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U.S. Meat Animal Research Center
Clay Center, NE

50 Years

The U.S. Meat Animal Research Center (USMARC) was authorized by Congress on June 16, 1964, following transfer of the Naval Ammunition Depot from the Department of Defense to the Department of Agriculture. Presently, research programs are using female populations of 6,750 cows, 2,800 ewes, and 400 sows.

Mission

Scientists at the Roman L. Hruska U.S. Meat Animal Research Center (USMARC) are developing scientific information and new technologies to solve high priority problems for the U.S. beef, sheep, and swine industries. Objectives are to increase efficiency of production while maintaining a lean, high quality, safe product; therefore, the research ultimately benefits the consumer as well as the production and agri-business sectors of animal agriculture.

Research Units:

- **Genetics, Breeding & Animal Health:** To define the role of genetics in animal, pathogen, and microbial community interactions in domestic livestock production. Our overall goal is to develop effective genetic strategies that improve meat quality, animal health, and production efficiency.
- **Meat Safety and Quality:** Reduce risk of human illness associated with pathogen contamination of red meat, increase efficiency of lean meat production and improve eating quality of meat.
- **Nutrition and Environmental Management:** Develop knowledge and technology to improve the efficiency of livestock production, and minimize the environmental impact of beef cattle, sheep, and swine.
- **Reproduction:** Increase reproductive efficiency in cattle and swine by decreasing the number of breeding-age livestock required to produce a given number of offspring.

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U.S. Meat Animal Research Center
Genetics, Breeding, and Animal Health Research Unit

Scientists in the Genetics, Breeding, and Animal Health Research Unit are working on high priority challenges of livestock industries in the U.S. such as:

- ***Respiratory Diseases in Cattle and Sheep***
- ***Genomics and Meta-genomics***
- ***Breed Evaluation and Utilization***
- ***DNA Marker Selection and Evaluation***

Respiratory Disease in Cattle and Sheep

Bovine Respiratory Disease Complex (BRDC) and Ovine Progressive Pneumonia (OPP) are two of the most costly diseases affecting the health of U.S. cattle and sheep, respectively. For both BRDC and OPP, scientists are using multidisciplinary approaches to understand the genetics of disease resistance at the pathogen and host levels. These include studies of natural infections, host immune function, pathogen virulence, and whole genome sequencing of animals and their pathogens. The overall goal is to develop effective genetic-based intervention strategies for controlling the major respiratory diseases in cattle and sheep.

OPP Virus, a Major Sheep Pathogen

Mannheimia haemolytica USMARC Strain 192, a Major BRDC Pathogen

Genomics and Meta-genomics

False Color Image of Complex Microbial Community

Advancing DNA sequencing technology is enabling new approaches to studying the challenges facing livestock production. Complete genome sequence, combined with targeted sequencing of genes, for animals in our gene discovery populations are being used to identify differences between individuals contributing to variation in production traits, such as reproductive fitness and disease susceptibility. Recognition that there are more microbial cells than animal cells in and on an animal has led us to begin characterizing the bacterial flora (the "microbiome") present in or on the alimentary and respiratory tracts.

Breed Evaluation and Utilization

16 of 18 Breeds Currently Sampled

Producers create genetic improvement by using differences among breeds, heterosis effects and genetic variation within breeds. Since 1970, scientists at the U.S. Meat Animal Research Center (USMARC) have studied 37 diverse beef breeds and provided information about these genetic effects on many traits affecting efficiency of beef production. The current project evaluates 18 of the most influential beef breeds for genetic changes that have resulted from selection within these breeds. In sheep, a new population of Romanov crossbreds is being developed and evaluated in a pasture-lambing, low-input production system. The goal is an easy-care maternal line of prolific hair sheep balancing prolificacy and maternal ability to raise triplets on pasture with minimal inputs.

DNA Marker Selection and Evaluation

The objective is to identify DNA markers that the beef and sheep industries can use to select for improved meat production and disease resistance. Variations in DNA sequence of animals with diverse performance are being evaluated in breeds commonly used in the U.S. beef and sheep industries. After their initial discovery, the genetic markers are evaluated in additional breeds at USMARC, industry cooperator herds, and international collaborator herds. Validated markers that are predictive for traits of interest are made publicly available for producers to use.

USMARC Lambs Used for Marker Validation

Updated February 2014

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U.S. Meat Animal Research Center
Meat Safety and Quality Research Unit

50 Years

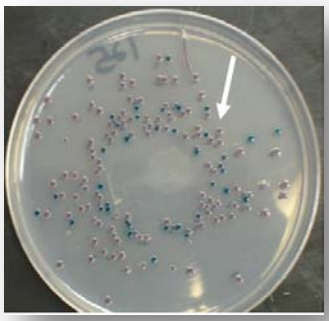
Scientists in the Meat Safety and Quality Research Unit are working on high priority issues of the meat and livestock industries in the U.S. such as:

- ***Post-Harvest Antimicrobial Interventions***
- ***Antibiotic Resistance***
- ***Improved Pathogen Tests***
- ***Pre-Harvest Pathogen Control***
- ***Meat Quality***

Post-Harvest Antimicrobial Interventions

Scientists in the MSQRU have evaluated the efficacy of antimicrobial interventions for a variety of pathogens and products and assessed the effects of the antimicrobials on meat quality. They demonstrated that interventions already used for *E. coli* O157:H7 were effective for non-O157 STECs. In addition, they are evaluating innovative technologies that could become the next generation of interventions such as UV light, electrolyzed oxidizing water, micro-nano bubble, radiant catalytic ionization, and light activated titanium dioxide coatings.

Improved Pathogen Tests



More rapid, sensitive, and specific tests are needed to improve the detection of pathogens on meat and reduce the risk of foodborne illness. MSQRU scientists provided industry with third-party, unbiased evaluations of the accuracy and sensitivity of rapid, DNA-based *E. coli* O157:H7 and non-O157 STEC tests so companies could make informed decisions about which tests to use. They also have used genome sequencing of *E. coli* and *Salmonella* to identify DNA targets to differentiate pathogenic bacteria and provide sensitive and specific pathogen detection.

Pre-Harvest Pathogen Control

Current data indicate "super shedding" animals, those shedding high levels of pathogens in their feces, are responsible for most of the pathogen load on animals and pen surfaces. MSQRU scientists are conducting experiments to better understand the factors that control colonization of the recto-anal junction of the gut and the reasons that some animals become super shedders. These factors could include host animal genetics or immune response, other bacteria present (gut microbiome), and level of environmental exposure to pathogens, or some combination of these factors. In addition, risk of feedlot dust and flies carrying pathogens to produce fields has been demonstrated.

Antibiotic Resistance

MSQRU scientists are addressing the complex issue of the contribution of animal agriculture to the occurrence of antibiotic resistant human bacterial infections. They have demonstrated that therapeutic treatment of disease in feedlot cattle does not increase the occurrence of antibiotic resistant bacteria at harvest. They are investigating the role of production practices on the occurrence of antibiotic resistant bacteria and the differences in antibiotic resistant bacterial populations associated with animal production environment runoff and municipal waste-water treatment discharge. In addition, they have shown lysozyme may be a viable alternative to antibiotics in growing swine.

Meat Quality

MSQRU scientists developed a beef carcass grading system for yield grade and marbling now used in virtually all major beef processing plants and recently have added tenderness prediction capability to the grading system. Scientists have demonstrated that steaks from extreme dark-cutting beef carcasses have significant off-flavors and mild dark-cutting results in less tender steaks. They also demonstrated that freezing and thawing steaks or freezing, thawing, and then aging steaks results in significant improvement in tenderness over traditional fresh aging processes. They are currently working on commercial application of these findings.

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U.S. Meat Animal Research Center
Nutrition and Environmental Management Research Unit

Scientists are conducting research to develop knowledge and technology to improve the efficiency of livestock production, and minimize the environmental impact of beef cattle, sheep, and swine.

Improving feed efficiency

Scientists in the Nutrition and Environmental Research Unit are conducting research to improve feed efficiency by determining the nutrient value of new feed resources and defining how new technologies change nutrient requirements of animals. They identify physiological mechanisms associated with the regulation of feed intake and growth, and identify functional mutations that lead to alterations in feed efficiency.

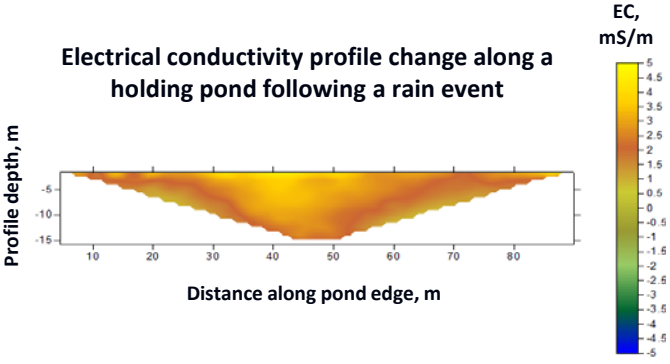
Production efficiency of cow-calf herd

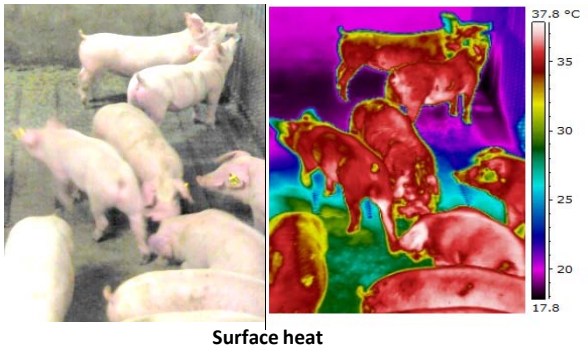
Feed and replacing cows are the greatest input costs associated with the cow herd. Scientists in the Nutrition and Environmental Research Unit are determining what specific nutrients are required by the heifer and the cow in different stages of the production cycle, and the role of nutrition in developmental programming. They are also determining the biological mechanisms responsible for reproductive failure and developing biomarkers to predict reproductive success in the cow herd at younger ages.

Minimizing the impact of livestock on the environment

Scientists and engineers in the Nutrition and Environmental Research Unit are developing new technologies and practices to better manage the impact of livestock production on air, soil, and water quality. They are determining interactions between diet and bedding material in indoor feeding facilities on emissions, and are developing real-time monitoring tools of waste ponds.

Electrical conductivity profile change along a holding pond following a rain event





Surface heat

Precision animal management

Engineers in the Nutrition and Environmental Research Unit are developing new technologies to monitor individual animal behavior and physiology in commercial production settings. Changes in animal behavior or physiology are bio-indicators that can be used to create housing designs to will optimize animal performance. Bio-indicators also can be used to monitor animal health.

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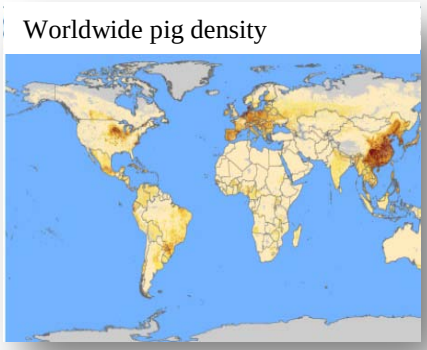
U.S. Meat Animal Research Center
Reproduction Research Unit

50 Years

Scientists in the Reproduction Research Unit (RRU) perform research dealing with Reproduction and Genomics of Swine. Areas of research include:

- ***Whole Genome Analysis***
- ***Development of Genetic Markers for Healthy Pigs***
- ***Basic Reproductive Physiology of Swine***
- ***Translational Physiological Factors Affecting Reproductive Efficiency***



Whole Genome Analysis

Scientists in the RRU contributed to the international consortiums that sequenced the genome and developed the Illumina Swine SNP60BeadChip. The swine chip remains the state of the art for swine genotyping used by researchers and industry worldwide for whole genome analysis of swine. RRU scientists have used the chip to discover genetic markers for a variety of important growth, reproductive, behavioral and meat quality traits. RRU scientists are now using high throughput sequencing of the swine genome to increase the utility of the Illumina chip, and facilitate fine mapping efforts for economically relevant traits.

Development of Genetic Markers for Swine Health and Survival

Scientists in the RRU developed genetic markers that will allow selection of pigs with improved survival and health. Genomic regions have been identified that are associated with stillbirth, colostrum intake, poor reaction to stress, and susceptibility to respiratory diseases. Pigs with a poor response to stress are similar to forms of muscular dystrophy, and pigs with this genotype are now being used as a biomedical model for this disease. Respiratory disease markers could allow for the selection of disease resistant pigs.

Basic Reproductive Physiology of Swine

Scientists in the RRU explore important basic aspects of physiology that control puberty, conceptus and placental development, energy storage and usage and metabolic function as they relate to reproductive efficiency. Recent studies demonstrated the role of kisspeptin in the control of the estrous cycle. In vitro methods to promote conceptus elongation, which is required to obtain adequate placental surface area, were explored. Placental genes involved in development and nutrient transport were defined. Metabolites associated with excessive weight loss during lactation were discovered.

Translational Physiological Factors Affecting Reproductive Efficiency

Scientists in the RRU perform translational research in high priority topics of swine reproduction including sow productive lifetime, efficient gilt development, and piglet preweaning survival. We recently demonstrated that piglets that don't receive colostrum immediately after birth have reduced growth rates and reduced fertility in adulthood. Other ongoing studies include the effects of the size of the litter during the preweaning period on age at puberty and the influence of lactation metabolic stress on retention of sows in the breeding herd.

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