

# ANIMAL PRODUCTION PORTFOLIO



## Knowledge Area 301: Reproductive Performance of Animals Highlights of FY2006 CSREES Investments (\$14.184 million)

### USDA Goal 2:

**Enhance the Competitiveness and Sustainability of Rural and Farm Economies**

### CSREES Objective 2.2:

**Provide Research, Education, and Extension to Increase the Efficiency of Agricultural Production and Marketing Systems**



#### **Characterization of Livestock Sperm that Demonstrate Susceptibility to DNA**

**Denaturation In Situ:** Scientists at **South Dakota State University** used the sperm chromatin structure assay to show that sperm DNA fragmentation is a solid marker for identifying bulls, boars, and stallions at risk of infertility. The sperm chromatin structure assay identifies sperm DNA fragmentation, which is primarily due to oxidative stress. The sperm chromatin structure assay was significantly correlated with fertility while plasma membrane, acrosome integrity, and mitochondrial functionality were not. In boars, ejaculates having more than 8% sperm with DNA fragmentation resulted in lower fertility and smaller litter sizes. Use of the sperm chromatin structure assay to identify low fertility males will lead to higher male breeding efficiencies. (Hatch; CRIS Accession Number 0186180)

**Use of Fourier Harmonic Analysis of Sperm Morphology to Predict Bull Fertility:** The cattle artificial insemination industry needs quality control standards to identify low fertility bull ejaculates prior to distribution to producers. Results of studies conducted at the **University of Wisconsin** revealed that fourier harmonic analysis detected reduced semen quality and was related to *in vitro* fertility measures. Cull sperm had nuclei that were smaller overall, longer, and more pinched in the posterior nuclear region. In all experiments, the fourier harmonic analysis proved to be a superior approach to traditional methods to detect low fertility bulls or ejaculates. (NRI Grant; CRIS Accession Number 0192819)

#### **Large-Scale Production of Sex-Selected Embryos by In Vitro Fertilization (IVF) in Cattle:**

**A New Opportunity for Global Business:** Investigators at **Evergen Biotechnologies, Inc.** demonstrated a feasible system for the large-scale production, cryopreservation, and transfer of sexed IVF embryos produced by sorted semen. High rates of blastocyst development from IVF with sexed sperm, high post-warming survivability of vitrified embryos, and high pregnancy rates were achieved. Thus, this technology demonstrated that sperm sexing, *in vitro* embryo production, vitrification, and embryo transfer are efficient methods to produce livestock of a desired gender for the purposes of herd expansion and rapid genetic replacement. (SBIR Phase I Grant; CRIS Accession Number 0202992)

**Molecular Markers and Mediators of Porcine Uterine Development:** Embryos depend upon the uterus to recognize and integrate maternal and conceptus signals to insure that a supportive uterine environment is established and maintained. Researchers at **Auburn University** provided the first evidence that Indian hedgehog (a secreted morphoregulatory protein that acts via the patched receptor) is expressed in the porcine uterus and regulated developmentally. They also showed that the primary morphoregulatory genes, including Hoxa-10, Hoxa-11, Wnt4, Wnt5a, and Wnt7a are involved in normal and estradiol-17 beta valerate-disrupted uterine organizational events in early postnatal life. Results of this project will provide the first systematic evaluation of normal and aberrant expression patterns for morphoregulatory genes and signaling systems that regulate development and functional programming of uterine tissues in pigs. (NRI Grant; CRIS Accession Number 0196601)

## KNOWLEDGE AREA 301: REPRODUCTIVE PERFORMANCE OF ANIMALS (CONTINUED)

***Expression and Function of the Mx Gene in the Uterus:*** The uterine Mx gene is a type-I interferon inducible gene known to play a role in the antiviral response. Scientists at the **University of Idaho** identified a stimulatory region and an inhibitory region in the distal enhancer of the ovine Mx1 gene. Two interferon-tau response elements in the Mx1 promoter were shown to mediate the stimulatory effects of interferon-tau on expression of the Mx1 gene. The investigators also cloned the Mx2 gene from the ovine uterus and showed that its pattern of expression is similar to Mx1, but Mx2 is expressed in different tissues compared to Mx1. Thus, Mx1 and Mx2 may have different functions in the uterus during early pregnancy. Amounts of Mx1, Mx2, and interferon-stimulated gene-15 protein in circulation are all elevated starting at day 18 after breeding in pregnant cows, whereas levels of these proteins stay low in cattle that have failed to conceive. These gene products are reasonable targets to aid in the early identification of failed pregnancies. (Hatch; CRIS Accession Number 0191033)

***Placental Nitric Oxide and Polyamine Syntheses in Pigs:*** A major problem in swine production is a high prenatal mortality, which is primarily due to placental insufficiency. Arginine is a common substrate for the synthesis of nitric oxide and polyamines that are crucial for placental angiogenesis and growth in mammals. Scientists at **Texas A&M University** showed that arginine supplementation increased the number of pigs born alive by 22% and live litter birth weight of piglets by 24% compared to controls. This novel finding provides the first evidence for a marked increase of live-born piglets by 2 per litter through nutritional intervention in gilts. (NRI Grant; CRIS Accession Number 0189072)

***Recombinant Monomeric Gonadotropins with Enhanced Biopotency:*** Scientists at the **University of California, Davis** used recombinant monomeric proteins that encode components of both luteinizing hormone and follicle-stimulating hormone. In female sheep during seasonal anestrus, the monomeric gonadotropins induced significant ovarian follicle development, ovulation, and formation of functional corpora lutea. In addition, the recombinant monomeric gonadotropins were more potent than pituitary-derived gonadotropins and the duration of the physiological response was markedly extended. These novel recombinant monomeric gonadotropins may be effective alternatives to pituitary- or placenta-derived gonadotropins in induction of multiple ovulations for embryo transfer in cattle and out-of-season breeding in sheep. (Hatch; CRIS Accession Number 0193880)

***Contraception of Mammalian Wildlife:*** Investigators at **Pennsylvania State University** established the safety and long-term efficacy of two different immunocontraceptive vaccines in feral pigs, white-tailed deer, and Nevada mustangs. The first vaccine blocked the synthesis and secretion of gonadotropin-releasing hormone resulting in immunological castration. In female pigs and white-tailed deer, a single injection of the vaccine was at least 80% effective for up to two or four years, respectively. Responses were less consistent in males and antler development was adversely affected in male deer. The second vaccine targeted the zona pellucida and interfered with ovum development or fertilization. A single injection of this vaccine in does and mares was more than 80% effective at five or four years, respectively. Thus, immunocontraception may be an effective tool for dealing with concerns related to over population of wildlife and feral species. (Hatch; CRIS Accession Number 0191287)

***Enhancing Management and Profitability on Small and Mid-Sized Dairy Farms:*** Investigators at **Michigan State University** and collaborators developed a new free online teaching tool (Virtual Dairy Cattle Encyclopedia of Reproduction) which features over 400 pages of readily accessible information, photographs, illustrations, videos, and diagrams on dairy cattle reproductive physiology and tools for successful reproductive management. Bovine reproductive ultrasound workshops were developed to improve reproductive efficiency and pregnancy rates in dairy cattle by decreasing the interval between artificial insemination (AI) services thereby increasing AI service rate. More than 30 workshops were conducted on small- to mid-sized dairy farms in Wisconsin with more than 250 veterinarians in attendance from 24 different states and 2 Canadian provinces. Significant improvements were also made to the timed-AI estrous synchronization program, Ovsynch, so that small and mid-sized producers can utilize this technology to improve reproductive performance of their dairy cows. Education programs on cost-effective heifer management were also developed. Results of research by this team of investigators showed that excessive body fat is a better predictor of impaired mammary development than is rapid body weight gain in dairy heifers. Many small farms could improve profitability equivalent to a 10% increase in first lactation milk yield by decreasing the age at first calving from 28 to 22 months. A new farmer-friendly software program for balancing dairy heifer rations was also developed. This software contains two spreadsheets to help producers determine the value of sexed semen and the most cost effective way to manage heifers. (IFAFS Grant; CRIS Accession Number 0190253)