**National Program 101 Food Animal Production**
**National Program Annual Report: FY2015**

***Introduction***

The USDA-ARS National Program for Food Animal Production (NP 101) had another productive and dynamic year in 2015.

Food animal products fill a vital role in the diets of people around the world as valuable sources of high quality protein, fatty acids, vitamins and minerals. The dramatic improvements in production efficiencies developed and harvested by ARS scientists help ensure international food security and directly impact human health and obesity by reducing the real cost of nutritionally valuable meat animal products, making animal products more available to those populations most in need. Ongoing improvements in production efficiencies also continually lessen the environmental impact of meat animal production by reducing grain and forage requirements and lessening the amount of manure produced. These improvements have dramatically reduced the amount of greenhouse gas emissions produced by livestock and will continue to have impact.

**NP 101 Vision Statement:**
The vision for NP 101 is to furnish the scientific community and the food animal industries with scientific information, biotechnologies, and best management practices that (1) ensure that consumers have an abundant supply of competitively priced animal products that enhance human health, (2) ensure domestic food security, and (3) enhance the efficiency, competitiveness, and economic and environmental sustainability of the food animal industries.

**NP 101 Mission Statement:**
The mission of NP 101 is to foster an abundant, safe, nutritionally wholesome, and competitively priced supply of animal products produced in a viable, competitive, and sustainable animal agriculture sector of the U.S. economy by:

1. Safeguarding and utilizing animal genetic resources, associated genetic and genomic databases, and bioinformatic tools;
2. Developing a basic understanding of food animal physiology for food animal industry priority issues related to animal production, animal well-being, and product quality and healthfulness; and
3. Developing information, best management practices, novel and innovative tools, and technologies that improve animal production systems, enhance human health, and ensure domestic food security.

The scientific accomplishments of the USDA Agriculture Research Service and National Program 101 are truly remarkable and were again well documented in 2015. NP 101 scientists continue to make inroads toward a better understanding of food animal production challenges relating to genomic discovery science and application, growth and production efficiency, lifetime productivity, animal well-being, environmental adaptation, product quality and healthfulness, reduction of feed and energy inputs, enhancements in energy retention, and reduced environmental impact. Application of technologies developed or enhanced by NP 101 scientists promise to continue to address the high priority issues for

consumers while enhancing the profitability and competitiveness of food animal producers across the United States in today's very competitive global agriculture community.

During FY 2015, 87 full-time scientists working at 13 locations across the United States were actively engaged in more than 150 independent research projects in the program. Research projects in NP 101 were approved through the ARS Office of Scientific Quality Review in 2012, making this the third year of implementation of these five-year project efforts. The gross fiscal year 2015 appropriated funding for NP101 was $48 million; total funding was $53 million including extramural awards. Four new inventions were disclosed and 3 patents awarded. Additional technology transfer included 15 Material Transfer Agreement and 7 Material Transfer Research Agreements.

***Personnel in NP 101***

**New additions to the NP 101 team in 2015 are:**
The position of National Program Leader for Food Animal Production was filled in 2015 through a number of Acting Detailees including Dr. LeAnn Blomberg, Dr. Tad Sonstegaard, and Dr. Caird Rexroad.

**El Hamidi Hay,** Miles City, Montana, joined the Fort Keogh Livestock and Range Research Laboratory as a Geneticist.

**Jay Johnson,** West Lafayette, Indiana, joined the Livestock Behavior Research unit.

**The following scientists retired from the ranks in NP 101:**
**Thomas Caperna,** Animal Bioscience and Biotechnology Laboratory, Beltsville, Maryland

**Kreg Leymaster,** Genetics, Breeding and Animal Health Unit, Clay Center, Nebraska

The distinguished record of service of these scientists is recognized world-wide and they will be missed in NP101.

**The following scientists in NP 101 received prominent awards in 2015:**
**John Cole,** Beltsville, Maryland, was the recipient of the Jay L. Lush Award in Breeding and Genetics from the American Dairy Science Association

**George Wiggans,** Beltsville, Maryland, received the Washington, D.C. Area Chapter Vern Pursel Outstanding Animal Scientist Award from the American Registry of Professional Animal Scientists

**R. Mark Thallman,** Clay Center, Nebraska, received the Outstanding Alumni Award from Texas A&M University College of Agriculture and Life Sciences

**In 2015 NP 101 scientists participated in research collaborations with scientists in**: Australia, Austria, Belgium, Brazil, Canada, China, Denmark, Egypt, Finland, France, Germany, India, Israel, Italy, Kenya, Malawi, Mexico, Netherlands, Norway, Poland, Russia, Scotland, Spain, Sweden, Switzerland, Turkey, Uganda, and United Kingdom.

***Major Accomplishments in 2015***

This section summarizes significant and high impact research results which address specific components of the FY2013 – 2018 action plan for the Food Animal Production National Program. Each section summarizes accomplishments of individual research projects in NP101. Many of the programs summarized for FY2015 include significant domestic and international collaborations with both industry and academia. These collaborations provide extraordinary opportunities to leverage funding and scientific expertise for USDA - ARS research to ensure international food security by rapidly disseminating technology that enhances the productivity and efficiency of meat and milk production. Improved production efficiencies decrease the real cost of food and animal products and make these products more available to people worldwide.

## NP 101 Top Accomplishments – FY2015

Accomplishments are listed below that correspond to each of the Components and Problem Statements of the 2013 – 2018 National Program Action Plan.

### Component 1: Improving Production and Production Efficiencies and Enhancing Animal Well-Being and Adaptation in Diverse Food Animal Production Systems

#### *Problem Statement 1A: Improving the Efficiency of Growth and Nutrient Utilization*

***Lysozyme is an alternative antimicrobial for swine production***. Sub-therapeutic levels of antibiotics are used in swine feeds to promote growth, improve feed efficiency, and reduce susceptibility to bacterial infections. As a result, the use of antibiotics improves profitability. However, swine producers are currently under pressure to eliminate sub-therapeutic antibiotic use throughout the production cycle. Finding safe and effective alternatives to traditional antibiotics will give producers viable options in the event traditional antibiotics are no longer allowed. ARS researchers in Clay Center, Nebraska, determined that feeding an antimicrobial enzyme, lysozyme, to nursery pigs was as effective as traditional antibiotics in increasing growth performance, including growth, nutrient accretion, and feed efficiency.

***New dairy dietary starch method will benefit livestock producers and consumers***. Accurate information on feed composition is essential for formulating healthy diets for cows and for informing consumers about the nutritional qualities of the animal feeds and pet foods they purchase. In particular, starch is a carbohydrate in feeds that helps to meet an animal's energy requirements, but it also can cause health disorders if overfed. Consumers and field nutritionists need reliable starch values to better evaluate and develop animal feeds and pet foods. ARS scientists in Madison, Wisconsin, tested and refined a recently improved starch assay to make it more reliable and consistent. The scientists then directed a collaborative study with 14 state, commercial, and research feed analysis laboratories to fully

test the method, which was found to be sufficiently precise and reliable across a range of diverse feedstuffs. An expert review panel appointed by the Association of Official Analytical Chemists International gave the new method First Action approval as AOAC Official Method 2014.10. The new method can now be used for animal feed and pet food labeling to provide producers and consumers with information needed to properly feed their animals, and is also used by commercial feed analysis laboratories to analyze the starch content of feedstocks and ingredients used by field nutritionists to formulate rations for livestock.

***Identification of a major serum protein that inhibits growth in pigs***. Selection by commercial breeders for increased litter size in swine has resulted in a greater incidence of neonates exhibiting slower growth, which has resulted in an approximate loss of 300 million pounds of pork annually in the United States. Biomarkers are needed that predict postnatal growth rates at birth such that producers can maximize their investments. ARS scientists in Beltsville, Maryland, showed that piglets that are small at birth or that grow slowly have an increased serum level of the protein alpha 1-acid glycoprotein (AGP). A rapid and reliable assay was developed that quantifies AGP in blood from newborn pigs and can be used to demonstrate the value of AGP for predicting future growth rates in newborn pigs. This assay will be used in follow-on research to demonstrate selection in a commercial population, with perhaps an industry partner.

***Determination of optimum level of glycerin to include in cattle diets***. Expansion of the biodiesel industry in the United States has increased the supply of glycerin, a sweet, liquid, non-toxic waste product of biodiesel production. Glycerin is energy dense and can be fed to cattle; however, the energy value is not known. ARS researchers in Clay Center, Nebraska, determined that cattle feed intake decreased with increased glycerin intake. Also, cattle lost less energy in the feces as glycerin inclusion increased in the diet, meaning that glycerin was more digestible than the corn it replaced. Cattle consuming 15 percent glycerin retained the least amount of energy and nitrogen. However, a high metabolic cost associated with glycerin at greater than 10 percent was observed. The researchers determined that to optimize animal performance, glycerin should not be fed at greater rates than 10 percent in beef cattle diets.

***Problem Statement 1B: Reducing Reproductive Losses***

***Using ultrasound to select replacement heifers***. Replacement beef heifers must wean between 3 and 5 calves to pay for their development costs. Research conducted at Clay Center, Nebraska, has demonstrated that only 50% of the heifers that enter production in the Plains Area produce 3 calves and that heifers that give birth early in that first season will produce more calves. Researchers at ARS in Clay Center, Nebraska, confirmed previous findings that heifers giving birth early in the calving season have a significantly greater number of ovarian follicles detectable by ultrasonography at pre-breeding examination than heifers giving birth later in the calving season. These findings add to the body of evidence indicating that pre-breeding follicle numbers are predictive of reproductive longevity and profitability of heifers. Having a veterinarian perform an ultrasonographic examination of the ovaries before the breeding season may provide organic beef producers with a means by which they can consolidate the calving season without the use of hormones.

***Programming the fetal bovine immune system***. ARS scientists from the Livestock Issues Research Unit in Lubbock, Texas, and the University of Florida conducted a collaborative study to evaluate the

possibility of prenatally programming the immune system of beef calves. Gestating beef cows were administered a subcutaneous dose of bacterial endotoxin during the third trimester of pregnancy. Calves whose dams had been administered the bacterial endotoxin were more tolerant of the bacterial endotoxin themselves at 6 months of age compared to calves whose dams were not administered the bacterial endotoxin. Specific differences were observed in the febrile response, the pro-inflammatory cytokine response, and the metabolic hormone response due to the single exposure to the endotoxin during fetal development. Thus, clear evidence is provided that fetal programming of the immune system in beef cattle is achievable, and may prove to be a beneficial tool with regard to improving the health and well-being of cattle in the future.

***Preincubation egg storage results in smaller, less developed turkey embryos after 8 days of incubation***. For logistical reasons, commercial hatcheries must store fertilized eggs in cold storage for up to 3 weeks before incubation resulting in progressively higher rates of embryo mortality. ARS scientists in Beltsville, Maryland, stored turkey eggs at intervals from less than 5 days to more than 21 days and then incubated the eggs for 8 days. Negative correlations between the duration of egg storage and both embryo weight and stage of embryonic development were observed suggesting that smaller, less developed embryos as a result of egg storage contributed to embryonic death during incubation. This research will benefit commercial hatchery personnel attempting to reduce embryo mortality associated with egg storage.

***Development of a new genetic tool for turkey producers***. Historically, genetic improvement for commercial turkeys has been achieved using selective breeding programs based on physically measured traits, such as body size and breast muscle development. To improve production for traits that are expensive or difficult to measure, such as those associated with immunity and reproduction, more sophisticated approaches, such as genomic selection, are needed. Genomic selection requires a large number of genetic markers such as single nucleotide polymorphisms (SNPs). ARS scientists in Beltsville, Maryland, in partnership with poultry industry leaders and university collaborators, documented 5.49 million SNPs that are potential markers for genetic improvement, and used this information to develop a commercially available SNP-based assay for the turkey industry. This assay will allow producers to select for traits that are difficult to evaluate.

***Problem Statement 1C: Enhancing Animal Well-Being and Reducing Stress***

***Breed differences for calving ease***. Dystocia or calving difficulty can be a problem in heifers that have not yet achieved full mature size, especially when mated to sires that produce large calves. Sire breed differences for calving ease, or absence of dystocia, do exist, partially because of larger calf birth weights, but also because of other factors such as frame size and calf shape. ARS researchers, using data from the germplasm evaluation program in Clay Center, Nebraska, were able to derive differences in calving ease for 18 different beef cattle breeds. They also were able to develop methods to adjust these differences to the genetic potential of the sires that were sampled using statistical scaling techniques. These differences are being reported to producers to help them make breeding decisions when choosing sires to mate to heifers.

***Yeast supplementation reduces severity of heat stress in beef cattle***. Heat stress is known to affect beef cattle production by reducing growth rates and limiting reproductive success. ARS scientists in Lubbock, Texas, partnered with a commercial partner to specifically evaluate whether a combined live

yeast/yeast cell wall product would reduce the negative impact of a controlled heat stress challenge in a group of commercial feedlot heifers. The scientists found that providing yeast supplements to feedlot heifers for approximately 50 days prior to exposing them to a controlled heat stress improved water intake, reduced body temperature, and reduced weight loss associated with exposure to heat stress. Therefore, yeast supplementation may prove to be a beneficial tool for reducing the negative impact of heat stress on feedlot cattle.

***Yeast fermentation product helps weaned pigs during immune challenge***. ARS scientists from the Livestock Issues Research Unit in Lubbock, Texas, and a commercial partner evaluated the influence of feeding yeast fermentation products to weaned pigs prior to an immune challenge. Weaned pigs were supplemented with yeast fermentation products for 14 days prior to an immune challenge using a bacterial endotoxin. They found that supplementing the diets with the yeast metabolites reduced the febrile response, decreased white blood cell counts, and decreased the stress hormone response following the immune challenge compared to the non-supplemented pigs. Therefore, it appears that supplementing the diets of weaned pigs with yeast fermentation products provides a level of immune protection against bacterial endotoxins.

***Perches for laying hens***. Osteoporosis is widespread in today's commercial laying hens and contributes to approximately 20 to 35 % of all mortalities during the egg production cycle of caged hens. Bone fractures during production are a significant welfare issue because of the chronic pain these hens may experience. ARS researchers at West Lafayette, Indiana, found that mechanical loading on bones achieved through perching has beneficial effects on pullet health by stimulating leg muscle deposition and increasing the bone mineral content of certain bones without causing a concomitant decrease in bone mineral density. These results provide evidence that provision of a perch in the hens' early life has long term benefits to enhance skeletal health and welfare.

**Component 2: Genetic Improvement - Understanding, Improving, and Effectively Using Animal Genetic and Genomic Resources**

***Problem Statement 2A: Develop bioinformatic and quantitative genomic capacity and infrastructure for research in genomics and metagenomics.***

***Identification of genetic variants linked to the presence of lung lesions, a proxy for respiratory disease***. Development of genetic markers that could potentially identify animals at increased risk for experiencing respiratory disease would be an initial step toward reducing the impact of this issue for the beef cattle industry, which costs up to $1 billion dollars annually and is a primary reason for the use of antibiotics in beef production. Previous efforts have relied on the identification of animals with disease by observing them for symptoms, which has been shown to be too subjective to be very reliable. ARS researchers at Clay Center, Nebraska, tried a different approach by examining the lungs of animals postmortem, with lesions being probable indicators of previous infection. The project identified 85 sequence variants associated with the incidence of severe lung lesions, which can be used to help identify biomarkers for incorporation into national sire genetic evaluation and select cattle with reduced susceptibility to respiratory disease, and potentially reduce the use of antibiotics to control disease.

***Improvement of livestock reference genomes***. Genome studies in livestock species have made significant advances in weeding out deleterious mutations, and in improving production traits that are

difficult or expensive to measure. However, genome studies have great reliance on the reference genome sequence assemblies that were made at great expense in the preceding decade. ARS researchers at Clay Center, Nebraska, and Beltsville, Maryland, with university and federal contractor collaborators, have used the latest long-read sequencing technology available at Clay Center to improve the goat and pig reference genome assemblies. Both assemblies have 30-40 times better contiguity, a key measure of quality and utility, compared to the current public reference genomes for those two species. The improved reference genomes are supporting advances in genome analysis and identification of biomarkers, for example DNA variants associated with susceptibility to emerging swine disease.

***Cow breeding programs for resilience to variable climate***. The relationships of calf preweaning gains to dam milk yield and quality may not be the same for all breeds of beef cattle. Scientists at El Reno, Oklahoma, and collaborators at the University of Arkansas, and Gansu Agricultural University, China, determined calf preweaning gains based on milk yield and quality in cows sired by Bonsmara, Brangus, Charolais, Gelbvieh, Hereford, and Romosinuano breed groups, all from Brangus dams. Increases in milk traits beyond a maximum effective level in European breed types, such as Charolais and Gelbvieh, do not always result in improvements in calf performance. Increasing milk traits in Herefords and tropically-adapted breed types has the potential to increase calf preweaning performance, within the range of the data of this study. This information can be useful in refining beef cattle breeding and production programs for better resilience to variable climates.

***Improved detection of DNA mutations in whole genome sequencing***. Several types of structural DNA variations remain difficult to detect within sequenced genomes. Mutations that affect traits of interest often are not simple differences in single-nucleotide polymorphisms but instead are deletions or insertions that can result in false positive detection. An ARS researcher in Beltsville, Maryland, published software for the detection of such variants using the orientation and distance of paired-end and split-read mappings in whole genome DNA sequence data. In simulations and with real data, the method was 27.5 times more precise than two competing programs in detecting tandem duplications and also was able to detect twice the number of duplications. This high degree of precision enables better functional prediction of structural DNA variants from short-read sequence data and allows discovery of many more of the actual mutations that affect traits. Investigators from the University of Missouri, Texas A&M University, and Australia's La Trobe University already are using this software for research projects.

***Problem Statement 2B: Identify Functional Genomic Pathways and Their Interactions.***

***Discovery of genetic markers for temperament***. Flight speed is a measure of the time it takes an animal to traverse a certain distance after being contained in a chute and is considered to be an objective measure of an animal's temperament. As handling cattle is necessary for disease treatment, during breeding seasons, weaning and other various reasons, a calm animal response to handling is important for the safety of both the animal and the handlers. ARS researchers at Clay Center, Nebraska, determined that single nucleotide polymorphisms located on BTA6 that are strongly associated with average daily gain and average daily feed intake and are also associated with cattle temperament. Genetic markers associated with feed intake and body weight gain can also be used to select for temperament in animals.

***Response to vaccination for Marek's disease***. Marek's disease is an avian tumor virus-induced disease and is primarily controlled by host genetics. Since the introduction of vaccines in the 1970s, the influence of host genetics on vaccine protective efficacy has been overlooked by the vaccine and poultry industries. ARS scientists in East Lansing, Michigan, demonstrated that host genetics contributes up to 83 percent of Marek's disease vaccine protective efficacy. Poultry breeders will benefit from this research in knowing of these gene-vaccine interactions, which will allow them to select not only for resistance but for genes that interact with a vaccine treatment in a positive way.

***Problem Statement 2C: Preserve and Curate Food Animal Genetic Resources.***

***Implementation of Animal-GRIN Version 2 information system***. A multi-national internet based information system for animal genetic resources was launched by ARS scientists in Fort Collins, Colorado, in collaboration with scientists from Empresa Brasileria Pesuisa Agropecuaria, and Agriculture and Agri-Foods Canada. The information system allows gene bank managers, government and university scientists, and various stakeholder groups to view germplasm and tissue collections for potential use. Gene bank managers can use the system to assess the status of the collection and identify collection gaps and thereby plan future collection activities. This new version has the ability to compare production parameters of animals with samples in the collection and living populations. Furthermore, this version of the system will allow the gene bank managers in the three countries to compare various aspects of the collection.

***Subpopulations of Hereford cattle exist in varying ecoregions***. Using single nucleotide polymorphisms previously identified as having a role in an animal's ability to cope with environmental stress, an assessment was performed that identified subpopulations of Hereford cattle in specific ecoregions of the United States. The findings suggest that as the full impact of climate change occurs there are groups of cattle which may have a genetic structure that enables them to better cope with such changes.

***Problem Statement 2D: Develop and Implement Genome-Enabled Genetic Improvement Programs.***

***Improved chicken genome assembly to aid genetic and biological studies***. The chicken genome provides the blueprint for the underlying biology of all traits including those that are agronomically important such as growth, reproduction, health, and well-being. ARS scientists at East Lansing, Michigan, in collaboration with investigators at Washington University School of Medicine in St. Louis, Missouri, used advanced sequencing technologies to increase the coverage and length of sequence contigs of the chicken genome assembly. This tool will allow scientists and commercial companies to conduct more complete and accurate studies to identify specific genes and pathways that will result in precision breeding and rearing of chickens with superior agronomic performance. As chicken is the primary meat consumed, this will benefit consumers and society by reducing the amount of feed and waste produced, and increasing health and well-being of reared birds.

***Weekly national genomic evaluation of dairy cattle***. The dairy industry wanted to have a shorter time between collecting DNA samples and receiving genomic evaluations, which were being calculated monthly. ARS researchers in Beltsville, Maryland, developed a method to calculate preliminary genomic evaluations daily or weekly before the release of official monthly evaluations by processing only newly genotyped animals using estimates of single nucleotide polymorphism effects from the previous official evaluation. The Council on Dairy Cattle Breeding implemented this method in

November 2014 for national genomic evaluations. ARS researchers in Beltsville, Maryland, also developed and tested additional methods that allow the weekly computation of evaluation accuracy and inbreeding statistics, and Council implementation in August 2015 is anticipated. The Council provides the evaluations to nominators, dairy records processing centers, and breed associations to facilitate transfer to owners of more than 1 million animals in 44 countries. Earlier access to genomic evaluations benefits producers by enabling earlier sale or culling of animals (or embryos) not needed for breeding purposes to minimize the expense and environmental impact of raising newborn calves.

***Expanded set of genetic variants for use in genomic evaluation of dairy cattle***. Adding additional genetic markers (single nucleotide polymorphisms or SNPs) to genotyping chips can result in genotypes that increase the accuracy of genomic evaluations. As an improved replacement for a high-density SNP chip used for genotyping dairy cattle, ARS researchers in Beltsville, Maryland, selected a set of more than 140,000 SNPs for inclusion into a new genotyping chip that was put into commercial production by Neogen Corporation. ARS researchers tested 140,000 SNPs for their effect on evaluation accuracy; approximately 77,000 of the most informative SNPs were selected for use in genomic evaluations. Holstein evaluations resulted in a gain of 1.4 percentage points in accuracy, and the Council of Dairy Cattle Breeding is expected to use those 77,000 SNPs as the standard for national evaluations by December 2015.

***Introduction of genetic-economic selection index for pasture-based dairy cattle***. Pasture-based dairy producers have costs, revenue streams, and management challenges that often differ from those associated with conventional dairy production systems and consequently need a selection index designed specifically for breeding grazing herds. ARS researchers in Beltsville, Maryland, in collaboration with researchers at Purdue University in West Lafayette, Indiana, developed an index to rank animals based on "grazing merit" in conjunction with economic updates to the traditional lifetime merit indexes; all of the indexes also include heifer and cow conception rates as traits of economic importance for the first time. The new and updated indexes were implemented by the Council of Dairy Cattle Breeding in December 2014 along with a genetic base change. The updated indexes promote balanced selection to ensure maximum economic progress for herds with differing milk markets.

***Problem Statement 2E: Improved Techniques for Genetic Modification and Genetic Engineering of Food Animals.***

***Antimicrobial surfaces created by attaching enzymes that kill bacteria***. There is an urgent need for antimicrobial surface treatments that are semi-permanent, can eradicate both biofilms (growing masses of bacteria that attach to surfaces) and planktonic (growing in liquid) bacterial pathogens over long periods of time, and that do not allow resistant strain development. ARS scientists at Beltsville, Maryland, have recently demonstrated a simple, robust method to attach antibacterial enzymes to a variety of surfaces to generate surfaces that kill bacteria. The immobilization of the enzymes was carried out under conditions compatible with mammalian cells that maintains antimicrobial activity and kills both human and animal strains of *Staphylococcus aureus* in a few minutes. The simultaneous use of three distinct lytic activities in one enzyme can reduce the development of antimicrobial-resistant strains. Use of this type of antimicrobial coated surface has utility to prevent bacterial biofilm formation by the targeted pathogens. This strategy may be utilized to develop antimicrobials against numerous pathogens in addition to *Staphylococcus aureus*, and is expected to be useful for both food safety (food

packaging) as well as animal (e.g., milking machines) and human health concerns (catheters).

***Anti-Clostridium perfringens antimicrobial with high thermostability created by enzyme fusion***. *Clostridium perfringens* is a notorious poultry pathogen that causes necrotic enteritis (a poultry gut disease) that results in billions of dollars in loss to the poultry industry annually, and is currently controlled by antibiotics in animal feed. Antibiotics in animal feed are being phased out world-wide due to concerns for antibiotic resistance transfer from farm to clinic. It is important for feed additives to be heat-resistant due to the high temperatures used to process animal feed. ARS scientists in Beltsville, Maryland, and Athens, Georgia, engineered an antimicrobial enzyme (endolysin) from a bacterial virus (bacteriophage) that is specific for *C. perfringens* and is more heat-tolerant than the parental *C. perfringens*-specific enzyme from which it was derived. An antimicrobial enzyme from a bacteriophage that infects Geobacillus, a heat-loving bacterium (a thermophilic bacterium), was fused to a *C. perfringens* bacteriophage enzyme melding both the specificity of the *C. perfringens* phage endolysin and the thermostability of the Geobacillus endolysin into one enzyme. This is an important step toward identifying novel replacements for antibiotic growth promotants that can be added to poultry feed.

**Component 3: Measuring and Enhancing Product Quality and Enhancing the Healthfulness of Meat Animal Products**

***Problem Statement 3A: Systems to Improve Product Quality and Reduce Variation in Meat Animal Products.***

***Inclusion of top sirloin in the USDA/ASTM tenderness claim standards***. Several beef industry entities are considering tenderness-based marketing strategies, which have the potential of increasing beef consumption. The recent development of meat tenderness marketing claims standards by the American Society of Testing Materials (ASTM) and USDA Agricultural Marketing Service has given the industry added impetus to implement a tenderness-based marketing system. For retailers to effectively execute a tenderness-based marketing strategy, retailers need to be able to market all loin and rib cuts as certified tender. However, contemporary certification protocols do not favor inclusion of top sirloins, which represent a substantial retail meat cut feature. Data were needed to determine the extent to which top sirloin could be included in a certified tender program and what postmortem aging specifications are needed to insure a high level of customer satisfaction. ARS researchers in Clay Center, Nebraska, determined that inclusion of the top sirloin in tenderness marketing claim programs was warranted; but, aging specifications should be 7 days greater for top sirloin than top loin, depending on the quality grade program. These findings will allow for inclusion of top sirloin in the USDA/ASTM tenderness claims standards, and should facilitate use of this marketing process by retailers.

***Effect of Zilpaterol hydrochloride on consumer acceptance of tenderness of top loin steaks***. ß adrenergic agonists have been used in swine, turkey and beef production to increase lean growth efficiency. Zilpaterol hydrochloride is a ß adrenergic agonist that causes a very strong lean-growth response in cattle and, thus, has been widely used by beef feedlots. Previously, we have shown a very significant negative impact of Zilpaterol hydrochloride on instrumental measures of beef tenderness. Yet, some members of the beef industry questioned whether this difference could be detected by consumers. ARS researchers at Clay Center, Nebraska, determined that consumer ratings were lower for steaks from animals administered Zilpaterol hydrochloride compared to controls after either 14 (typical) or 35 (extended) days of postmortem aging. This finding will be used by the beef industry as it

considers moderation of lean growth strategies and mitigation of the impact of ß adrenergic agonists on beef tenderness.

***Problem Statement 3B: Improving the Healthfulness and Nutritional Value of Meat Products from Traditional and Non-Traditional Production Systems.***

***Grasses that produce short-chain fructan carbohydrates could be the solution to the laminitis problem***. Rapid fermentation of carbohydrate in the hindgut is one of the primary causes of laminitis in horses, which is a malady of major concern in the industry. It was determined from a laboratory experiment that *Enterococcus faecalis* is the causal agent in starch associated laminitis. Another experiment determined that the length of a fructan carbohydrate chain affects fermentation characteristics. Short-chain fructans are more readily fermented than long-chain fructans. Selection of grass species or cultivars that produce long-chain fructans could be an option for eliminating the laminitis that can occur on cool-season grass pastures.