

NCERA057: Swine Reproduction

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Location of the NCR-26 and NCR-57 (NCERA057) Committee Meetings

1961	University of Illinois
1962	Iowa State University
1963	University of Missouri - Columbia
1964	University of Nebraska
1965	Purdue University
1966	University of Wisconsin
1967	University of Illinois
1968	Beltsville
1969	University of Minnesota
1970	Ohio State University
1971	Kansas State University
1972	Michigan State University
1973	Iowa State University
1974	University of Nebraska
1975	North Dakota State University
1976	University of Missouri - Columbia
1977	Purdue University
1978	University of Wisconsin
1979	Purdue University
1980	South Dakota State University
1981	Ohio Agricultural Research & Development Center
1982	R. L. Hruska Meat Animal Research Center
1983	Beltsville Agricultural Research Center
1984	University of Missouri - Lincoln
1985	University of Illinois
1986	University of Minnesota
1987	Pennsylvania State University
1988	Ohio State University
1989	University of Nebraska
1990	Kansas State University
1991	North Dakota State University
1992	Iowa State University
1993	University of Missouri - Columbia
1994	Oklahoma State University

1995	University of Wisconsin
1996	R. L. Hruska Meat Animal Research Center
1997	Beltsville Agricultural Research Center
1998	University of Missouri - Lincoln
1999	Purdue University
2000	University of Illinois
2001	University of Missouri - Columbia
2002	University of Nebraska - Lincoln
2003	Kansas State University
2004	Iowa State University
2005	University of Wisconsin-Madison
2006	North Carolina State University
2007	Michigan State University
2008	Purdue University
2009	West Virginia University
2010	University of Illinois (Maschhoff Farms)
2011	R. L. Hruska, U.S. Meat Animal Research Center, Nebraska
2012	Iowa State University
2013	Beltsville Agricultural Research Center, Maryland
2014	University of Nebraska
2015	Kansas State University
2016	University of Missouri

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			2017	Chair Secretary	L. Rempel J. Clapper

Project/ Activity Title: NCERA57 – Swine Reproductive Physiology (Multistate Research Coordinating Committee and Information Exchange Group)

Date of Annual Report: 06/10/2016

Annual Meeting Dates: 05/24/2016 - 05/25/2016

Period the Report Covers: 10/01/2015 - 09/01/2016

In Attendance:

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Summary of Minutes:

On Tuesday, May 24, welcome and introduction was given by institutional co-host, Dr. Tim Safranski. Dr. Tom McFadden, Director of the Division of Animal Science, gave an overview of the University of Missouri – College of Agriculture, Food and Natural Resources (CAFNR), of which, approximately 500 undergraduate and 60 graduate students are within the Animal Science curriculum. Current Chair, Dr. Jean Feugang, Mississippi State, opened the annual meeting portion with greetings followed by station reports.

Station Reports: Each institution provided a brief presentation of current research with group discussions.

1. Kansas State University, Dr. Duane Davis
Studies are currently underway to evaluate piglet birth weight consistency with neonatal development. Lighter weight barrows at birth had increased backfat thickness at finishing. Work has found that brain sparing occurs as early as day 60 gestation in piglets with intrauterine growth restriction. And expression of Early Growth Response-1 (EGR-1) from Wharton's jelly (product from the umbilical cord region) was inversely related to birthweight and piglet survival.

2. University of Nebraska, Dr. Brett White

Gonadotrophin Releasing Hormone-II (GnRH-II) in the boar testis was much greater than that present in the hypothalamus, anterior pituitary, or other secondary male tissues (e.g. prostate, bulbourethral gland, etc). Early work has also observed putative changes between testis expression of GnRH-II in pre- and post-pubertal boars. Transgenic pigs with disrupted GFP-GnRH-II have similar body weights through 300 days of age in comparison to wild-type contemporary pigs. Knockdown of GnRH-II in these boars, yields reduced testosterone and predicted testis volume in comparison to control boars.

3. Iowa State University, Dr. Jason Ross

Heat stress in swine operations has a major economic impact and heat-tolerant gilt identification could improve seasonal fertility. Studies at Iowa State have observed that increased heat stress was not correlated with decreased feed intake, therefore physiological response was different than biological response. Identified 'heat-susceptible' gilts had elevated thermoneutral temperatures and greatly increased in response to heat-stress in comparison to 'heat-tolerant' gilts. Heat-susceptible gilts exposed to elevated temperatures during follicular development and bred had piglets with increased crown-rump lengths, greater birth weights, but no effect on litter size or ovulation rate. *In utero* fetal heat-stress caused an increased fat:protein at finishing weight.

4. University of Illinois, Dr. David Miller

Data were provided investigating the sugar complexes associated with sperm receptors and oviduct environment. Specifically, sperm receptors (PKDREJ, ADAM-5, and lactadherin) bind to sugar complexes (e.g. sulfated Lewis-X and sialylated lactosamine) within the oviduct. These glycan associations increase the sperm lifespan thereby improving fertilization opportunity. Furthermore the sperm storage within the oviduct by association with glycans may facilitate appropriately timed sperm capacitation.

The business meeting and station reports were suspended until Wednesday morning for the mini-symposium – *Interactions of Health and Reproduction in Swine*. The mini-symposium was attended by approximately 60 people and presentations were given by Dr. Aaron Lower, Carthage Veterinary Services; Mike Diggs, Smithfield Hog Production; Dr. Matt Culbertson, Genus PIC; Dr. Ryan Dilger, University of Illinois; and Dr. Randall Prather, University of Missouri.

The business meeting reconvened Wednesday, May 25 at 8:00 am. It was decided that next year's meeting would be held at the conclusion of the International Conference on Pig Reproduction, June 11-14, 2017, Columbia, MO. Dr. Jeff Clapper was selected as Secretary and Dr. Lea Rempel was approved as Chair. Let the minutes reflect that discussions about locations for 2018 and 2019 included Brookings, SD (SDSU) as an excellent location for the 2018 meeting/mini-symposium with the new swine research and educational facility as well as a large commercial and production swine base in SD and MN and Starkville, MS (MS State) as the 2019 meeting location.

All committee members and guests expressed their sincere appreciation to the Missouri hosts, Drs. Tim Safranski and Rod Geisert, for their gracious attitude and exceptional venue. Furthermore, it was recognized and appreciated that the mini-symposium was sponsored by Pork Checkoff funds and the University of Missouri, CAFNR.

In memoriam, members reflected upon the life and significant contributions of Dr. Phil Dziuk in the area of reproductive physiology. Dr. Dziuk, a founding member of this committee, passed away late last year and it was the wishes of his surviving family that it not be announced until recently. It was proposed that special recognition be given in honor of Dr. Dziuk at the 2018 mini-symposium.

Station Reports (cont'd)

5. USDA, ARS, Beltsville Agriculture Research Center, Dr. Timothy Ramsay
Scientists at BARC are actively investigating the identification of biomarkers in neonatal piglets that can be used to predict growth trajectory even in the absence of decreased birthweight. Levels of an acute phase protein at birth (alpha-1 acid glycoprotein), had an inverse relationship with average daily gain through weaning and was not influenced by parity structure or litter size. Metabolic pathways were also influenced between slow- and fast- growing littermates with similar birthweights.
6. University of Missouri, Dr. Rod Geisert and Ashley Hobbs (MSc student)
Work in the Geisert lab has begun using CRISPR technologies to evaluate targets associated with embryo elongation and uterine attachment. Ms. Hawes described her efforts using CRISPR technology to modify COX2 in which she hopes to generate a biallelic knockout for studies. Dr. Geisert briefly talked about delayed implantation in pigs. As part of a class project, students implanted IVF pig embryos into a delayed pregnant rat uterus to evaluate the embryonic response to an asynchronous environment.
7. Mississippi State, Dr. Jean Feugang
Dr. Feugang's research has been working on nanotechnology for the improvement of boar fertility. To eliminate poor quality sperm from extended semen nanopurification procedures were conducted prior to artificial insemination. In comparison to females bred with non-purified semen, nanopurified semen yielded heavier birthweight piglets. Additional studies will be conducted to increase accuracy of results.
8. USDA, ARS, US Meat Animal Research Center, Dr. Jeremy Miles
Within litter birthweight variation may be established as early as embryo elongation. Dr. Miles in collaboration with University of Nebraska investigator, Dr. Angela Pannier developed an *in vitro* elongation culture platform to study the activities around the time of initiation of elongation. Embryos were collected from donor gilts on d9, d10, and d11 post-insemination and encapsulated in an alginate gel compound then cultured in media for up to 96 hours. Metabolomic profiling efforts using embryos flushed from d9, d10, and d11

Dr. Geisert provided a tour of the Animal Science facility including labs and animal housing. Prior to concluding the meeting a brief discussion on the emerging concern in the swine industry of uterine prolapses was held. The meeting was officially adjourned.

Accomplishments:

Committee members acknowledged the growing concern of uterine prolapses in today's industry and made commitments to initiate investigations. Several labs are looking into the marketing of putative assays to assist with swine production. These areas of research include; the use of nanotechnology to filter/purify semen prior to insemination, glycan and sperm receptor interactions to enhance fertility, and identifying biomarkers that can assist with identifying young pigs that will have a reduced growth trajectory.

Several participants had recently applied for funding from the National Pork Board for a special boar seasonality call. Dr. Tim Safranski and colleagues received the proposal funding in which heat-stress upon boars will be evaluated.

Impacts:

Reported peer-reviewed publications from the cooperating institutions within the NCERA-57 group yielded 63 manuscripts associated with reproduction and an additional 35 publications related to animal physiology or genetics.

Iowa State and Missouri continue a group effort in studying the effects of heat stress in utero and the performance outcomes of progeny from this stress environment. USMARC and Wisconsin will be summarizing their collaboration, investigating the use of semen selected by Harmonic analysis of head shape on establishment of pregnancy during winter or summer.

Publications: For SAES-422 reports list the publications for **current** year only (with the authors, title, journal series, etc.). If the list exceeds the maximum character limit below, an attachment file may be used. (Max characters = 50,000. Single line breaks are not preserved, use double line breaks instead or use a <p> tag to separate paragraphs.)

Boar Performance (IL, MS, NC, IN, MO, NE, USMARC)

Daigneault B, McNamara K, Purdy P, Krisher RL, Knox RV, Rodriguez-Zas SL, Miller DJ. 2015. Enhanced fertility prediction of cryopreserved boar sperm using novel sperm function assessment. *Andrology*. DOI:10.1111/andr.12035.

Gonzalez-Peña, D., R. V. Knox, M. D. MacNeil, and S. L. Rodriguez-Zas. Genetic gain and economic values of selection strategies including semen traits in three- and four-way crossbreeding systems for swine production. 2015. *J. Anim. Sci.* 93:879-891.

Gonzalez-Pena, D, Knox, R.V., Rodriguez-Zas, S.L. 2016. Contribution of semen trait selection, artificial insemination technique, and semen dose to the profitability of pig production systems: A simulation study. *Theriogenology*. 85:335-44.

Knox, R.V., J. M. Ringwelski, K. A. McNamara, M. Aardsma, and M. Bojko. 2015. The effect of extender, method of thawing and duration of storage on in-vitro fertility measures of frozen-thawed boar sperm. *Theriogenology* 84:407-412.

Knox, R.V. 2015. The fertility of frozen boar sperm when used for artificial insemination. *Reprod. Dom. Anim.* 50 (Suppl 2):90-7.

Machado S, Kadirvel G, Bovin N, Miller DJ. 2015. Oviduct glycans regulate Ca²⁺ influx, protein tyrosine phosphorylation and viability of sperm. Submitted.

Miller DJ. 2015. Regulation of sperm function by oviduct fluid and epithelium: Insight into the role of glycans. *Reprod Domestic Anim* 50(Suppl 2): 31-39. doi: 10.1111/rda.12570.

Pedroso-Silva E, Frost D, Li L, Bovin N, Miller DJ. 2016. Identification of lactadherin as a Lewis X trisaccharide binding protein in porcine sperm. (Submitted)

Feugang JM, Greene JM, Sanchez-Rodríguez HL, Stokes JV, Crenshaw MA, Willard ST, Ryan PL. Profiling of relaxin and its receptor proteins in boar reproductive tissues and spermatozoa. *Reprod Biol Endocrinol*. 2015 May 20;13:46. doi: 10.1186/s12958-015-0043-y.

Flowers, W.L. 2015. Factors affecting the efficient production of boar sperm. *Reprod. Dom. Anim.* 50(suppl. 2), 25-30.

Flowers, W.L. 2016. Current strategies in boar management. *Proceedings, Reproduction Workshop, 2016 Annual Meeting of the American Association of Swine Veterinarians*, 17- 23.

Cabezón FA, Stewart KR, Schinckel AP, Barnes W, Boyd RD, Wilcock P, Woodliff J. Effect of natural betaine on estimates of semen quality in mature AI boars during summer heat stress. *Anim Reprod Sci.* 2016 Mar 22. pii: S0378-4320(16)30095-1. doi: 10.1016/j.anireprosci.2016.03.009.

Desaulniers, A.T., W.R. Lamberson, T.J. Safranski. 2016. Prenatal heat stress reduces male anogenital distance at birth and adult testis size, which are rescued by concurrent maternal *Artemisia absinthium* consumption. *J. Thermal Biology*, 57: 84-91.

Brauer, V.M., J.R. Wiarda Bell, A.T. Desaulniers, R.A. Cederberg and B.R. White. 2016. Functional activity of the *Gnrhr2* gene promoter in testis-derived cells is partially conferred by nuclear factor- κ B, specificity protein 1 and 3 (SP1/3) and overlapping early growth response 1/SP1/3 binding sites. *Gene* (In Press).

Desaulniers, A.T., R.A. Cederberg, G.A. Mills, J.J. Ford, C.A. Lents and B.R. White. 2015. LH-independent testosterone secretion is mediated by the interaction between GnRH2 and its receptor within porcine testes. *Biol. Reprod.* 93:45.

Thorson, J.F., A.T. Desaulniers, C. Lee, B.R. White, J.J. Ford and C.A. Lents. 2015. The role of RFamide-related peptide 3 (RFRP3) in regulation of the neuroendocrine reproductive and growth axes of the boar. *Anim. Reprod. Sci.* 159:60-65.

Sow and Gilt Performance (IL, IA, NC, IN, MO, USMARC)

Knox, R.V. Artificial insemination in pigs today. *Theriogenology*. 2016.85: 83-93.

Knox, R.V. 2015. Recent advancements in the hormonal stimulation of ovulation in swine. *Vet. Med.: Research and Reports*. 6:309-320.

Nteeba, J., Sanz-Fernandez, M.V., Rhoads, R.P., Baumgard, L.H., Ross J.W., Keating, A.F. 2015 Heat stress alters ovarian insulin mediated phosphatidylinositol-3 kinase and steroidogenic signaling in gilt ovaries. *Biology of Reproduction*; 92:148.

Flowers, W.L. 2016. An update of factors affecting sow longevity. *Proceedings, Reproduction Workshop, 2016 Annual Meeting of the American Association of Swine Veterinarians*, 32-37.

An R, Wang C, Turek J, Machaty Z, Nolte DD. Biodynamic imaging of live porcine oocytes, zygotes and blastocysts for viability assessment in assisted reproductive technologies. *Biomed Opt Express*. 2015; 6:963-976.

Lee K, Davis A, Zhang L, Ryu J, Spate LD, Park KW, Samuel MS, Walters EM, Murphy CN, Machaty Z, Prather RS. Pig oocyte activation using a Zn²⁺ chelator, TPEN. *Theriogenology*. 2015; 84:1024-1032.

Wang C, Zhang L, Jaeger LA, Machaty Z. Store-operated Ca²⁺ entry sustains the fertilization Ca²⁺ Signal in pig eggs. *Biol Reprod*. 2015; 93:25.

Calderón Díaz JA, Vallet JL, Lents CA, Nonneman DJ, Miles JR, Wright EC, Rempel LA, Cushman RA, Freking BA, Rohrer GA, Phillips C, DeDecker A, Foxcroft G, Stalder K. 2015. Age at puberty, ovulation rate, and uterine length of developing gilts fed two lysine and three metabolizable energy concentrations from 100 to 260 d of age. *Journal of Animal Science* 93(7):3521-3527.

Freking BA, Lents CA, Vallet JL. 2016. Selection for uterine capacity improves lifetime productivity of sows. *Animal Reproduction Science* 167:16-21.

Miles JR, Vallet JL, Ford JJ, Freking BA, Oliver WT, Rempel LA. 2015. Contributions of the maternal uterine environment and piglet genotype on weaning survivability potential: II. Piglet growth, lactation performance, milk composition, and piglet blood profiles during lactation following reciprocal embryo transfers between Meishan and White crossbred gilts. *Journal of Animal Science* 93(4):1555-1564.

Rempel LA, Vallet JL, Lents CA, Nonneman DJ. 2015. Measurements of body composition during late gestation and lactation in first and second parity sows and its relationship to piglet production and post-weaning reproductive performance. *Livestock Science* 178:289-295.

Vallet JL, Calderón-Díaz JA, Stalder KJ, Phillips C, Cushman RA, Miles JR, Rempel LA, Rohrer GA, Lents CA, Freking BA, Nonneman DJ. 2016. Litter-of-origin trait effects on gilt development. *Journal of Animal Science* 94(1):96-105.

Vallet JL, McNeel AK, Miles JR, Freking BA. 2014. Placental accommodations for transport and metabolism during intra-uterine crowding in pigs. *Journal of Animal Science and Biotechnology* 5(1):55.

Vallet JL, Miles JR, Rempel LA, Nonneman DJ, Lents CA. 2015. Relationships between day one piglet serum immunoglobulin immunocrit and subsequent growth, puberty attainment, litter size, and lactation performance. *Journal of Animal Science* 93(6):2722-2729.

Wright EC, Miles JR, Lents CA, Rempel LA. 2016. Uterine and placenta characteristics during early vascular development in the pig from day 22 to 42 of gestation. *Animal Reproduction Science* 164:14-22.

Growth, Development, Physiology (BARC, IA, NC, MO, USMARC)

Ramsay TG, Stoll MJ, Blomberg le A, Caperna TJ. 2016. Regulation of cytokine gene expression by orosomucoid in neonatal swine adipose tissue. *Journal of Animal Science and Biotechnology* 7:25. doi: 10.1186/s40104-016-0081-0.

Ramsay TG, Blomberg L, Caperna TJ. 2016. α 1-acid glycoprotein inhibits lipogenesis in neonatal swine adipose tissue. *Animal* (5):812-820. doi: 10.1017/S1751731115002414.

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Sanz Fernandez, M.V., Johnson, J.S., Abuajamieh, M., Stoakes, S.K., Seibert, J.T., Cox, L., Kahl, S., Elsasser, T.H., Ross, J.W., Isom, S.C., Rhoads, R.P., Baumgard, L.H.. 2015. Effects of heat stress on carbohydrate and lipid metabolism in pigs. *Physiological Reports*; 3: e12315.

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