

ANNUAL REPORT (2013 to 2014)

Multistate Project NC1201: Methods to Increase Reproductive Efficiency in Cattle

Date of Annual Meeting: 09/04 - 09/05/2014

Period Report Covers: 10/01/2013 – 09/30/2014

PARTICIPANTS

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MINUTES

Cliff Lamb and colleagues hosted the annual NC1201 meeting at the North Florida Research and Education Center in Marianna, FL. Carl Dahlen served as Chair of the meeting. Teresa Steckler served as secretary. Attendees gave an overview of work conducted since the last meeting. Cliff provided a tour of the laboratory facilities, animal facilities, and new student dormitories on campus. Deb Hamernik (Administrative Advisor) thanked Cliff for hosting the meeting. She reminded the group that Bill Ravlin (former Administrative Advisor) recently moved to Michigan State University to be Head of the Department of Entomology. The group expressed appreciation to Bill for his many years of working with this committee. Deb reminded the group that this project will be up for mid-term review in January 2015. The 2014 annual report should be submitted by the end of December so that reviewers can access this information. Reviewers will look at attendance, accomplishments, impacts, and publications during the mid-term review. Jeff Stevenson volunteered to serve as Secretary in 2015. The next annual meeting will be hosted by Dave Patterson in Missouri. Potential dates are September 10-11, 2015. Teresa Steckler would like to host the 2016 meeting in Illinois.

OBJECTIVES

List objective(s) worked on. The objectives listed in the project are:

- 1) To determine mechanisms that regulate reproductive processes impacting production efficiency in cattle.
- 2) To increase the efficiency and predictability of sustainable reproductive management programs for cattle

Accomplishments

- OBJECTIVE 1
 - 1) Animals with greater concentrations of circulating estradiol prior to fixed-time AI experienced an up-regulation of the steroidogenic pathway during the preovulatory period,

thus management methods to up regulate the entire steroidogenic pathway are necessary. (South Dakota State University)

- 2) Treatment with exogenous GnRH was able to increase circulating concentrations of estradiol, but not as quickly or to the magnitude of the HighE2 animals. (South Dakota)
- 3) Selecting only cows that have exhibited estrus before timed artificial insemination can improve pregnancy success, and the pathways reported here give a starting point to investigate how preovulatory estradiol concentrations are impacting fertilization, early embryo development, and overall pregnancy success. (South Dakota)
- 4) Administration of bST during the time of TAI enhances plasma IGF-1 concentrations, but fails to improve pregnancy rates, fetal size and PSPB concentrations in suckled beef cows. (Florida)
- 5) Supplementation of a dietary cation-anion difference balancer (Bio-Chlor) did not alter milk production of beef cows or subsequent calf performance. (Florida)
- 6) An experiment was conducted to determine the effect of dietary n-3 polyunsaturated fatty acids supplementation (n-3 PUFA; Megalac-R) on pregnancy rates of primiparous cows exposed to fixed-time AI (TAI). Final pregnancy rates were unaffected by treatment. Forty percent of CTRL cows had initiated estrous cycles at TAI, whereas 30% of MLAC had initiated estrous cycles at TAI. (Florida)
- 7) Recently, a syncytin variant has been identified in cattle and sheep, syncytin-Rum1. Syncytin expression is detectable in beef heifers up to d 34 of pregnancy. (North Dakota)
- 8) Analysis of a limited number of candidate gene polymorphisms from the University of Florida indicated that estradiol signaling was an important up-stream regulator of pregnancy rate in dairy cows. To examine this in beef heifers, we performed pathway analysis of genes within 100 Kb of nominally significant markers ($P < 0.05$) for heifer pregnancy rate in our genome-wide association study. Pathway analysis of those genes demonstrated that estradiol was a strong up-stream regulator of these differentially expressed genes. Progesterone pathways were not activated in this model. Together, these data provide strong mechanistic evidence for the importance of estradiol in regulating fertility at the level of the uterus in cows. Identification of and selection for functional polymorphisms in the steroidogenic pathway and estradiol signaling pathway should improve fertility and decrease the incidence of silent estrus or estrus without ovulation. (US MARC)
- 7) We hypothesized that heifers exposed to a lower nutrition level during the peripuberal period would have less methylation of the DNA in the mammary gland and ovarian cortex. Our hypothesis that modifying peripubertal nutrition modifies global methylation of the mammary and ovary is not supported; however, our hypothesis that it modifies the ovarian reserve is supported. Three transcripts that were differentially expressed were members of the SLIT/ROBO family that have been implicated in primordial follicle formation. Combined with the morphometric data, these results suggest that the increase in primordial follicle number may be in part due to an increase in primordial follicle formation in Stair-Step heifers during the re-feed period. (US MARC)
- 8) As pregnant heifers grazing corn residue, winter range (WR) heifers tended to have reduced ADG compared with heifers that grazed winter range and corn residue (CR). Furthermore, in CR heifers had greater ADG grazing corn residue as pregnant heifers compared with drylot-developed heifers. Calving date, dystocia score, and calf birth BW were similar between development systems in both experiments. There appears to be a potential learned grazing behavior for heifers developed on corn residue allowing them to

better adapt to grazing corn residue as pregnant heifers compared with winter range and drylot heifers. (Nebraska)

- 9) Economic analysis revealed a \$58 reduced development cost for heifers developed to 55% compared with 62% of mature breeding weight without a loss in reproductive performance. (Nebraska)
- 10) We examined whether the induction of an accessory CL, via human chorionic gonadotropin (hCG), alters blood perfusion of CL, peripheral concentrations of progesterone, or hepatic steroid inactivating enzymes. The experiment provided evidence that although an ovary with 2 CL has increased overall blood perfusion compared to an ovary with 1 CL, this did not correspond to a change in circulating concentration of progesterone or a change in liver enzymes relating to progesterone clearance. Further research can lead to understanding the relationship to blood perfusion and progesterone. In addition, the technique of determining blood perfusion can be used in other physiological experiments. (Mississippi)
- 11) An experiment was conducted to examine the effects of maternal nutrient restriction during mid- to late gestation on uterine blood flow in multiparous Angus beef cows. Overall blood flow to the uterus did not change when dams were nutrient restricted, therefore, this may not impact immediate fetal growth and development. (Mississippi)

- OBJECTIVE 2

- 1) Presynchronization with GnRH 6 d before beginning an Ovsynch protocol increased P4 at the PGF injection of an Ovsynch protocol, and a second PGF injection 24 h after the first decreased P4 at TAI resulting in more P/AI in resynchronized cows. (Wisconsin)
- 2) Cows maintaining their original CL for 32 d after TAI were initially pregnant but underwent pregnancy loss based on residual serum PAG levels at 24 and 32 d after TAI. (Wisconsin)
- 3) Low relative PAG levels in both milk and serum resulted in NP and RC outcomes in pregnant cows using these assays and that both parity and milk production affected relative PAG levels in milk and serum. (Wisconsin)
- 4) Both clinical and subclinical mastitis influenced P/AI and differences in P/AI were observed among etiologies and clinical presentation. (Wisconsin)
- 5) Delaying the timing of AI, the second injection of GnRH, or both, may be warranted to allow enough time for progesterone concentrations to decrease sufficiently in response to a larger dose of PG on d 6 to prevent a reduction in conception. (Kansas)
- 6) Progesterone status preceding synchronization was explored in a large number of cows exposed to CO-Synch-like synchronization programs. Consistent in all models were the significant effects of progesterone supplementation, hormone initiating the synchronization program, parity, BCS, days postpartum, and progesterone status assessed in 3 ways. Progesterone status at the onset of synchronization was not critical to pregnancy outcome in multiparous cows, whereas pregnancy rate per AI was suppressed in primiparous cows starting in a low-progesterone environment (metestrus, estrus, or anestrus). Progesterone status at the onset of the synchronization program is critical to pregnancy outcomes in primiparous but not multiparous cows, reinforcing the necessity of developing heifers adequately for early puberty to increase the proportion that calve early in the calving season, which is related to their first postpartum reproductive performance. (Kansas)
- 7) By using estrus-detection patches and inseminating cows at 2 different times, one can maximize the number of AI-achieved pregnancies without significantly more labor. (Kansas)
- 8) Cows with an activated patch at 58 h had higher pregnancy rates than cows with unactivated

- patches. The interaction between patch status and PGF2 α to timed AI interval could be of importance for increasing precise timing of AI in mature beef cows. (Nebraska)
- 9) Pregnancy rates were greater for CO-Synch + CIDR compared to the CO-Synch synchronization protocol, resulting in more calves born earlier in the calving season and a \$55.22/cow increased net return utilizing the CO-Synch + CIDR protocol. (Nebraska)
 - 10) Ovulation in response to GnRH-1 at the onset of the 5dCO protocol reduced estrous response and timed-AI pregnancy rates in suckled beef cows. (Minnesota)
 - 11) Omission of the initial GnRH treatment in the 5-d CO-Synch + CIDR program did not influence TAI pregnancy rate in yearling beef heifers. Moreover, an additional dose of PGF at CIDR removal did not improved fertility in these yearling beef heifers, regardless of whether or not the initial GnRH treatment was given. (Minnesota)
 - 12) There may be a potential to improve FTAI pregnancy rates by delaying insemination of non-estrous females. Use of an estrus detection aid may be useful for producers in classifying females as having expressed estrus or as having failed to express estrus prior to FTAI. Females classified as having expressed estrus could be inseminated at the standard time, and females classified as not having expressed estrus could receive GnRH followed by insemination 20 h later. (Missouri)
 - 13) A meta-analysis revealed that among all currently recommended fixed-time AI protocols (CO-Synch, CO-Synch+CIDR, 5-d CIDR, PG 6-d CIDR, and the 14-d CIDR protocols), cows expressing estrus before fixed-time AI improved conception rates, and BCS and estrus-cycling status had the greatest influence on expression of estrus. (South Dakota)
 - 14) Pregnancy success was significantly influenced by time of insemination and estrus expression, but was not influenced by semen, or any interactions. (South Dakota)
 - 15) Administration of PGF2 α at CIDR insertion of the CO-Synch + CIDR protocol decreased concentrations of P4 and increased dominant follicle diameter at CIDR removal, but failed to increase TAI pregnancy rates in suckled beef cows. (Florida)
 - 16) Administration of PGF2 α at CIDR insertion of the CO-Synch + CIDR protocol decreased concentrations of P4 and failed to increase dominant follicle diameter at CIDR removal and failed to increase TAI pregnancy rates in suckled beef cows.
 - 17) Breeding system of origin did not influence growth rate during the development phase, attainment of puberty, or pregnancy rates in crossbred beef heifers. (North Dakota)
 - 18) When modified-live or killed pre-breeding vaccines were administered per label recommendations no impacts on pregnancy attainment of calving distribution were observed. (North Dakota)
 - 19) Managing cow-calf pairs for a 10 d synchronization period in a dry lot setting did not have detrimental effects on pregnancy rates in beef females but reductions in calf weights were still observed on d 35 after breeding compared with cattle managed on pastures. (North Dakota)
 - 20) Low dose aspirin consumption in beef heifers did not impact ovulation to an ovulation synchronization protocol or concentrations of progesterone during the subsequent luteal phase up to d 14. (North Dakota)
 - 21) The PregCard system allowed us to evaluate the impact of routine management practices on reported pregnancy rates in groups of beef females. (North Dakota)
 - 22) Administration of 25 mg PGF 24 hours prior or 12.5 mg PGF at the initiation of the CO-Synch + CIDR protocol does not improve pregnancy rates. (Illinois)
 - 23) Managing calving distribution data to improve reproductive decisions in beef herds in the northern plains. Preliminary results from 14 herds (3253 cows) indicate that approximately

43 % of the herds participating had an average calving day greater than 21. There is continued difficulty with record keeping/data management on the majority of these ranches. (US MARC)

- 24) The influence of puberty and antral follicle count on calving day in cross-bred beef heifers was examined. There was no relationship between puberty and calving day; however, when heifers were classified based on calving period, pre-breeding antral follicle number decreased as calving period increased. The average antral follicle count was not less than the cut-off that has been used to categorize a cow as “Low” and indicates that these arbitrary cut-offs may be of limited value. (US MARC)

IMPACTS

1. Results from current and ongoing research have been used to make recommendations to stakeholders and their consultants regarding implementation of systematic synchronization and resynchronization systems for lactating dairy cows as well as timing and methods for pregnancy diagnosis.
2. Using estrus-detection patches as part of a fixed time AI program allows managers to inseminate beef cows in two groups. The first group includes cows detected in estrus, which are inseminated at 60 h after the end of the program, whereas in the second group of cows not in estrus at 60 h, AI is delayed approximately 15 h. In doing so, the percentage of cows with AI calves in the first group should average 65% and that in the second group should average more than 50%. As a result, for the same or lesser amount of input costs for materials, the proportion of AI calves should increase by 50%.
3. Analysis of previous studies involving more than 8,500 suckled beef cows. Management changes that increase body condition scores of cows that result in earlier calving during the next calving season may increase their AI pregnancy outcomes in the next breeding season by 25 to 30%. In addition, pregnancy outcomes in 2-year-old cows can be improved by increasing their progesterone status before the breeding period. Treatments that induce earlier estrous cycles are possible remedies in addition to earlier breeding of heifers compared with the cow herd so heifers calve earlier in their first breeding season as cows. Pregnancy rates per AI in 2-year-old cows that initiated estrous cycles before applying a fixed time AI program were increased by 30% compared with their anestrus contemporaries.
4. Low input heifer development systems have resulted in a significant savings per pregnant heifer over conventional heifer development systems.
5. Synchronization systems decrease date of conception during the breeding season.
6. In beef cows, failure to respond to GnRH-1 at the onset of the 5-d CO-Synch + CIDR protocol did not negatively impact pregnancy rates, rather, cows failing to ovulation to GnRH-1 had greater timed-AI pregnancy rates. These results suggest that the necessity of GnRH-1 in the 5-d protocol in beef cows be investigated.
7. In beef heifers enrolled in the 5-d protocol, the administration of GnRH at CIDR insertion is not required. Furthermore, a single dose of prostaglandin is adequate for ovulation synchronization. Such a modification reduces the cost of implementing this protocol.
8. Development of breeding strategies that optimize FTAI pregnancy rates when using sex-sorted and conventional semen are timely given the need to rebuild the US beef cow herd.
9. Selecting only cows that have exhibited estrus before timed artificial insemination can improve pregnancy success.
10. Researcher have also documented that the adaptation of TAI results in a \$49.14 advantage per exposed cow compared to natural service. Therefore, in FL alone each, if every cow were to be

exposed to an estrous synchronization and artificial insemination protocol it would increase profitability of the FL beef cattle industry by \$82.3 million per year.

11. Based on economic research, the AI Cowculator is a smartphone application for Android and iPhone/iPad users that may be downloaded free of charge and is a decision aid tool to assist producers to determine whether they should consider TAI rather than purchasing herd sires for their cow herds. This application has been downloaded by 1,025 people in 38 states and four countries. In addition, the excel version of the economic model has been downloaded 138 times by industry professionals. The Facebook page developed as a support supplement to the AI Cowculator has received 430 'likes' and reaches between 50 and 900 readers for every post.
12. We developed a novel animal model that allows us to collect uterine endometrium and placental tissues in a fiscally responsible manner during the understudied windows of early pregnancy.
13. A breeding system that incorporated a single fixed-time artificial insemination resulted in similar year-end pregnancy rates, an earlier average calf birth date, lower birth weights, and heavier calves born within the first 21 days of the calving season compared to a breeding system that relayed solely on natural service.
14. We established a system to monitor real-time pregnancy rate data in the Upper Great Plains and subsequently enabled veterinarians to provide individual consultation on 1,782 beef operations representing 242,967 beef females. This system capitalized on the opportunity to capture a portion of the data that sentinel veterinary clinics can provide our industry and allowed us to evaluate the impact of recommended best management practices on herd level reproductive performance.
15. While reproductive traits are lowly heritable, the identification of polymorphisms in signaling cascades of hormones indicate that marker assisted selection using these polymorphisms may be the best way to improve response to exogenous hormones and insure that fertility is not negatively impacted by selection for production traits. Understanding these pathways may also help to decrease the variation we observe in response to estrogens and progestins in synchronization protocols.
16. Nutritional programming in the post-weaning period can improve ovarian development, leading to increased herd life.
17. Educating producers on using calving records to understand their calving distributions can aid them in making proper reproductive management decisions for their herd.
18. Pre-breeding ultrasounds to evaluate the status of the reproductive tract can help in selecting beef heifers that will calve early to increased life time productivity.
19. Isolating factors that affect reproductive efficiency in cattle is of growing importance as we work to improve overall production efficiency in efforts to feed a growing human population. These experiments and the techniques developed in them can facilitate the research necessary to improve reproductive efficiency and beyond. These discoveries are not only important for the science but also for the individual producer working to make the system profitable.

PUBLICATIONS

PEER-REVIEWED JOURNAL ARTICLES:

Carvalho, P. D., J. N. Guenther, M. J. Fuenzalida, M. C. Amundson, M. C. Wiltbank, and **P. M. Fricke.**

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- Stevenson, J. S.**, S. L. Pulley, and S. L. Hill. 2014. Pregnancy outcomes after change in dose delivery of prostaglandin F2 α in a 5-day timed artificial insemination program in lactating dairy cows. *J. Dairy Sci.* 97: In press.
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MEETING PROCEEDINGS AND PRESENTATIONS

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- Fricke, P. M.**, J. O. Giordano, P. D. Carvalho, A. Valenza, G. Lopes Jr., and M. C. Amundson. 2014. Expression and detection of oestrus in dairy cows: the role of new technologies. British Society of Animal Science (BSAS) Fertility Conference, May 19-21, Westport, Ireland.
- Fricke, P. M.** 2014. Setting up cows for first postpartum artificial insemination. Merck Animal Health Vet Meeting, May 7, Armagh, Northern Ireland.
- Fricke, P. M.** 2014. Strategies for resynchronization of ovulation and timed AI. Merck Animal Health Vet Meeting, May 7, Armagh, Northern Ireland.
- Lucy, M. C., **P. M. Fricke**, and S. T. Butler. 2014. Using timed AI to get more pregnancies in late-calving cows. Irish Farmers Journal.
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- Fricke, P. M.** 2014. Reproductive challenges of high-producing dairy cows managed on pasture. CEVA Ireland PRID-E launch. February 7, Thurles, Ireland.
- Fricke, P. M.** 2014. Reproduction workshop. Alta Genetics RCTC training session, March 11, Grasberg, Germany.
- Endecott, R.L., **R.N. Funston**, J.T. Mulliniks, and A.J. Roberts. 2014. Beef heifer development and lifetime productivity. *Proc. 46th Beef Improvement Federation Symposium*. Lincoln, NE. Pp. 56-62.
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