GnRH-16 h-AI).

Michigan

- Continued development of fertility programs for dairy cows increase pregnancies per AI and on-farm profit through decreased involuntary culling, increased herd level milk production, and increased calves born annually.
- Controlling calving interval with fertility programs reduces the percentage of cows with unhealthy body condition at time of parturition. Thus, fewer cows have metabolic and uterine problems following calving.

North Dakota

- Giving pregnant cows moderate amounts of an energy supplement during the second and third trimesters of pregnancy did not impact measures of reproductive potential in their male offspring.

Nebraska

- A variety of options exist for heifer development in earlier breeding seasons when nutrient quality isn't limiting. Feeding to increased target weights at breeding does not improve pregnancy rates in spring calving systems.
- Earlier birth in the calving season and greater preweaning growth are associated with desirable reproductive response in replacement beef heifers.

South Dakota

- Nutritional status before synchronization tended to impact interval to estrus and estrus expression. Both before and after AI impact early embryo development, with undernutrition negatively influencing embryo development.
- Blood pregnancy tests were able to separate AI pregnancies from natural service pregnancies when AI pregnancies were > 28 days and natural service pregnancies were < 25 days. Furthermore, these tests were sensitive at detecting differences in circulating PAGs among animals that experienced embryonic loss, but the majority of these animals would have been classified as pregnant at time of sample collection.

Texas

- Earlier administration of PGF2α altered the distribution of estrus in replacement beef heifers, resulting in an increased proportion of heifers exhibiting estrus within 60 h after CIDR

removal, thereby proving an opportunity to enhance the percentage of heifers exhibiting estrus by fixed-time AI and increasing pregnancy rates.
- Exposure of Nelore heifers to a puberty induction program before the initiation of the 5-d CO-Synch+CIDR protocol failed to induce puberty, indicating that yearling Bos indicus heifers may not respond favorably to an induction protocol before the breeding season.

USDA – ARS USMARC
- The diplotype of μ-calpain associated with increased tenderness also was associated with a later calving day in beef heifers. The easiest way to circumvent this problem would be the use of terminal sires in the beef industry.

Virginia
- We demonstrated that supplementation of calcium salts of soybean oil (CSSO) to beef cows enrolled in an estrus synchronization protocols changed fatty acid profile in blood and follicular fluid, however it did not alter diameter of ovulatory follicle, CL volume and concentration of progesterone following ovulation.
- Supplementation of CSSO post-AI improved pregnancy rates, which can be associated with increased mRNA expression of *interferon-tau* by the conceptus when CSSO is supplemented during early gestation.

Wisconsin
- Treatment of nulliparous dairy heifers with 2,000 IU hCG on d 7 of the estrous cycle increased P4 concentrations but did not affect P/AI or P/ET 32 d after estrus or ovulation but decreased pregnancy loss only for heifers receiving IVF embryos.

Impacts
- Supplemental progesterone at the time of embryo transfer of in vitro, frozenthawed embryos did not improve pregnancy rates
- Moderate energy supplementation during mid- to late-gestation did not enhance Sertoli or germ cell population in neonatal bull calves.
- Divergence in mineral intake observed with an electronic mineral feeder was corroborated by divergence in concentrations of mineral in the liver.
- Heifer feed intake was impacted by estrus, and bull presence in a pen reduced estrus-associated behavior.
- Estrus-detection patch activation at the time of final GnRH in a fixed-time embryo transfer protocols was a better indicator of potential pregnancy response compared with patch activation status at the time of embryo transfer.
- Heifers that achieved puberty before the start of breeding had greater ADG from birth to weaning but slower rates of gain from the start of breeding through pregnancy diagnosis.
- Lower input heifer development systems are successful in two breeding seasons.
- Yearling heifer pregnancy rates are decreased in later breeding seasons in the Nebraska Sandhills.
- Earlier birth in the calving season and greater preweaning growth are associated with desirable reproductive response in replacement beef heifers.
- Administration of a second PGF injection to yearling beef heifers that didn't respond to an MGA-PG protocol did not improve pregnancy rates.

- Feeding a *Saccharomyces cerevisiae* fermentation product -4 through +7 wk after calving to lactating dairy cows proposed to increase immune function failed to improve estrus-cycle activity, milk yield, or measures of metabolites associated with less negative energy balance.
- Feeding increasing doses of a rumen-protected glucose product to lactating dairy cows failed to increase glucose, insulin, milk yield, or progesterone during a synchronized estrous cycle (60 ± 3 DIM).
- When a functional corpus luteum is accurately diagnosed at a non-pregnant diagnosis of lactating dairy cows, apply a 3-day short timed AI program produced pregnancy outcomes similar to a standard 10-day Ovsynch program
- The 9-day CIDR-PG protocol is an effective protocol for synchronization of estrus among mature beef cows, and several factors associated with fertility in timed AI protocols are improved through use of the 9-day CIDR-PG compared to the 7-d CO-Synch + CIDR protocol.
- The Missouri Show-Me-Select^{TM} Replacement Heifer Program created 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 has been 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 provides further training and expertise in the area of beef cattle reproduction to veterinary students that intend to enter a food animal practice.
- An internet-accessible, standalone application was developed as an educational resource for genetic management of cattle. Selection simulations include Birth Weight, Yearling Weight, and Marbling EPD information, appropriate trait relationships, integration of genomic enhanced EPDs, and lethal recessives, as well as an additional marketing simulation in which students can sell animals as a source of revenue.
- Supplementation of CSSO post-AI improved pregnancy rates, which can be associated with increased mRNA expression of *interferon-tau* by the conceptus when CSSO is supplemented during early gestation.
- Dairy heifers have ample capacity to clear surplus propionate and that heifers infused with propionate have a tendency to reach greater maximum progesterone concentration following ovulation.
- Early weaning of beef heifers can have long-term effects on physiology. Some of these changes have implications for lifetime productivity.
- Steroid content of follicle fluid affects cumulus cell expansion and gene expression, but does not alter in vitro development of embryos to the blastocyst stage.
- Reproductive health issues increase and fertility decreases when cows have calving intervals extending >430 days. Reducing calving intervals utilizing Ovsynch technologies translate into approximately $180/cow/year.
- Nutritional status before synchronization tended it impact interval to estrus and estrus expression. Both before and after AI impact early embryo development, with undernutrition negatively influencing embryo development.
- Gender-skewed semen can successfully be used in fixed-time AI protocols among animals that exhibit estrus, but caution should be used among animals that do not exhibit estrus.

- Blood pregnancy tests were able to separate AI pregnancies from natural service pregnancies when AI pregnancies were > 28 days and natural service pregnancies were < 25 days. Furthermore, these tests were sensitive at detecting differences in circulating PAGs among animals that experienced embryonic loss, but the majority of these animals would have been classified as pregnant at time of sample collection.
- Earlier administration of PGF2α altered the distribution of estrus in replacement beef heifers, resulting in an increased proportion of heifers exhibiting estrus within 60 h after CIDR removal, thereby proving an opportunity to enhance the percentage of heifers exhibiting estrus by fixed-time AI and increasing pregnancy rates.
- Exposure of Nelore heifers to a puberty induction protocol prior to the initiation of the 5-d CO-Synch+CIDR protocol failed to induce puberty, indicating that yearling Bos indicus heifers may not respond favorably to an induction protocol prior to the breeding season.
- Embryo breed is likely responsible for the previously observed differences in concentrations of PAG between *Bos indicus* and *Bos taurus* cattle. Differences in circulating PAG depend on the antibody used in the assay, indicating that the profile of PAG production differs between subspecies. However, these difference may reflect an impact on embryo/fetal health and may be used as measures to determine embryo survival.
- Research conducted at USMARC demonstrated that the diplotype of μ-calpain associated with increased tenderness was also associated with a later calving day in beef heifers. The easiest way to circumvent this problem would be the use of terminal sires in the beef industry.
- Research conducted at USMARC demonstrated that the number of microscopic follicles in the ovaries of heifers born to heifers is less than that in heifers born to mature cows. If possible, it may be best to select replacement heifers that are born to mature cows.
- Fewer preantral follicles in the ovaries of heifers born to heifers suggest that replacement heifers should be selected from those born to mature cows when possible.
- Progesterone (P4) is the most biologically active progestogen in cattle and is primarily produced and secreted by the corpus luteum (CL) during the estrous cycle and the placenta during pregnancy. Reproduction in high producing dairy cows is impaired by inadequate progesterone concentrations due to hepatic steroid metabolism driven by high feed intake required for high milk production. Reproduction in nulliparous dairy heifers receiving an IVF embryo may also be affected by treatment with exogenous P4. Two studies were conducted to assess the effect of manipulating P4 before AI (lactating dairy cows) or after AI or IVF embryo transfer (nulliparous heifers). Submission of lactating dairy cows to an Ovsynch protocol that included a second PGF treatment to induce complete luteal regression in a low P4 environment increased the incidence of double ovulation at AI, twin pregnancies, PSPB concentrations, and relative expression of ISG15 at 18 and 20 d after TAI. Treatment of nulliparous dairy heifers with 2,000 IU hCG on d 7 of the estrous cycle increased P4 concentrations but did not affect P/AI or P/ET 32 d after estrus or ovulation but decreased pregnancy loss only for heifers receiving IVF embryos.

Publications

Book Chapters

Fricke, P. M. 2017. Reproductive programs to maximize fertility in dairy cows. In: Large Dairy Herd Management (3rd Ed.) D. K. Beede (Ed.). Elsevier Inc., Philadelphia, PA, pp. 503-519.

Giordano, J. O. and P. M. Fricke. 2017. Automated detection and prediction of estrus as a complimentary technology for reproductive management. In: Large Dairy Herd Management (3rd Ed.) D. K. Beede (Ed.). Elsevier Inc., Philadelphia, PA, pp. 1265-1277.

Peer-reviewed Journals

Morina, D. L., S. Demarais, B. K. Strickland, and J. E. Larson. 2018. While males fight, females choose: Male phenotypic quality informs female mate choice in mammals. Animal Behaviour 138:69-74.

Muth-Spurlock, A. M., J. A. Dix, M. P. T. Coleson, C. G. Hart, C. O. Lemley, T. M. Schulmeister, G. C. Lamb, and J. E. Larson. 2017. The effect of follicular wave on fertility characteristics in beef cattle. J. Anim. Sci. 95:866-874 (DOI:10.2527/jas2016.0898).

McLean, K.J., M.S. Crouse, M.R. Crosswhite, N. Negrin Pereira, C.R. Dahlen, P P. Borowicz, L.P. Reynolds, A.K. Ward, B.W. Neville, and J.S. Caton. 2017. The effects of nutrients restriction on mRNA expression of endogenous retroviruses, interferon tau, and pregnancy-specific protein-B during the establishment of pregnancy in beef heifers. J. Anim. Sci. -217-1523.R1 (Accepted)

Crouse, M.S., K.J. McLean, N.P. Greseth, M.R. Crosswhite, N. Negrin Pereira, A.K. Ward, L.P. Reynolds, C.R. Dahlen, B.W. Neville, P.P. Borowicz, and J.S. Caton. 2017. Maternal nutrition and stage of early pregnancy in beef heifers: Impacts on expression of glucose, fructose, and cationic amino acid transporters in utero-placental tissues. J. Anim. Sci. 95:5563-5572. doi.org/10.2527/jas2017.1983

Oosthuizen, N., A.C. Lansfrod, L.B. Canal, P.L.P. Fontes, C.D. Sanford, C.R. Dahlen, N. DiLorenzo, R.N. Funston, and G.C. Lamb. 2017. Comparison of two alternate PGF2α products in two estrus synchronization protocols in beef heifers. J. Anim. Sci. (E-2017-1819; Accepted)

Oosthuizen, N., L.B. Canal, P.L.P Fontes, C.D. Sanford, N. DiLorenzo, C.R. Dahlen, G.E. Seidel, and G.C. Lamb. Effects of administration of prostaglandin F2α 7 days prior to initiation of the 7-day CO-Synch + CIDR protocol in beef heifers on estrus response and pregnancy rates. J. Anim. Sci. (E-2017-1809; Accepted).

Greseth, N.P., M.S. Crouse, K.J. McLean, M.R. Crosswhite, N. Negrin Pereira, A.K. Ward, L.P. Reynolds, C. R. Dahlen, B.W. Neville, P.P. Borowicz, and J.S. Caton. 2017. The effects of maternal nutrition on the mRNA expression of neutral and acidic AA transporters in bovine uteroplacental tissues from day 16 to 50 of gestation. J. Anim. Sci. 95:4668-4676. doi.org/10.2527/jas2017.1713

Lansford, A.C., J.A. Musgrave, and R.N. Funston. 2018. Effect of supplementation during the breeding season on a May-calving herd in the Nebraska Sandhills. *Prof. Anim. Sci.* (Accepted)

Springman, S.A., H.R. Nielson, and R.N. Funston. 2018. Impact of heifer development system on subsequent growth and reproduction in two breeding seasons. *Prof. Anim. Sci.* (Accepted)

Bondurant, R.G., J.C. MacDonald, G. E. Erickson, K. Brooks, K. Bruns, and R. N. Funston. 2018. Effect of extended days on feed on carcass gain, efficiency, quality, and profitability for beef steers. *Prof. Anim. Sci.*

Roberts, A.J., da Silva, A.G., A.F. Summers, T.W. Geary, and R.N. Funston. 2017. Developmental and reproductive characteristics of beef heifers classified by pubertal status at time of first breeding. *J. Anim. Sci*. 95:5629-5636.

Rolfe, K.M., L.A. Stalker, T.J. Klopfenstein, J.A. Musgrave, and R.N. Funston. 2017. Influence of weaning date and late gestation supplementation on beef system productivity I: Animal performance. *Prof. Anim. Sci.*

Rolfe, K.M., L.A. Stalker, M.C. Stockton, T.J. Klopfenstein, and R.N. Funston. 2017. Influence of weaning date and late gestation supplementation on beef system productivity II: Economic analysis. *Prof. Anim. Sci.*.

Springman, S.A., T.L. Meyer, and R.N. Funston. 2017. Effect of postweaning heifer development system on average daily gain, pregnancy rates, and subsequent feed efficiency as a pregnant heifer. *J. Anim. Sci.* 95:5320-5326.

Britt, J. H., R. A. Cushman, C. D. Dechow, H. Dobson, P. Humblot, M. F. Hutjens, G. A. Jones, P. S. Ruegg, I. M. Sheldon, and J. S. Stevenson. 2019. Invited Review: Learning from the future: A vision for dairy farms and cows in 2067. J. Dairy Sci.101.

Hill, S. L., K. C. Olson, J. R. Jaeger, and J. S. Stevenson. 2018. Serum and plasma metabolites associated with postpartum ovulation and pregnancy risks in suckled beef cows subjected to artificial insemination. J. Anim. Sci. 96: Accepted.

Voelz, B. E., F. Scortegagna, L. Rocha, J. S. Stevenson, and L. G. D. Mendonça. 2018. Response of lactating dairy cows with or without purulent vaginal discharge to gonadotropin-releasing hormone and prostaglandin F2α. J. Anim. Sci. 96: Accepted.

Sauls, J. A., B. E. Voelz, L. G. D. Mendonça, and J. S. Stevenson. 2018. Additional small dose of prostaglandin F2α at timed AI fails to improve pregnancy risk of lactating dairy cows. Theriogenology 110:27-33.

Voelz, B., C. E. Payne, L. Hulbert, J. S. Stevenson, M. Brouk, and L. G. D. Mendonça. 2017. Kansas dairy producers' needs survey: Reproductive management of Kansas dairy farms. J. Extension 55(4): https://www.joe.org/joe/2017august/rb6.php

Thomas, JM, JWC Locke, BE Bishop, JM Abel, MR Ellersieck, SE Poock, MF Smith, and DJ Patterson. 2017. The 9-d CIDR-PG protocol II: Characterization of endocrine parameters, ovarian dynamics, and pregnancy rates to fixed-time AI following use of long-term CIDR-based estrus synchronization among mature beef cows. Theriogenology. In press.

Bishop, BE, JM Thomas, JM Abel, SE Poock, MR Ellersieck, MF Smith, and DJ Patterson. 2017. Split-time artificial insemination in beef cattle: III. Comparing fixed-time artificial insemination to split-time artificial insemination with delayed GnRH administration in postpartum cows. Theriogenology. 99: 48-52.

Thomas, JM, JWC Locke, R Vishwanath, JB Hall, MR Ellersieck, MF Smith and DJ Patterson. 2017. Effective use of SexedULTRA™ sex-sorted semen for timed artificial insemination of beef heifers. Theriogenology. 98: 88-93.

Thomas, JM, JWC Locke, BE Bishop, JM Abel, MR Ellersieck, JV Yelich, SE Poock, MF Smith, and DJ Patterson. 2017. Evaluation of the 14-d CIDR-PG and 9-d CIDR-PG protocols for synchronization of estrus in *Bos indicus*-influenced and *Bos taurus* beef heifers. Theriogenology. Volume 92, Number 1: 190-196.

Bishop, BE, JM Thomas, JM Abel, SE Poock, MR Ellersieck, MF Smith, and DJ Patterson. 2017. Split-time artificial insemination in beef cattle. II. Comparing pregnancy rates among non-estrous heifers based on administration of GnRH at AI. Theriogenology. Volume 87, Number 1: 229-234.

Abel, JM, BE Bishop, JM Thomas, MR Ellersieck, SE Poock, MF Smith, and DJ Patterson. 2017. Comparing strategies to synchronize estrus and ovulation prior to fixed-time artificial

insemination in primiparous two-year-old beef cows. Theriogenology. Volume 87, Number 1: 306-315.

Stewart, J.L., V.R.G. Mercadante, Dias, N.W., Canisso, I.F., Yau, P., Imai, B., Lima, F.S. 2018. Nerve Growth Factor-Beta, purified from bull seminal plasma, enhances corpus luteum formation and conceptus development in *Bos taurus* cows. Theriogenology. 106: 30-38.

Zezeski, A.L., V.L. McCracken, R.K. Poole, A. Al Naib, J.K. Smith, M.A. McCann and M.L. Rhoads. 2017. Metabolic and reproductive characteristics of replacement beef heifers subjected to an early-weaning regimen involving high-concentrate feeding. Animal 11(5):820-825. doi: 10.1017/S1751731116002123.

Lugar, D.W., M.L. Rhoads, S.G. Clark-Deener, S.R. Callahan, A.K. Revercomb, K.J. Prusa and M.J. Estienne. 2017. Immunological castration temporarily reduces testis size and function without long-term effects on libido and sperm quality in boars. Animal 11(4):643-649. doi: 10.1017/S1751731116002081.

Martins, J.P.N., D. Wang, N. Mu, G. F. Rossi, A. P. Martini, V. R. Martins, and J. R. Pursley. 2018. Level of circulating concentrations of P4 during ovulatory follicle development affects timing of pregnancy loss in lactating dairy cows. J. Dairy Sci. (In review).

Martins JPN, T. Cunha, C. Piterinni, and JR Pursley. 2017. The effect of presynchronization with PGF2α and GnRH simultaneously, 7 d prior to Ovsynch, compared to Presynch-10/Ovsynch on luteal function and first service pregnancies per AI. J. Dairy Sci. 100(6):5107-5116.

Channa, A.A., J.P.N. Martins, F. Jimenez-Krassel, J.R. Pursley. 2017. Effect of immersion of CIDR in ethanol on steady state circulating concentrations of progesterone and follicular dynamics in Holstein heifers and non-lactating cows. Livestock Sci. 198:191-194.

Jimenez-Krassel, F., D.M. Scheetz, L.M. Neuder, J.R. Pursley, and J.J. Ireland. 2017. A single ultrasound determination of ≥ 25 follicles ≥ 3 mm in diameter in dairy heifers is predictive of a reduced productive herd life. J. Dairy Sci. 100(6): 5019-5027.

Sartori, R., J. R. Pursley, and M. C. Wiltbank. 2017. The estrous cycle of heifers and lactating dairy cows: Ovarian and hormonal dynamics and estrous cycle abnormalities. Book chapter published in Large Dairy Herd Management (3rd ED.) David K. Beede, editor. Elsevier e-book.

Marques, R.S. R. F. Cooke, M. C. Rodrigues, A. P. Brandão, K. M. Schubach, K. D. Lippolis, P. Moriel, G. A. Perry, and D. W. Bohnert. 2017. Effects of rumen-protected essential fatty acids supplementation to late-gestating beef cows on performance and physiological responses of the offspring. J. Anim. Sci. 95:5347-5357.

Piccolo, M.B., J.D. Arthington, G.M. Silva, G.C. Lamb, R.F. Cooke, and P. Moriel. 2018. Preweaning injections of bovine ST enhanced reproductive performance of Bos indicus - influenced replacement beef heifers. J. Anim. Sci. 96:618-631

Cook, E.K., M.E. Garcia-Ascolani, R.E. Ricks, S.K. Duckett, G.C. Lamb, N. DiLorenzo, and N.M. Long. 2017. The effect of frequency of supplementing rumen protected unsaturated fatty acids on blood serum fatty acid profiles in beef heifers and lactating cows. J. Anim. Sci. 95:2977-2985.

Moriel, P, P. Lancaster, G.C. Lamb, J.M.B. Vendramini, and J.D. Arthington. 2017. Effects of post-weaning growth rate and puberty induction protocols on reproductive performance of Bos indicus-influenced beef heifers. J. Anim. Sci. 95:3523-3531.

Muth-Spurlcok, A. M., J. A. Dix, M. P. T. Coleson, C. G. Hart, C. O. Lemley, T. M. Schulmeister, G. C. Lamb, and J. E. Larson. 2017. The effect of follicular wave on fertility characteristics in beef cattle. J. Anim. Sci. 95:866-874.

Tait RG Jr., Cushman RA, McNeel AK, Casas E, Smith TPL, Freetly HC, Bennett GL. *μ-Calpain* (*CAPN1*), *calpastatin* (*CAST*), and *growth hormone receptor* (*GHR*) genetic effects on Angus beef heifer performance traits and reproduction. Theriogenology. 2018; 113:1-7.

Barletta, R. V., P. D. Carvalho, V. G. Santos, L. F. Mello, C. E. Consentini, A. S. Netto, and P. M. Fricke. 2018. Effect of dose and timing of prostaglandin F2α treatments during a Resynch protocol on luteal regression and fertility in lactating Holstein cows. J. Dairy Sci. 101:1730–1736.

Ricci, A., P. D. Carvalho, M. C. Amundson, and P. M. Fricke. 2017. Characterization of luteal dynamics in lactating Holstein cows for 32 days after synchronization of ovulation and timed artificial insemination. J. Dairy Sci. 100:9851-9860.

Abstracts/Posters/Professional Presentations

Larson, J. E., G. R. Dunnam, K. C. Yankey, M. P. T. Owen, M. M. Steichen, K. J. McCarty, A. E. Stone, and C. O. Lemley. 2017. Additional exercise among grazing dairy cows and effects on uterine artery blood flow, milk production, and milk quality parameters. *J. Anim. Sci.* 95:251-252.

Underdahl, S.R., A.B.P. Fontoura, L. Hulsman Hanna, K.A. Vonnahme, K.C. Swanson, K.A. Ringwall, T.C. Gilbery and C.R. Dahlen. 2018. The effect of estrus on dry matter intake and feeding behavior in beef heifers. 2018 ASAS Midwest Section Meeting.

McCarthy, K.L., M. Undi, and C.R. Dahlen. 2018. Mineral intake, feeding behavior, and growth performance of cow-calf pairs grazing native range. 2018 ASAS Midwest Section Meeting.

Lansford, A.C., J.A. Musgrave, and R.N. Funston. 2018. Effects of late gestation supplementation on dam and subsequent progeny performance. J. *Anim. Sci.* (e- Suppl.).

Broadhead, D.L., M. Stockton, L.A. Stalker, J.A. Musgrave, and R.N. Funston. 2018

Economics of creep feeding a spring calving beef herd in the Nebraska Sandhills. J. *Anim. Sci.* (e-Suppl.).

Springman, S.A., D.C. Adams, B.L. Plugge, J.D. Volesky, T.M. Walz, and R.N. Funston. 2018. The Nebraska Ranch Practicum: A holistic approach to beef and forage systems. J. *Anim. Sci.* (e-Suppl.).

Lasnsford, A.C., J.A. Musgrave, and R.N. Funston. 2018. Effects of a late-gestation forage system on dam and subsequent progeny performance. J. *Anim. Sci.* (e-Suppl.).

Springman, S.A., T.L. Meyer, M.E. Drewnoski, and R.N. Funston. 2018. Effects of hydroxyl trace mineral supplementation on gain and reproductive performance in beef heifers. J. *Anim. Sci.* (e-Suppl.).

Erickson, M., A.C. Lansford, J.A. Musgrave, and R.N. Funston. 2018. Effect of backgrounding and feedlot system strategies on May-born steer performance. J. *Anim. Sci.* (e-Suppl.).

Springman, S.A., D.C. Adams, J.D. Volesky, J.T Mulliniks, and R.N. Funston. 2018. The Nebraska Ranch Practicum: An insight into cow and calf production from varying precipitation and two weaning dates. J. *Anim. Sci.* (e-Suppl.).

Erickson, M., K.C. Ramsay, and R.N. Funston. 2018. Efficacy of a second injection of Prostaglandin F2α in yearling beef heifers following previous estrus synchronization. J. *Anim. Sci.* (e-Suppl.).

Thomas, JM, JWC Locke, MR Ellersieck, MF Smith, and DJ Patterson. 2018. The 9-d CIDR-PG protocol: Evaluation of synchrony of estrus, endocrine parameters, ovarian dynamics, and pregnancy rates to AI in comparison to the 7-d CO-Synch + CIDR protocol. American Society of Animal Science Midwest Section. In press.

Ortega MS, JGN Moraes, DJ Patterson, MF Smith, and TE Spencer. 2017. Effect of sire conception rate on pregnancy establishment in dairy cattle. Society for the Study of Reproduction.

Taylor JF, DS Brown, JE Decker, BP Kinghorn, MD MacNeil, MM Rolf, RD Schnabel, MF Smith, AL Van Eenennaam, and DJ Patterson. 2017. Identification of variants causing early embryonic loss in cattle. J. Animal Sci. 95, Suppl.5/J: pp 11.

Thomas JM, JWC Locke, MF Smith, and DJ Patterson. 2017. Effective use of SexedULTRA™ sex-sorted semen for timed artificial insemination of beef heifers. Applied Reproductive Strategies in Beef Cattle. Manhattan, KS.

Locke JWC, JM Thomas, ER Knickmeyer, MR Ellersieck, JV Yelich, SE Poock, MF Smith, and DJ Patterson. 2017. Comparison of long-term progestin-based protocols to synchronize estrus prior to fixed-time artificial insemination or natural service in Bos indicus-influenced beef heifers. Applied Reproductive Strategies in Beef Cattle. Manhattan, KS.

Woods MM, MJ Ellison, JM Thomas, and JB Hall. 2017. Effect of feed efficiency and sexed semen on pregnancy rate and early embryonic mortality in beef heifers. American Society of Animal Science Wester Section. Fargo, ND.

Thomas JM, JWC Locke, R Vishwanath, JB Hall, MR Ellersieck, MF Smith, and DJ Patterson. 2017. Young Scholar Presentation: Effective Use of SexedUltra Sex-Sorted Semen for Timed Artificial Insemination of Beef Heifers. American Society of Animal Science Midwest Meetings. Omaha, NE.

Thomas JM, JWC Locke, BE Bishop, JM Abel, MR Ellersieck, JV Yelich, SE Poock, MF Smith, and DJ Patterson. 2017. Evaluation of the 14-d CIDR-PG and 9-d CIDR-PG protocols for synchronization of estrus in *Bos indicus*-influenced and *Bos taurus* beef heifers. American Society of Animal Science Southern Section. Nashville, TN. Abstract No. 71.

Fontes, P. L. P., N. Oosthuizen, D. D. Henry, F. M. Ciriaco, C. D. Sanford, L. B. Canal, V. R. G. Mercadante, S. E. Johnson, A. D. Ealy, N. DiLorenzo and G. C. Lamb. 2017. Differences in embryo survival between *Bos indicus* and *Bos taurus* females receiving energy restricted diets during early gestation. J. Anim. Sci. 95(Suppl. 4):231. (Abstr)

Fontes, P. L. P., N. Oosthuizen, D. D. Henry, F. M. Ciriaco, C. D. Sanford, L. B. Canal, V. R. G. Mercadante, S. E. Johnson, A. D. Ealy, N. DiLorenzo and G. C. Lamb. 2017. Impact of fetal versus maternal contributions of *Bos indicus* and *Bos taurus* genetics on early embryonic development. J. Anim. Sci. 95(Suppl. 4):163. (Abstr)

Oosthuizen, N., P. L. P. Fontes, D. D. Henry, C. D. Sanford, F. M. Ciriaco, L. B. Canal, N. DiLorenzo, V. R. G. Mercadante and G. C. Lamb. 2017. Administration of recombinant bovine somatotropin prior to fixed-time artificial insemination and the effects on pregnancy rates and conceptus development in beef heifers. J. Anim. Sci. 95(Suppl. 4):67. (Abstr)

Harl, A.W.*, E.L. Larimore, A. Al Naib†, L.K. Wooldridge, A.D. Ealy, G.A. Perry and M.L. Rhoads. 2017. Maturation of bovine cumulus-oocyte complexes with follicle fluid varying in estradiol content affects cumulus cell expansion without affecting subsequent embryo development in vitro. Reprod. Fertil. Dev. 29(1):199.

Dias, N.W., C.L. Timlin, F.V. Santili, T.B. Wilson, R.R. White, V. R.G. Mercadante. 2018. Establishing the efficacy of Faecalibacterium prausnitzii as a probiotic to enhance pre-weaning health, growth and performance of beef calves. J. Anim. Sci. Southern Section (Abstract accepted).

Timlin, C.L., L.K. Wooldridge, A.D. Ealy, V.R.G. Mercadante. 2018. Effects of supplementing various ratios of polyunsaturated fatty acids to in-vitro production of bovine embryos. J. Anim. Sci. Southern Section (Abstract accepted).

Powers, D., C.L. Timlin, N.W. Dias, F.V. Santili, V.R.G. Mercadante. 2018. Progesterone concentration, follicle diameter and corpus luteum volume in beef cows supplemented with ca salts of soybean oil. J. Anim. Sci. Southern Section (Abstract accepted).

Rhoads, M.L. 2018. Nutritional and metabolic strategies to improve reproductive performance during heat stress. J. Dairy Sci. (accepted).

Perry, G.A., J.A. Walker, J.J.J. Rich, E.J. Northrop, S.D. Perkins, E. E. Beck, M. D. Sandbulte, and F. B. Mokry. 2018. Influence of Sexcel™ (Gender Ablation Technology) Gender-Skewed Semen in Fixed-Time Artificial Insemination of Beef Cows and Heifers. J. Anim. Sci. Midwest

Northrop, E. J., J. J. J. Rich, R. A. Cushman, and G. A. Perry. 2018. Regulation of preovulatory estradiol and its impacts throughout the bovine estrous cycle. J. Anim. Sci. Midwest

Perkins, S. D., E. J. Northrop, J. J. J. Rich and G. A. Perry. 2018. Role of Epididymal Proteins and Mannose on Sperm Longevity. J. Anim. Sci. Midwest

Beck, E. E., R. T. Douglas, J. J. J. Rich, E. J. Northrop, S. D. Perkins, T. W. Geary, G. A. Perry, and J. A. Walker. 2018. Effects of Pre- and Post-insemination Maternal Plane of Nutrition on Peripheral and Uterine Luminal Fluid Metabolites. J. Anim. Sci. Midwest

Rich, J. J. J., E. J. Northrop, S. D. Perkins, E. E. Beck, J. R. Rhodes, and G. A. Perry. 2018. Comparison of two serum pregnancy tests in detection of AI versus natural service pregnancies in beef herds. J. Anim. Sci. Midwest

Northrop, E. J., J. J. J. Rich, J. R. Rhodes, and G. A. Perry. 2018. Comparison of two methods of bovine pregnancy tests to determine embryonic loss in beef cows. J. Anim. Sci. Midwest

Douglas RT, E. E. Beck, J. J. J. Rich, E. J. Northrop, S. D. Perkins, T. W. Geary, J. A. Walker , and G. A. Perry. 2018. Effects of pre- and post-insemination maternal plane of nutrition on estrus and embryo development. J. Anim. Sci. Midwest

Anderson, P. P. D. T. Smerchek, J. E. Held, A. R. Kolthoff, T. Stenberg, and G. A. Perry. 2018. Influence of post-pubertal ram semen quality on ewe conception rates. J. Anim. Sci. Midwest

Smerchek, D. T., P. P. Anderson, J. E. Held, A. R. Kolthoff, T. Stenberg, and G. A. Perry. 2018. Changes in ram semen quality between subsequent ejaculates. J. Anim. Sci. Midwest

Ciriaco, F. M., D. D. Henry, T. M. Schulmeister, P. L. P. Fontes, N. Oosthuizen, C. D. Sanford, L. B. Canal, G. C. Lamb and N. DiLorenzo. 2017. Intake and ruminal fermentation parameters of beef steers consuming bahiagrass hay treated with calcium oxide. J. Anim. Sci. 95(Suppl. 4):263. (Abstr)

Garcia-Ascolani, M. E., A. Lopez, T. M. Schulmeister, M. Ruiz-Moreno, D. D. Henry, F. M. Ciriaco, G. C. Lamb and N. DiLorenzo. 2017. Effect of fermenten on nitrogen metabolism and ruminal fermentation profile of Angus crossbred steers. J. Anim. Sci. 95(Suppl. 4):285. (Abstr)

Henry, D. D., F. M. Ciriaco, R. C. Araujo, P. L. P. Fontes, N. Oosthuizen, M. E. Garcia-Ascolani, C. D. Sanford, T. M. Schulmeister, M. Ruiz-Moreno, L. Rostoll-Cangiano, G. C. Lamb and N. DiLorenzo. 2017. Effects of bismuth subsalicylate and calcium-ammonium nitrate on ruminal fermentation of beef cattle. J. Anim. Sci. 95(Suppl. 4):275. (Abstr)

Moriel, P., M. Piccolo, P. A. Lancaster, G. C. Lamb, J. Vendramini and J. D. Arthington. 2017. Effects of post-weaning plane of nutrition and estrus synchronization on reproductive performance of Bos indicus-influenced beef heifers. J. Anim. Sci. 95(Suppl. 4):243. (Abstr)

Oosthuizen, N., P. L. P. Fontes, C. D. Sanford, F. M. Ciriaco, D. D. Henry, L. B. Canal, N. DiLorenzo and G. C. Lamb. 2017. Impact of estrus synchronization and fixed-time artificial insemination on calving distribution in Bos indicus influenced beef heifers. J. Anim. Sci. 95(Suppl. 4):249. (Abstr)

Owen, M. P. T., K. J. McCarty, M. M. Steichen, C. D. Sanford, L. B. Canal, P. L. P. Fontes, N. Oosthuizen, N. DiLorenzo, K. Vonnahme, G. C. Lamb and C. O. Lemley. 2017. Effects of biweekly administration of recombinant bovine somatotropin on steroid metabolizing enzymes during early gestation. J. Anim. Sci. 95(Suppl. 4):52. (Abstr)

Piccolo, M., P. Moriel, G. M. Silva, R. F. Cooke, G. C. Lamb, J. Vendramini and J. D. Arthington. 2017. Pre-weaning injections of bovine somatotropin altered liver gene expression, and enhanced puberty attainment and calving rates of Bos indicus-influenced beef heifers. J. Anim. Sci. 95(Suppl. 4):244. (Abstr)

Piccolo, M., G. M. Silva, G. C. Lamb, J. M. B. Vendramini, J. D. Arthington and P. Moriel. 2017. Pre-Weaning Injections of Bovine Somatotropin Enhanced Puberty Attainment of Bos Indicus-Influenced Beef Heifers. J. Anim. Sci. 95(Suppl. 1):11. (Abstr)

Rostoll-Cangiano, L., D. D. Henry, F. M. Ciriaco, M. E. Garcia-Ascolani, T. M. Schulmeister, I. R. Ipharraguerre, G. C. Lamb and N. DiLorenzo. 2017. J. Anim. Sci. 95(Suppl. 4):270. (Abstr)

Sanford, C. D., N. Oosthuizen, P. L. P. Fontes, L. B. Canal, K. A. Vonnahme, C. O. Lemley, N. DiLorenzo and G. C. Lamb. 2017. The effects of biweekly administration of recombinant bovine somatotropin during the first trimester on fetal development in gestating beef heifers. J. Anim. Sci. 95(Suppl. 4):158. (Abstr)

Schulmeister, T. M., M. Ruiz-Moreno, J. Benitez, M. E. Garcia-Ascolani, F. M. Ciriaco, D. D. Henry, G. C. Lamb, J. C. B. Dubeux and N. DiLorenzo. 2017. Evaluation of Brassica carinata meal as a protein supplement for growing beef heifers. J. Anim. Sci. 95(Suppl. 4):280. (Abstr)

Schulmeister, T. M., M. Ruiz-Moreno, G. M. Silva, M. E. Garcia-Ascolani, F. M. Ciriaco, D. D. Henry, G. C. Lamb, J. C. B. Dubeux and N. DiLorenzo. 2017. J. Anim. Sci. 95(Suppl. 4):264. (Abstr)

Niles, A. M., P. D. Carvalho, and P. M. Fricke. 2018. Serum progesterone, expression of interferon-tau stimulated gene 15 (ISG15) in blood leukocytes, and serum PSPB concentrations in Holstein dairy heifers after artificial insemination or IVF embryo transfer. J. Dairy Sci. (accepted).

Carvalho, P. D., V. G. Santos, and P. M. Fricke. 2018. Effect of manipulating progesterone before timed artificial insemination on double ovulation and twinning in high-producing Holstein cows. J. Dairy Sci. (accepted).

Extension Reports/Publications

Pursley, J. R. 2014 to present. www.dairycattlereproduction.com website. Features a resource guide for bovine veterinarians and dairy producers to enhance their knowledge on the management of reproduction of dairy cattle. Included are 3D animations/videos of ovaries throughout an estrous cycle and during fertility programs**.** Impact past 4 years: >57,000 views on website. Added "Adventures of Blaze and Star" – videos that help to explain importance of reproduction on dairies.

Pursley, J. R. 2017. Enhancing fertility of lactating dairy cows. ESGAL Congress. Puerto Vallarta, MX.

Pursley, J. R. 2017. Pregnancy loss in dairy cows. ESGAL Congress. Puerto Vallarta, MX.
Pursley, J. R. 2017. Factors that affect fertility of dairy cows. ANEMBE. Pamplona, Spain.
Pursley, J. R. 2017. Pregnancy loss in dairy cows. ANEMBE. Pamplona, Spain.
Funston, R.N., G.A. Perry, and M.F. Smith. 2017. General management considerations to improve success of artificial insemination. *Proc. Appl. Reprod. Strategies in Beef Cattle.* Manhattan, KS. p. 97-113.
da Silva, A.G., A.J. Roberts, T.L. Meyer, and R.N. Funston. 2018. Analysis of birthdate and growth in beef heifers categorized by puberty and pregnancy status. *Nebraska Beef Cattle Report.* Univ. Nebraska, Lincoln. MP 105:5-8.
Lansford, A.C., T.L. Meyer, and R.N. Funston. 2018. Comparison of two alternate prostaglandin F2alpha products in yearling beef heifers. *Nebraska Beef Cattle Report.* Univ. Nebraska, Lincoln. MP 105:12-14.
Musgrave, J.A., D.L. Broadhead, L.A. Stalker, and R.N. Funston. 2018. Impact of pre and postpartum nutrition on March-calving cow and progeny productivity. *Nebraska Beef Cattle Report.* Univ. Nebraska, Lincoln. MP 105:15-17.
Broadhead, D.L., L.A. Stalker, J.A. Musgrave, and R.N. Funston. 2018. Effects of late gestation supplementation, synchronization, and creep feeding in a spring calving beef herd in the Nebraska Sandhills. *Nebraska Beef Cattle Report.* Univ. Nebraska, Lincoln. MP 105:18-20.
Lansford, A.C., J.A. Musgrave, and R.N. Funston. 2018. Effect of supplementation during the breeding season on a May-calving herd in the Nebraska Sandhills. *Nebraska Beef Cattle Report.* Univ. Nebraska, Lincoln. MP 105:21-23.
Springman, S.A., H.R. Nielson, and R.N. Funston. 2018. Impact of winter supplementation of May calving cows and heifer development system in two different breeding seasons on subsequent growth and reproduction. *Nebraska Beef Cattle Report.* Univ. Nebraska, Lincoln. MP 105:24-27.
Springman, S.A., J.G. Maddux, M.E. Drewnoski, and R.N. Funston. 2018. Effect of injectable trace mineral on reproductive performance in beef heifers. *Nebraska Beef Cattle Report.* Univ. Nebraska, Lincoln. MP 105:33-34.
DJ Patterson, JM Thomas, BE Bishop, JM Abel, JWC Locke, and MF Smith. 2017. Control of estrus and ovulation in heifers. In: Proceedings, Applied Reproductive Strategies in Beef Cattle. August 29-30, Manhattan, KS.
DJ Patterson, JM Thomas, BE Bishop, JM Abel, JWC Locke, JE Decker, and MF Smith. 2016. Control of estrus and ovulation in beef cows. In: Proceedings, Applied Reproductive Strategies in Beef Cattle. August 29-30, Manhattan, KS.

Articles in the Popular Press (non-peer reviewed)

Stevenson, J. S. 2018. Give cows a place to "moo". Hoard's Dairyman 163:162. March 10, 2018.
Stevenson, J. S. 2018. Here's your checklist for A.I. success. Hoard's Dairyman 163:89. February 10, 2018.
Stevenson, J. S. 2018. We have an improved perspective on fertility. Hoard's Dairyman 163:31. January 10, 2018.
Stevenson, J. S. 2017. More why's and how's of timed A.I. Hoard's Dairyman 162:709. November, 2017.
Stevenson, J. S. 2017. Understand timed A.I. to boost preg rates. Hoard's Dairyman 162:604. October 10, 2017.

Stevenson, J. S. 2017. People make the difference. Hoard's Dairyman 162:546. September 10, 2017.
Stevenson, J. S. 2017. Should we administer a second prostaglandin? Hoard's Dairyman 162:480. August 10, 2017.
Lamb, G.C. 2017. Repro Tracks – Synchronization programs and reproductive technologies. Angus Journal (February 2017:192-194)
Lamb, G.C. 2017. Repro Tracks – Estrus-synchronization products. Angus Journal (March 2017:172-175)
Lamb, G.C. 2017. Repro Tracks – Herd health and reproduction. Angus Journal (April 2017:126-127)
Lamb, G.C. 2017. Repro Tracks – Data and fertility. Angus Journal (August 2017:74-75)
Lamb, G.C. 2017. Repro Tracks – Reproductive research and innovation. Angus Journal (September 2017:82-83)
Lamb, G.C. 2017. Repro Tracks – Lifetime productivity. Angus Journal (October 2017:132-133)
Fricke, P. M. 2017. About 20% of cows don't return to estrus. Dairy Herd Management, October 2017, p. 36.
Fricke, P. M. 2018. Get more pregnancies per AI. Dairy Herd Management, January 2018, p. 32.

Scientific and Outreach Oral Presentations

G. C. Lamb – Texas

Management of reproduction to enhance production efficiency in beef cattle operations, Texas A&M University Beef Cattle Short Course, College Station, TX
Use of reproductive technologies to enhance profitability of beef cattle operations (4 presentations in Australia)
Reproductive management for beef herds (4 presentations in PA)
Donor and recipient management to optimize embryo technology success. Applied Reproductive Strategies in Beef Cattle Symposium, Manhattan, KS
Managing reproduction to enhance efficiency of beef operations. International Braford Congress, Ft. Worth, TX
How does altering the calf-crop enhance profitability of beef operations? Angus Convention, Ft. Worth, TX
Assessing the interaction of fetal and maternal contributions of *Bos indicus* and *Bos taurus* genetics on early embryonic development. IFRB Seminar Series, College Station, TX

J. S. Stevenson - Kansas

Kansas Dairy Days, January 31 and February 2, 2018, Seneca and Whitesides
Kentucky Dairy Partners Annual meeting, February 27-28, 2018, Bowling Green, KY
Midwest ADSA/ASAS annual meeting, March 14, 2018, Omaha, NE

J. R. Pursley - Michigan

Pursley, J. R. 2017. Reproductive management of donor cows. Dairy Scope 2017. South Bend, IN.
Pursley, J. R. 2017. Improving reproductive outcomes in your dairy herds. Dairy Scope 2017. South Bend, IN.
Pursley, J. R. 2017. Importance of applied reproductive research for the dairy industry of Michigan. MSUE and AgBioResearch Council. MSU, East Lansing, MI.

Pursley, J. R. 2017. Managing cows for greater fertility. Herd Health Management group. Phoenix, AZ.
Pursley, J. R. 2017. Managing cows for greater fertility. Dairy Veterinary Services group, Phoenix, AZ.
Pursley, J. R. 2017. Enhancing fertility of lactating dairy cows. ESGAL Congress. Puerto Vallarta, MX.
Pursley, J. R. 2017. Pregnancy loss in dairy cows. ESGAL Congress. Puerto Vallarta, MX.
Pursley, J. R. 2017. Factors that affect fertility of dairy cows. ANEMBE. Pamplona, Spain.
Pursley, J. R. 2017. Pregnancy loss in dairy cows. ANEMBE. Pamplona, Spain. Pursley, J. R. 2017. Physiology of the estrous cycle. Production medicine class. Federal University of Mato Grosso, Sinop, MT.
Pursley, J. R. 2017. Abbreviated BRED workshop (1/2 day). Students and faculty. Federal University of Mato Grosso, Sinop, MT.
Pursley, J. R. 2017. Ovulation Synchronization Programs: An Update. Dairy Cattle Reproduction Conference (DCRC). Webinar.
Pursley, J. R. 2017. Managing cows for greater fertility. Sunnyside Veterinary Clinic bovine group. Sunnyside, WA
Pursley, J. R. 2017. Managing cows for greater fertility. Dairy veterinarians in northwest Washington. Lyndon, WA.
Pursley, J. R. 2017. Enhancing fertility of lactating dairy cows. Invited seminar, Shanxi Agricultural University, Physiology group, Taigu, China.
Pursley, J. R. 2017. Introduction to anatomy and physiology of reproduction in dairy cows. Nestle Dairy Farming Institute managed by U of Wisconsin-Madison. Shuangcheng, China.
Pursley, J. R. 2017. Introduction to anatomy and physiology of reproduction in dairy cows. Nestle Dairy Farming Institute managed by U of Wisconsin-Madison. Shuangcheng, China.
Pursley, J. R. 2017. Ovarian Function – Structures and the hormones produced. Nestle Dairy Farming Institute managed by U of Wisconsin-Madison. Shuangcheng, China.
Pursley, J. R. 2017. Ovarian Function- Follicle development during the estrous cycle/Ovsynch. Nestle Dairy Farming Institute managed by U of Wisconsin-Madison. Shuangcheng, China.
Pursley, J. R. 2017. Active learning session – controlling follicle and corpus luteum function. Nestle Dairy Farming Institute managed by U of Wisconsin-Madison. Shuangcheng, China.
Pursley, J. R. 2017. On farm active learning – ultrasonography of ovaries / treatment with GnRH and PG. Nestle Dairy Farming Institute managed by U of Wisconsin-Madison. Shuangcheng, China.
Pursley, J. R. 2017. Active learning breakout – 1st AI. Nestle Dairy Farming Institute managed by U of Wisconsin-Madison. Shuangcheng, China.
Pursley, J. R. 2017. Developing a reproductive management program – 1st AI. Nestle Dairy Farming Institute managed by U of Wisconsin-Madison. Shuangcheng, China.
Pursley, J. R. 2017. Determination of pregnancy. Nestle Dairy Farming Institute managed by U of Wisconsin-Madison. Shuangcheng, China.
Pursley, J. R. 2017. Active learning breakout – AI following non-pregnancy diagnosis. Nestle Dairy Farming Institute managed by U of Wisconsin-Madison. Shuangcheng, China.
Pursley, J. R. 2017. On farm active learning – ultrasonography of uterus for pregnancy diagnosis. Nestle Dairy Farming Institute managed by U of Wisconsin-Madison. Shuangcheng, China.

Pursley, J. R. 2017. Developing a reproductive management program – AI following non-pregnancy diagnosis. Nestle Dairy Farming Institute managed by U of Wisconsin-Madison. Shuangcheng, China.

Pursley, J. R. 2017. Active learning breakout - managing diagnosis of twins and cows that lose pregnancies. Nestle Dairy Farming Institute managed by U of Wisconsin- Madison. Shuangcheng, China.

Pursley, J. R. 2017. Analysis of on farm data. Nestle Dairy Farming Institute managed by U of Wisconsin-Madison. Shuangcheng, China.

Pursley, J. R. 2017. Active learning breakout – Identifying problems utilizing on farm data. Nestle Dairy Farming Institute managed by U of Wisconsin-Madison. Shuangcheng, China.

Pursley, J. R. 2017. - How reproductive performance impacts farm profit. Nestle Dairy Farming Institute managed by U of Wisconsin-Madison. Shuangcheng, China.

Pursley, J. R. 2017. Cost analyses of reproductive management programs. Nestle Dairy Farming Institute managed by U of Wisconsin-Madison. Shuangcheng, China.

Pursley, J. R. 2017. Active learning breakout – Calculating costs of changes in reproductive management programs. Nestle Dairy Farming Institute managed by U of Wisconsin-Madison. Shuangcheng, China.

Pursley, J. R. 2017. Managing cows for greater fertility. Dairy veterinarians in San Joaquin Valley, CA. Tulare, CA.

Pursley, J. R. 2017. Managing cows for greater fertility. Dairy veterinarians in Central Valley, CA. Hilmar, CA.

Pursley, J. R. 2017. Dairy GlobalSynch Protocols Update. CRI Brazil invited talk. Three breakout sessions (1 h each). Hotel Rancho Silvestre, Sao Paulo, Brazil.

Pursley, J. R. 2017. Enhancing fertility of dairy cows. 2 h presentation. Dairy Veterinarians in Northern Indiana. Goshen, IN.

Pursley, J. R. 2017. Enhancing fertility of dairy cows. 2 h presentation. Dairy Veterinarians in Thumb Region. Sandusky, MI.

Middleton, E. L., T. Minela, and J. R. Pursley. Relationship of body condition changes during the first 30 d of lactation and pregnancy rate per AI at 75 to 81 DIM In: Dairy Cattle Reproduction Conference, Reno, NV.

Middleton, E. L., T. Minela, and J. R. Pursley. Relationship of body condition changes during the first 30 d of lactation and pregnancy rate per AI at 75 to 81 DIM In: American Dairy Science Association Annual Meeting, 2017, Pittsburgh, PA.

D. J. Patterson - Missouri

American Angus Association – Cattlemen's College. Selecting Fertile Heifers. Fort Worth, TX. November 5, 2017.

Beef Improvement Federation Meeting. NAAB Symposium. Adding value to replacement beef heifers. A working model: The Missouri Show-Me-Select Replacement Heifer Program. Athens, GA. May 31, 2017.

University of Missouri Extension Beef Cattle ReproGene Meeting. Taking the next steps in beef cattle reproduction and genetics. Jackson, MO. March 28, 2017.

University of Missouri Extension Beef Cattle ReproGene Meeting. Taking the next steps in beef cattle reproduction and genetics. Springfield, MO. March 16, 2017.

American Society of Animal Science Midwest Meetings. Young Scholar Invited Presentation: Effective use of SexedUltra sex-sorted semen for timed artificial insemination of beef heifers. Omaha, NE. March 14, 2017.

University of Missouri Extension Beef Cattle ReproGene Meeting. Taking the next steps in beef cattle reproduction and genetics. Macon, MO. March 11, 2017.

University of Missouri Extension Beef Cattle ReproGene Meeting. Taking the next steps in beef cattle reproduction and genetics. Kingsville, MO. March 9, 2017.

University of Missouri Extension Beef Cattle ReproGene Meeting. Taking the next steps in beef cattle reproduction and genetics. Maryville, MO. March 7, 2017.

Genex Field Staff Update Webinar. University of Missouri beef reproduction research update. Web-based. March 2, 2017.

Select Sires MidAmerica Field Staff Update. Beef reproduction update. Columbia, MO. February 16, 2017.

The Missouri Show-Me-Select Replacement Heifer Program. Missouri Farm Bureau Young Farmers and Ranchers. February 4, 2017.

Southwest Missouri University of Missouri Extension Beef Cattle Conference. Beef reproduction update and the latest from the Show-Me-Select Replacement Heifer Program. Stockton, MO. January 26, 2017.

Control of the bovine estrous cycle with progestin-based protocols. January 19 – February 2, 2017. Veterinary CE, United Kingdom; England, Northern Ireland, Scotland.

International Embryo Transfer Society Annual Conference. Sunrise Sponsor Session: Effective use of SexedUltra sex-sorted semen for timed artificial insemination of beef heifers. Austin, TX. January 17, 2017.

J. E. Larson - Mississippi

Larson, J. E. 2017. Heat detection for a successful AI program. MSU Extension Fall Artificial Insemination School, Mississippi State, MS.

R. N. Funston - Nebraska

Applied reproductive strategies in beef cattle symposium. Des Moines, IA. Beef heifer development systems and lifetime productivity.

Grazing Livestock Systems Class. Beef systems research.

State of Beef Conference. North Platte. Strategies for breeding high risk beef females.

Ranching for Profit Series. Synchronization systems and reproductive management.

Missouri Veterinary Medical Association Annual Meeting. Increasing production efficiency through reproductive management.

Missouri Veterinary Medical Association Annual Meeting. Heifer development before and after birth.

Kansas Veterinary Medical Association Annual Meeting. Increasing production efficiency through reproductive management.

Kansas Veterinary Medical Association Annual Meeting. Heifer development before and after birth.

Montana youth tour. North Platte, NE. Beef Systems Research.

Morrill County Cattlemen's meeting. Bridgeport, NE. Increasing production efficiency through reproductive management.

Harrisonville, MO Veterinary Meeting. Increasing production efficiency through reproductive management.
Springfield, MO Producer Meeting. Increasing production efficiency through reproductive management.
Rush Creek manager meeting. Beef Systems Research.
Leadership Lincoln County. North Platte. Beef systems research.
Angus Boot Camp. Lincoln, NE. Increasing production efficiency through reproductive management.
Shattuck, OK, Veterinary Producer Meeting. Increasing production efficiency through reproductive management.
Beef Summit Group meeting. Clay Center, NE. Beef Systems research.
Australian beef producer tour. Beef Systems research.
TN Cattle producer's tour. Gudmundsen Ranch. Beef Systems research.
Australian beef producer tour. Beef Systems research.
New faculty tour. North Platte. Beef Systems research.
Beef Cattle Short Course. TX A&M. Heifer development systems.

G. A. Perry – South Dakota

Ceva Symposium on Beef Cattle Reproductive efficiency Edinburgh Scotland September 19 and 20, 2017. Title "Beef Cattle Reproductive management in the United States."
The Range Beef Cow Symposium XIX. 2017. Title "Influence of Modified Live Vaccines on Reproductive Performance in Beef Cattle."
Midwest ASAS/ADSA 2018 Meeting Title "Regulation of preovulatory estradiol and its impacts throughout the bovine estrous cycle"

V. R. G. Mercadante - Virginia

Scott County Cattlemen Association Annual Meeting. Implementing reproductive technologies.
Southern Piedmont Agriculture Research and Extension Center, Annual Field Day. Tools for Selecting Replacement Heifers.
Shenandoah Valley Agriculture Research and Extension Center, Annual Field Day. Tools for Selecting Replacement Heifers.
Cargill Beef Cattle Team, monthly webinar. Current Reproductive Technologies in Beef Production.
Carrol-Grayson Cattlemen Association Field Day. Establishing an estrus synchronization program.

M. L. Rhoads - Virginia

Rhoads, M.L. 2017. Heat stress near the time of conception affects daughter milk production and composition. Proc. 32nd Annu. Southwest Nutr. & Mgmnt. Conf. in press.

P. M. Fricke - Wisconsin

Fricke, P. M. 2017. Integration of Reproductive Programs and Technology to Maximize Fertility. One-day veterinary workshop. Vetoquinol. September 21, London, Ontario.
Fricke, P. M. 2018. Reproduction Workshop. Alta Dairy Manager School. January 17-19, Abbotsford, BC, Canada.

Fricke, P. M. 2018. Integration of reproductive technologies to improve reproductive performance. 4th Cirio Dairy Meeting, February 7-8, Caserta, Italy.

Fricke, P. M. 2018. Barriers to high fertility in dairy herds. 4th Cirio Dairy Meeting, February 7-8, Caserta, Italy.

Fricke, P. M. 2018. Five keys of successful reproductive management programs. Dairy farmer meeting, February 13, Cremona, Italy.

Fricke, P. M. 2017. Integration of Reproductive Programs and Technology to Maximize Fertility. Midwest Dairy Day, December 1, Calmar, IA.

Fricke, P. M. and M. W. Overton. 2017. Physiologic and economic perspectives around achieving high fertility in high-producing dairy cows. National DCRC Elanco Preconference Seminar. November 8-9, Reno, NV.

Fricke, P. M. 2018. Integration of reproductive technologies to improve reproductive performance. Merck Dairy Meeting, January 26, Sioux Falls, SD.

Fricke, P. M. 2018. Five keys of successful reproductive management programs. Logan Bethel Vet Client Meeting, January 31, Hopkinsville, KY.

Fricke, P. M. 2018. Five keys of successful reproductive management programs. Renaissance Nutrition Dairy Meeting, February 28, East Earl, PA.

Funding (include grants and contracts)

Funding Agency	Value ($)	Years of funding	States Included
Florida Cattle Enhancement Fund	95,788	2017	MO
Florida Cattle Enhancement Fund	33,784	2016-2017	FL, TX
Florida Cattle Enhancement Fund	33,100	2016-2017	FL, TX
Florida Cattle Enhancement Fund	43,283	2016-2017	FL, TX
Florida Cattle Enhancement Fund	36,449	2016-2017	FL, TX
Florida Cattle Enhancement Fund	139,000	2016-2017	FL, TX
Grains States Soya, Inc.	3,600	2018	KS
Michigan Alliance for Animal Agriculture	150,000	2018-2020	MI
Select Sires, Inc	13,700	2018	KS
Sexing Technologies	20,000	2017	MO
Univ. of Missouri Thompson Research Center	15,000	2017	MO
USDA-Hatch	10,000	2017	KS
USDA-NIFA	2,997,040	2013-2018	MO
USDA-NIFA	150,000	2018-2020	SD
USDA-NIFA	450,000	2015-2018	FL, TX, VA
USDA-NIFA	480,000	2017-2020	FL, TX, VA