

The 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 6,500 cows, 3,700 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:

- **Animal Health:** Understand the interactions between infectious agents and domestic livestock that result in disease and loss of production.
- **Environmental Management:** Develop management tools for reducing the risks of livestock heat stress and for improving environmental sustainability of livestock feeding operations.
- **Genetics and Breeding:** Understand the role of genetics in livestock production and quality and develop ways to effectively use genetic variation to reduce costs and improve meat quality.
- **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:** Develop knowledge and technology to improve the efficiency of feed resource utilization for the production of edible animal products, while minimizing environmental impact.
- **Reproduction:** Increase reproductive efficiency in cattle and swine by decreasing the number of breeding-age livestock required to produce a given number of offspring.

Providing research for high-impact diseases with molecular and genomic technologies

- DNA-based disease traceback
- Atypical Bovine Spongiform Encephalopathy (BSE)
- Bovine respiratory disease
- Bovine Gene Atlas

DNA-Based Traceback of the 2003 Washington State BSE Case



The first recorded BSE case in U.S. history was announced on December 23, 2003 by Secretary of Agriculture, Ann Veneman. On December 27th, scientists from the Animal Health Research Unit were asked to use DNA markers to help trace the origin of the affected animal. AHRU scientists designed DNA experiments, decoded the results, and wrote the report. On January 6, 2004, USDA's Chief Veterinarian Dr. Ron DeHaven of APHIS announced "We now have DNA evidence that allows us to verify with a high degree of certainty, the [Canadian] birthplace of the BSE-infected cow." Canadian officials concurred.

Atypical BSE

Atypical BSE, is a rare type of "mad cow" disease that is not linked to the consumption of contaminated feed. The second (Texas) and third (Alabama) announced cases of U.S. BSE were atypical. AHRU scientists used molecular and high-throughput genomic approaches to identify a genetic risk factor for atypical BSE susceptibility. Additionally, AHRU research has shown that a majority of U.S. cattle do not harbor this genetic risk factor for atypical BSE.



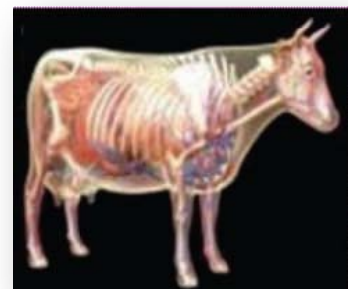
Bovine Respiratory Disease Complex

Bovine respiratory disease complex (BRDC) is the most costly disease affecting beef cattle in U.S. feedlots. Animals infected with BRDC have reduced feedlot performance including lower daily gains and reduced quality grades, and deaths due to BRDC cost the cattle industry over \$1 billion annually. AHRU scientists are using a combination of molecular, cellular, and whole animal approaches to identify animals with increased susceptibility or resistance to this multi-factorial disease, as well as to clarify the roles of the heterogeneous pathogen populations involved.



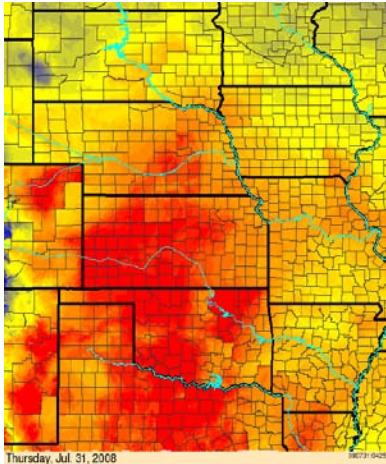
Bovine Gene Atlas

The Bovine Gene Atlas provides gene expression information for 100 tissues from animals used in sequencing the bovine genome. These tissues and gene expression patterns are from animals old and young, and represent important body functions like cardiovascular, digestive, muscular, nervous, reproductive, and respiratory. Scientists world-wide can access and use these gene expression patterns via the internet to answer fundamental molecular genomics questions on their research.



Scientists in the Environmental Management Research Unit are working on high priority environmental issues of the animal feeding industries in the U.S. such as:

- *Heat Stress*
- *Manure Management*
- *Feeding Ethanol Byproducts*
- *Climate Change, Odor, and Air Quality*



Heat Stress

In 2009, a single catastrophic heat wave caused the death of thousands of cattle at an estimated loss of \$20 million. USMARC scientists have developed a website to give a 7-day forecast of cattle heat stress events. By combining our knowledge of animal susceptibility to heat stress with data from the National Weather Service, we are helping producers take action before these critical events occur. The map to the left is a typical example of a heat stress forecast available from the website.

Manure Management

More than 20 million beef cattle are fed in the U.S., producing nearly 100 million tons of manure annually. The fertilizer value of this manure exceeds \$200 million. Improperly managed, manure can result in soil, water, and air contamination. USMARC scientists have developed novel methods for assessing the effectiveness of manure applied to soil as a fertilizer. Also, they have pioneered technologies and methods for evaluating the nutrient and energy value of manure on the feedlot surface. These advances have improved environmental sustainability and reduced the risk of contamination while using manure as a resource.



Ethanol Byproducts

The recent boom in corn ethanol production has produced an abundance of ethanol byproducts. In Nebraska alone, the processing of 16.8 million tons of corn produces 5 million tons of 'distillers grains' byproducts. These byproducts are highly nutritious and are currently being fed to beef and swine. There is evidence that the feeding of ethanol byproducts contributes to increased emissions of odor, phosphorus, and pathogens in the manure. USMARC scientists are investigating methods to reduce the environmental impacts of feeding ethanol byproducts to livestock.

Odor Control and Air Quality

Odor is still one of the most important environmental issues in the vicinity of animal feeding operations. Working collaboratively with large swine feeding operations, USMARC scientists have identified technologies to reduce odor emissions from swine barns by 75%. Ongoing research is focused on reducing odor emissions from wastewater lagoons and feedlot surfaces. By studying the biological and microbial activities of odorant production, we will continue to benefit producers and the public by reducing overall odor emissions from animal feeding operations.

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

- **Genomics**
- **Breed Evaluation**
- **Marker Assisted Selection**
- **Utilization of Genetic Differences**

Genomics



BovineSNP50 Chip (Illumina, Inc.)

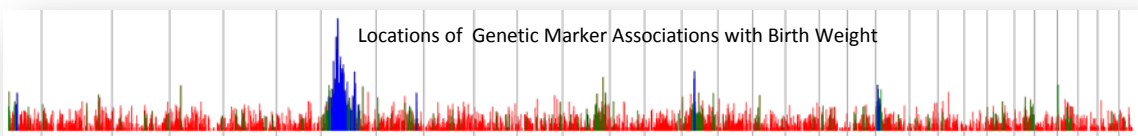
Normal bone Osteopetrosis



The Center contributed to publishing the DNA sequence of cattle in 2009 and then participated in the development of an affordable SNP chip used to quickly genotype 50,000 genetic markers. These markers are spread evenly across the cattle chromosomes to allow identification of genetic differences wherever they occur. An early successful use of this chip to help cattle breeders was the identification of one of the mutations causing osteopetrosis (Marble Bone Disease) in cattle. The genotyping chip helped to identify the location of the mutation which led to a commercial DNA test being available to breeders within 1 year of beginning the research.

Marker Assisted Selection

As new DNA marker technology becomes available, breeders have questions about how to use the technology to select their cattle. Research is underway to identify which markers are associated with important cattle production traits such as feed intake, carcass traits, meat quality, growth, and disease resistance. Additional research is being done to identify how to use this information in selection. National and international collaborations are helping to determine and verify genetic marker associations and to develop the statistical methodology to use the information.



Breeds Currently Sampled

Breed Evaluation

Throughout the history of the U.S. Meat Animal Research Center, evaluation of cattle breeds has successfully provided research information on differences among breeds for many traits important to efficient beef production. In all, 36 breeds have been evaluated as crossbreds, and the beef cattle industry used this information to make dramatic changes. There is now less emphasis in the industry on evaluating new sources of breeds and more on genetic changes resulting from selection within breeds and genetic differences correlated with genetic markers. The structure of this important research project has been changed to emphasize evaluating genetic change within influential breeds and genetic marker associations.

Utilization of Genetic Differences

Sheep producers are often reluctant to use prolific breeds in pasture-lambing, low-input production systems because of the perception that such breeds require extra labor at lambing and that the increased prolificacy will be entirely offset by lower lamb survival. The experimental goal is to create, evaluate, and develop an easy-care maternal line of hair sheep for use in pasture-lambing, low-input production systems. The genetic strategy is to balance prolificacy and maternal ability in Romanov crossbred ewes to realize acceptable lamb survival.



White Dorper x Romanov Ewes with Lambs

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:

- **Pathogen Reduction**
- **Improved Pathogen Tests**
- **Instrument Grading**
- **Protecting the Environment**
- **Emerging Pathogens**

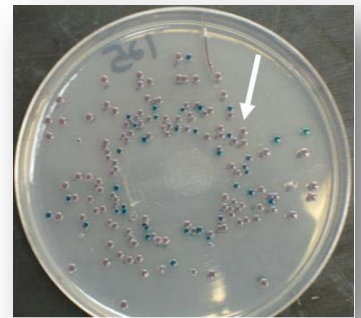


Pathogen Reduction

MSQRU scientists established that meat contamination originates from pathogen contaminated hides during carcass dressing. They subsequently developed a hide-on carcass wash technology that a majority of the beef processing industry has implemented, which greatly reduces the risk of carcass contamination. MSQRU scientists are currently developing less complicated and less expensive versions for small processors.

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 tests so companies could make informed decisions about which ones to use. MSQRU scientists also have collaborated with companies like Dupont Qualicon to provide improved DNA targets which were used to develop an improved *E. coli* O157:H7 test that was released commercially last summer.



Emerging Pathogens

Recognizing and understanding emerging food safety risks are critical for reducing foodborne illness. MSQRU scientists were among the first to investigate the risk of emerging pathogens such as multi-drug resistant (MDR) *Salmonella* and non-O157 Shiga-toxin producing *E. coli* in various stages of meat production. They also are developing DNA-based tests and typing methods to assist regulatory agencies in developing reasonable and effective strategies for regulating these pathogens in meat products. MSQRU scientists provided the first comprehensive baseline study in beef processing indicating the risk of *Mycobacterium paratuberculosis* in beef was very low.

Protecting the Environment



Livestock are a source of pathogens for the contamination of food crops, water, and additional animals in the production system. MSQRU scientists are identifying critical control points and developing approaches for reducing pathogen shedding by cattle and swine, as a means of reducing risk of foodborne illness. In addition, MSQRU scientists are developing procedures for reducing pathogens from animal manure, the production environment, and runoff, thereby minimizing the risk of pathogen contamination of the environment.

Instrument Grading Technologies

The beef industry has needed an instrument grading technology for many years to eliminate the inconsistency in human grading that has been historically used to value beef. MSQRU scientists developed a technology for yield and quality grading beef carcasses that has been implemented by virtually all major beef processors. They also have recently developed a technology for determining the tenderness of beef at the time of grading and are currently developing tenderness models for use on pork.



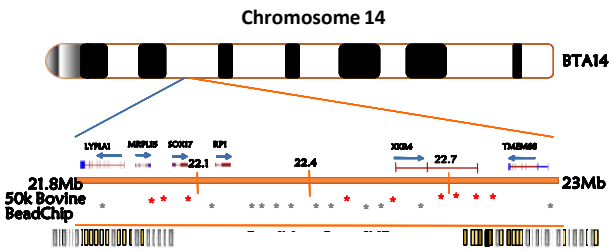
Scientists in the Nutrition Research Unit conduct research to develop knowledge and technology to improve the efficiency of feed resource utilization for the production of edible animal products with minimal environmental impact.

Feed Efficiency

The single largest annual cost of beef production is feed. Increasing the efficiency with which animals convert nutrients in feed to edible product is a potential tool for increasing the profitability of animal production while decreasing the environmental impact of animal production. There is variation amongst animals in their efficiency of feed utilization. Scientists in the Nutrition Research Unit are using new technologies to identify efficient animals and develop genomic markers to allow for marker-assisted selection and management.



Feed Efficiency Facility



Locating Genes Controlling Feed Intake

Regulation of Feed Intake and Growth

Feed intake and growth rate are major contributors to feed efficiency. Understanding the biological mechanisms that regulate feed intake and growth offers the potential to develop technologies to improve feed efficiency. Scientists in the Nutrition Research Unit are identifying genes responsible for the natural variation in rates of growth and feed intake amongst animals, and they are identifying biological mechanisms responsible for the regulation of protein accretion.

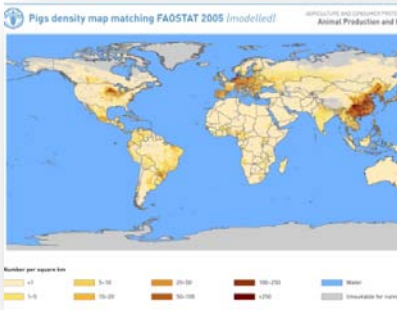
Developmental Programming

Developing replacement females for the cow herd is costly. A heifer has her first calf at two years of age. Three calves are often required in order to recover the costs associated with developing a replacement female. Increasing the length of time that a cow remains in the cow herd reduces the number of heifers that need to be developed each year. Scientists in the Nutrition Research Unit are identifying critical periods during development where malnutrition reduces the time a cow remains in the herd. Scientists are studying the effect of malnutrition during fetal and adolescent development on lifetime fertility, production efficiency, and nutrient utilization.



Scientists in the Reproduction Research Unit perform research dealing with Reproduction and Genomics of Livestock. Areas of research include:

- *Whole Genome Analysis of Swine*
- *Reproductive Efficiency of Swine*
- *Development of Genetic Markers for Pork Tenderness*
- *Fertility in Beef Cattle*



Whole Genome Analysis of Swine

Scientists in the RRU discovered approximately 20% of the genetic markers currently incorporated into the Illumina Swine SNP 60 beadchip, and contributed significantly to the International consortium that developed this valuable resource. The Swine SNP 60 chip is currently being used by swine researchers worldwide for whole genome analysis of swine for a variety of traits. We have also used the chip to genotype approximately 3000 pigs for genetic marker development for a variety of important growth, reproductive, behavioral and meat quality traits that have been collected by scientists in the RRU and other research units at USMARC.

Development of Genetic Markers for Pork Tenderness

RRU scientists, with support from the National Pork Board, further developed genetic markers for pork tenderness based on the Calpastatin gene, a gene known to regulate the tenderization of meat. Results indicated that the newly developed markers were useful in diverse populations of swine. Improvement in pork tenderness has been identified by the National Pork Board as a priority research topic.



Reproductive Efficiency of Swine

We perform research in high priority topics of swine reproduction including sow productive lifetime, efficient gilt development, and piglet preweaning survival. We recently developed a simple, rapid and inexpensive method to measure the success of initiation of nursing between sows and piglets within 24 hours of birth. Failure to nurse contributes to piglet mortality and the method should be useful in developing and assessing management strategies to improve the nursing interaction.

Fertility in Beef Cattle

Physiologists in the RRU are investigating practical methods to improve and assess fertility in cattle. One promising approach is the use of ultrasound to count ovarian follicles. Our studies indicate that the number of follicles on the ovary is associated with pregnancy rates. Ultrasound is a noninvasive technique that could be used to screen replacement heifers entering the breeding herd.

