National Program 101 Food Animal Production

National Program Annual Report: FY2017

NP 101 Mission Statement:

Conduct research to improve food animal production efficiency, industry sustainability, animal welfare, product quality and nutritional value while safeguarding animal genetic resources.

Introduction

Food animals contribute substantially to the U.S. economy. For example, 2016 estimates from the National Agricultural Statistics Service indicate that receipts for cattle and hogs were $83 billion. Aside from the economic value, food animals convert plant materials into animal products that are excellent sources of high biological value protein and contain nutrients like vitamin B12 that are essential for humans. Some food animals convert forages (e.g., grasses, alfalfa) that are unsuitable for human consumption, which are grown on marginal lands that are also unsuitable for human edible crop production, into human food products. The nutrient density of 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.

Despite these clear benefits, food animal production also has some real challenges. As technologies that improve the efficiency of animal production are developed, they must not compromise the health and well-being of food animals, and continued improvement in the well-being of animals in a production setting are needed. In addition to animal well-being concerns, recent reports draw attention to the potential negative impact of food animal production on the environment, so research is needed to ensure that production methods are sustainable in the long term. A related issue is the concern regarding the contribution of food animal production to the development of antimicrobial resistance to medically important antibiotics. These concerns have led to a ban on the use of antibiotics for growth promotion. Thus, research is needed for economically viable alternatives to antimicrobials in food animal production. This research has two goals: (1) restore the growth improvement that was realized through the use of antimicrobials and (2) reduce disease incidence, to reduce the need for antibiotics in animal production.

Given the health benefits of food animal products, dramatic improvements in production efficiencies developed by ARS scientists will help ensure international food security and directly impact human health by reducing the real cost of nutritionally valuable animal products, making animal products more available to those populations most in need. Studies within this program that identify indicators of animal stress and methods to alleviate stress in the production environment will ensure that as production efficiency improves, so does animal well-being in those production systems. Improvements in food animal production efficiencies will reduce food animal wastes. Reductions in the numbers of breeding animals to maintain production reduce the livestock waste environmental footprint. Ongoing improvements in food animal nutrition and other production efficiencies reduce grain requirements and manure production, and science based animal waste management strategies provide for the beneficial return of animal waste nutrients to the environment. Improvements in production efficiency will reduce microbial pathogen contamination of the environment and greenhouse gas emissions from livestock production systems and ensure that livestock production remains environmentally sustainable.

During FY 2017, National Program 101 (NP 101) had 86 full-time scientist positions working at 14 locations across the United States. Twenty nine appropriated research projects in NP 101 were approved through the ARS Office of Scientific Quality Review this past year. In their initial review. The fiscal year 2016 appropriated funding for NP101 was $49 million; total funding was $51 million including extramural awards. Two new inventions were disclosed and 3 patents awarded. Additional technology transfer included 18 Material Transfer Agreements and 4 Material Transfer Research Agreements.

In 2017 NP 101 scientists participated in research collaborations with scientists in: Australia, Austria, Belgium, Brazil, Canada, China, Colombia, Denmark, England, Finland, France, Germany, Ireland, Israel, Italy, Japan, Malawi, Mexico, Netherlands, New Zealand, Nigeria, Northern Ireland, Romania, Russia, Scotland, South Africa, Spain, Sweden, Switzerland, Turkey, Uganda, and United Kingdom.

<u>New scientists in NP 101:</u>

Shelby Curry, Ames, Iowa, joined the Agroecosystems Management Research Unit as an ORISE Research Fellow.

Chris Magee, Mississippi State, Mississippi, joined the Poultry Research Unit as a Veterinarian.

Victoria Hansen, Beltsville, Maryland, joined the Animal Biosciences and Biotechnology Laboratory as an ORISE Research Fellow.

Katrina Krasnec, Beltsville, Maryland, joined the Animal Biosciences and Biotechnology Laboratory as an ORISE Research Fellow.

Monika Proszkowiec-Weglarz, Beltsville, Maryland, joined the Animal Biosciences and Biotechnology Laboratory as a Molecular Biologist.

Yang Qu, Beltsville, Maryland, joined the Animal Biosciences and Biotechnology Laboratory as an ORISE Research Fellow.

Katie Summers, Beltsville, Maryland, joined the Animal Biosciences and Biotechnology Laboratory as a Microbiologist.

Steve Swift, Beltsville, Maryland, joined the Animal Biosciences and Biotechnology Laboratory as a Postdoctoral Researcher.

The following scientists in NP 101 received prominent awards in 2015:

Glen Aiken, Lincoln, Nebraska, received a Pioneer Award from The Kentucky Beef Network.

Brad Bearson, Shawn Bearson, David Mark, Renee Wagner, Diana Halsey, and Cathleen Cohen, Ames, Iowa, received the 2017 Federal Laboratory Consortium for Technology Transfer's Midwest Regional Excellence in Technology Transfer Award for a vaccine to reduce Salmonella in food animals.

Michael Flythe, Lexington, Kentucky, received a Merit Award from The Forage and Grassland Council.

Thomas Geary, Miles City, Montana, received The Distinguished Alumnus: Science, Education, and Technology Award from the Department of Animal Sciences at Washington State University.

Wenli Li, Madison, Wisconsin, submitted the top-ranked proposal in the Midwest Area 2017 Summer Internship Program.

Steven Shackelford, Clay Center, Nebraska, was named an American Meat Science Association Fellow, and received the American Meat Science Association Signal Service Award.

Richard Mark Thallman, Clay Center, Nebraska, received the Industry Service Award from the Braunvieh Association of America.

Tommy Wheeler, Clay Center, Nebraska was honored by The National Provisioner magazine as one of the 25 industry icons that significantly impacted the meat industry in the last 25 years.

Major Accomplishments in 2016

This section summarizes significant research results for Fiscal Year 2017 that addressed specific components and anticipated products of the 2013 – 2018 action plan for the Food Animal Production National Program. Within each section, selected accomplishments of individual research projects in NP 101 are presented. These accomplishments are highlighted here due to their significance and alignment to action plan components and anticipated products. They are a subset of accomplishments within the program. To see all the accomplishments for each project within the program, please visit the USDA ARS National Program 101 website: https://www.ars.usda.gov/research/project-reports-by-program/?npCode=101

Many of the projects are the result of 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 and allow scientists to tackle larger problems than can be addressed without such collaborations. Improved food animal production efficiencies decrease the real cost of animal products, making the products more available to people worldwide, and decreasing the environmental footprint of animal production.

Accomplishments are listed below that correspond to each of the Components and Problem Statements of the *Action Plan National Program 101 Food Animal Production 2013 – 2018*. **Following each accomplishment, the corresponding anticipated product listed in the NP101 Action plan is indicated.**

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

Corn oil supplementation reduced methane production from finishing cattle diets. Methane loss from finishing cattle is important as it represents an energy loss that could be used for maintenance and growth, and methane is a greenhouse gas with a global warming potential much greater than that of carbon dioxide. The use of an added fat source is common in high-concentrate finishing diets. Scientists at Clay Center, Nebraska, determined that corn oil does not affect intake across dietary treatments, but reduces methane production as it is increased in the diet. They also determined that the proportion of protein in the energy that steers retained decreased, and the proportion of fat and carbohydrate increased as oil levels increased. These results indicate that adding corn oil to cattle diets decreases enteric methane production in addition to increasing the amount of energy retained as fat and carbohydrate instead of protein.

Anticipated product: Strategies that alter metabolic pathways to improve growth performance and nutrient utilization efficiency in livestock.

Methane production by beef cattle varies over time after a meal. Methane production by finishing cattle is inefficient because it represents dietary energy loss that could have been used for maintenance and growth. An ARS scientist at Clay Center, Nebraska, determined that the greatest methane production occurred 5 to 6 hours after feeding with a secondary peak in methane production occurring 9 to 11 hours after feeding in steers fed above maintenance intake. In steers fed at a maintenance level of intake, there was only one peak in methane production usually four to seven hours after feeding. The differences in methane production after a meal indicate that caution should be exercised when using a single time point measure of methane production and extrapolating it to an estimate of 24-hour methane production.

Anticipated product: Development of refined methodology allowing precise real time nutrient evaluation of forages including improved sampling procedures.

Problem Statement 1B: Reducing Reproductive Losses

The value of more prolific sheep breeds in a rangeland setting. Ewe production inefficiencies hamper the ability of producers to deliver the necessary volume of lamb to meet market needs. Increasing the total weight of lamb weaned is an effective strategy to increase production output. ARS researchers at Dubois, Idaho, in collaboration with the U.S. Meat Animal Research Center at Clay Center, Nebraska, Virginia Tech University, and Montana State University, partnered to determine the utility of semiprolific (2-4 kids per litter rather than 1-2) breeds to increase weight of lamb weaned in a range production system. Researchers demonstrated that semiprolific breeds, such as Polypay and Romanov-cross, yielded much more total weight of lambs weaned than traditional wool-type breeds. Although semiprolific breeds had poorer wool quality and lighter fleeces than wool-type breeds, the weight of lamb weaned compensated for reduced returns from wool sales. Results are being used by the U.S. sheep industry to guide producers in selecting breeds and genetics that will increase lambing rates of flocks in rangeland production systems.

Anticipated product: Data to facilitate appropriate matching of management and production resources with genetic potential of breeding animals with the goal of increasing reproductive rate.

Development of a tool to more accurately predict estrus in pigs. Accurate estrus detection can improve sow conception rates and increase swine production efficiency. Unfortunately, current practices based on observing individual animal behavior are inefficient due to large sow populations at commercial farms and the associated labor required. ARS researchers in West Lafayette, Indiana determined that at the onset of estrus in sows, body temperature was reduced and activity was increased. Measurement of both can be automated electronically. These data may provide initial physiological and behavioral markers of estrus in sows that can be used in the development of a precision livestock management tool that will help producers more accurately predict estrus in their sow herd.

Anticipated product: Strategies based on physiological data and biological markers for increasing longevity and lifetime productivity of breeding females in livestock systems.

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

Alternatives to dietary antibiotics after weaning and transport of piglets. Weaning, transport, and thermal stressors have the potential to increase disease incidence and reduce growth rates and animal welfare. To combat the negative effects of weaning and transport stress on piglet health and well-being, traditional management practices used dietary inclusion of antibiotics. However, due to the recent 2017 Veterinary Feed Directive, many dietary antibiotics can no longer be used, potentially reducing growth and putting the health and welfare of newly weaned and transported pigs at risk. ARS researchers in West Lafayette, Indiana, performed two studies, one in a controlled environment and the other in a production environment, to compare the use of L-glutamine (an amino acid, fed at 0.20% of the diet) as a replacement for traditional dietary antibiotics following weaning and transport in newly weaned pigs. In the controlled environment, pigs provided L-glutamine had an improvement in performance compared to those provided either antibiotics or no antibiotics. In a production environment when compared to pigs provided no antibiotics, those given either L-glutamine or traditional dietary antibiotics grew faster, ate more, and had a 2-fold reduction in their requirements for additional therapeutic antibiotic injections. These data suggest that providing L-glutamine at 0.20% of the diet following weaning and transport can improve piglet health and well-being similarly to traditional dietary antibiotic treatments, thereby providing swine producers with an effective alternative that reduces feed costs by approximately 18% (on a per ton basis) when compared with traditional dietary antibiotics.

Anticipated product: Species-specific, cost-effective strategies to mitigate animal stress and improve animal health and well-being in conventional production systems.

Cooling of heat stressed sows during lactation. In summer, farrowing sows are often exposed to temperatures above their upper critical temperature. This heat stress can affect sow welfare and productivity and have economic impacts. Cooling the room is not an option as piglets need high temperatures. ARS researchers in West Lafayette, Indiana, collaborated with Purdue University and designed a water-cooled floor pad that is placed under the sow. When exposed to acute heat stress, the pad successfully reduced sow body temperature, heart rate and respiration rate, and reduced posture-changes and drinking behavior, all indicating greater sow comfort. These results indicate improved sow welfare and production benefits in maintaining sow feed intake and milk production and also decreasing risk of piglet crushing.

Anticipated product: Species-specific, cost-effective strategies to mitigate animal stress and improve animal well-being and longevity in conventional production systems.

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.

Production and public release of an improved reference genome assembly for cattle and swine. Use of genomics to study cattle and swine rely upon reference genomes to accurately represent all the genes and regulatory sequences, in their correct order and orientation. The reference genome for cattle has been the Hereford breed assembly produced in 2007 (published in 2009) and has many inaccuracies and deficiencies. Likewise, the reference genome for pigs has been the Duroc breed assembly produced in 2010 (published in 2012) and also has many deficiencies. For cattle, ARS researchers at Clay Center, Nebraska, collaborated with researchers at University of California, Davis; University of Missouri, Columbia; University of Maryland; the National Human Genome Research Institute; and ARS researchers in Beltsville, Maryland. For swine, ARS researchers at Clay Center, Nebraska worked in a collaboration led by the Roslin Institute in Scotland, which also included collaborators at two U.S. universities and three genome industry partners. An improved cattle reference assembly of the same animal as the previous assembly was generated using a combination of modern technologies available at Clay Center, Nebraska that is over 100 times more continuous (a key measure of accuracy and quality) than the existing cattle reference assembly. Significantly, genes related to immune functions, which are notoriously difficult to assemble, are now accurately represented in the reference. In pigs, two improved reference assemblies were developed using a combination of modern technologies available at Clay Center, Nebraska and at a genome industry partner. The primary assembly used the same animal as the original reference assembly, and is over 200 times more continuous than the existing reference. The second assembly was of a crossbred pig from Clay Center, Nebraska and is 100 times as continuous as the original reference. The new assemblies of the original cow and pig are now the accepted reference genome assemblies for cattle and swine, and the alternate crossbred pig assembly is being used to investigate genome structure and function of commercial pig populations.

Anticipated product: Improved annotation of genome sequence assemblies for food animals.

DNA methylation maps in cattle and their relationship to gene expression. DNA methylation is a reversible biological modification of DNA in tissues that affects gene function and plays important roles in individual development and various diseases. However, only limited data describing such modifications in various tissues exist in cattle. ARS scientists in Beltsville Maryland, determined the presence of absence of this type of modification throughout the bovine genome in ten different bovine tissues. They detected thousands of differences in the methylation patterns in different tissues, including in regions known to control gene expression. Consistent with this role, analyses revealed that the degree of methylation within these regions were correlated with the expression of nearby genes in specific tissues. This study provided a baseline dataset and essential information for DNA methylation and gene expression profiles of cattle that will help understand DNA sequence regions that affect gene expression.

Anticipated product: Improved annotation of genome sequence assemblies for food animals.

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

Comprehensive detection of loss of function mutations in swine. One of the key aims of livestock genetics and genomics research is to discover the genetic variants underlying economically important traits such as reproductive performance, feed efficiency, disease resistance/susceptibility, and product quality, but most are not known. ARS scientists at Clay Center, Nebraska sequenced the genomes of 72 sires and dams that were used in many matings and produced a large number of offspring within the U.S. Meat Animal Research Center swine herd. They identified approximately 22 million variants and submitted them to public databases. By aligning these sequences to the pig genome, researchers found that ~139,000 of these variants (less than 1%) were expected to alter or disrupt proteins coded by genes in the genome, or were likely to regulate protein production. Because these variants are likely to alter proteins, they are most likely to have a significant effect on various traits of interest to livestock producers. Five hundred sixty-five variants were classified as high-impact loss-of-function (LOF) mutations, meaning they rendered the protein inoperable. These LOF variants, along with functional variants likely to influence various reproductive traits, were included in a commercially-available genotyping microarray.

Anticipated product: Continued improvement in the annotation of the genome sequences of food animals.

The ability to identify animals that consume less feed yet perform well in terms of weight gain could benefit producers. A previous study of the genes transcribed by the rumen papillae tissue in beef steers identified genes that were differentially expressed in animals that varied in weight gain and feed intake. Some of the genes identified as differing between animals with high gain-low feed intake and those with low gain-high feed intake were examined for association with a related trait, residual feed intake (RFI), in a separate population of Angus x Hereford steers. ARS scientists at Clay Center, Nebraska, tested 17 genes and determined 2 were differentially expressed by residual feed intake classification. These genes included NAD(P)H dehydrogenase, quinone 1 and, regulator of G-protein signaling 5. A third gene, acetyl-CoA acetyltransferase 1, displayed a trend towards association with residual feed intake. These results validate the potential utility of genes identified in a previous rumen transcriptome study for identifying animals with superior feed efficiency in other cattle breeds and populations. Measuring these genes in cattle may assist with the identification of cattle with greater feed efficiency.

Anticipated product: Gene targets for the development of additional strategies to beneficially manipulate the environment of the food animal to improve economic traits.

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

Use of the animal germplasm collection to restore lost genetic resources. ARS has a comprehensive collection of animal genetic resources, and the stored collection has been used to regenerate or analyze important lost animal genetic resources. For example, Purdue University acquired pig germplasm samples from the stored collection to reconstitute a research line of pigs known to affect meat quality (homozygous for halothane sensitivity, which has been eliminated in modern pigs) that was no longer available. The reestablished line was used in a project that garnered substantial funding, generated more than 10 scientific articles and prompted Virginia Tech University to establish a second research population of this pig line. In another example, the Angus Association obtained a stored semen sample from a prominent bull and determined that the bull was free of a lethal mutation, which meant more than 29,000 other cattle did not have to be genotyped. The availability of the sample saved the Association approximately $2 million. In a final example, collaborative research between ARS scientists in Fort Collins, Colorado, and researchers at Pennsylvania State University, determined there were only two different Y chromosomes (the Y chromosome determines whether an animal is male) in the current U.S. Holstein population (our major milk producing breed) and that there were two additional Y chromosomes in semen stored in the collection that were not identified in the present Holstein population. ARS and Penn State scientists worked with industry to produce bull calves with these two lost Y chromosomes from the collection as a first step to re-introducing them to increase genetic diversity. These examples demonstrate the utility of the germplasm collection to the U.S. livestock sector as a tool for industry and researchers to use in their efforts to solve a range of livestock industry problems.

Anticipated product: DNA, somatic cell and other tissue banks in place for research and genetic resource preservation purposes for livestock and poultry species.

Use of cholesterol during cryopreservation improved the fertility of frozen-thawed semen from seven unique poultry lines. To maintain the genetic diversity of poultry in the United States, the germ-line of all turkey and chicken populations needs to remain accessible; however, it is not feasible to maintain live populations indefinitely. Storage of semen from the males of these lines as frozen stock would provide a reasonable insurance against loss of genetic diversity but fertility rates from poultry semen frozen with current methods are not reliable enough for germ-line retrieval, especially from lines with low reproductive efficiency. Poultry sperm are known to lose cholesterol from the plasma membrane after exposure to cold temperature, which may contribute to their poor fertility after freezing and thawing. ARS scientists in Beltsville, Maryland, investigated whether adding different amounts of cholesterol to semen prior to freezing would improve the fertility of frozen-thawed semen. Three of the four turkey lines showed an improvement in fertility when cholesterol was used (32.1% fertile eggs) compared to semen frozen without cholesterol (3.8% fertile eggs); also, 15% more live birds were hatched when cholesterol was used during cryopreservation. The data indicate that this strategy would result in high enough fertility rates to reconstitute the lines from frozen semen, and that semen frozen in this manner could be stored in a germplasm repository for successful future use.

Anticipated product: Successful and efficient cryopreservation technologies and methods available for all livestock and poultry species.

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

Updated lifetime merit indexes for dairy cattle. National genetic-economic indexes for selection of dairy cattle have been used for many years to improve the efficiency of the national population. However, those indexes need revision when new traits are introduced or prices change. Therefore, ARS researchers in Beltsville, Maryland, added cow livability, a new trait developed in 2016, to lifetime merit indexes and substituted a body weight composite for the body size composite used previously so that feed consumption could be estimated more precisely; this revision also updated other prices used in the formulas. Selection using the new indexes will reduce death losses and improve cow health and feed efficiency with no additional cost of data collection. The revised lifetime merit indexes were adopted and officially released to the dairy industry by the Council on Dairy Cattle Breeding in April 2017.

Anticipated product: Genetic prediction tools for traits in food animals related to health, production efficiencies, adaptability, and functionality in varied domestic and international production systems.

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

Successful knockout of a gene involved in sperm maturation using gene editing. It is believed that genetically modified livestock will be important in feeding the world in 2050 when the human population of Earth is predicted to exceed 9 billion. The domestic pig is an agriculturally important food species and a proven model of human physiology. ARS scientists from Beltsville, Maryland, in collaboration with scientists from University of Maryland, College Park, Maryland, Renovate Biosciences Inc., Reisterstown, Maryland, Washington State University, Pullman, Washington, The Roslin Institute, Edinburgh, Scotland, and Genus PIC, De Forest, Wisconsin, used genome editing technology to rapidly modify the pig genome and eliminate the function of an economically important gene (NANOS2 knockout) known to be essential for sperm maturation. These animals no longer generate mature sperm, and can be used as a recipient for germ cell transplantation from desirable boars, thus expanding their utility in genetic selection.

Anticipated product: Strategies to elucidate the genetic, protein and metabolic pathways that translate genotypes into phenotypes in food animals.

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.

Identified differentially expressed genes associated with a ham color defect. Cured ham color is of great importance in meeting consumer expectations for ham products. The pork industry recently identified a ham color defect causing consumer dissatisfaction. A very pale portion of one of the ham muscles does not produce normal pink color when processed into cured ham products. ARS scientists at Clay Center, Nebraska, began working with pork processors to identify solutions to this problem. Initial efforts to characterize the color defect indicated that the condition occurs in the vast majority of pigs regardless of production system and management practices, although variation exists in its severity. Results identified 340 genes that were differentially expressed between the normal and affected portion of the muscle. These results provide information regarding the biological causes of this condition and identified candidate genes that might lead to the development of markers for genetic selection to reduce or eliminate the color defect in ham muscles.

Anticipated product: Better understanding of the biological mechanisms that control and influence meat product quality and consistency.

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

None

NP101 Projects contributing accomplishments to this report:

PROJECT NO.	PROJECT TITLE	CITY	STATE
3012-31000-005-00D	National Animal Germplasm Program	FORT COLLINS	CO
3040-31000-090-00D	Genetic Research to Enhance Efficient and Sustainable Production of Beef Cattle and Sheep	CLAY CENTER	NE
3040-31000-091-00D	Improving Sow Lifetime Productivity in Swine	CLAY CENTER	NE
3040-31000-093-00D	Strategies to Improve Heifer Selection and Heifer Development	CLAY CENTER	NE
3040-31000-094-00D	Genetic and Genomic Approaches to Improve Swine Reproductive Efficiency	CLAY CENTER	NE
3040-31320-012-00D	Genomic and Metagenomic Approaches to Enhance Efficient and Sustainable Production of Beef Cattle	CLAY CENTER	NE
3040-31430-005-00D	Strategies to Optimize Meat Quality and Composition of Red Meat Animals	CLAY CENTER	NE
3070-31630-006-00D	Improving the Efficiency and Sustainability of Diversified Forage-Based Livestock Production Systems	EL RENO	OK
5042-32630-002-00D	Optimizing the Biology of the Animal-Plant Interface for Improved Sustainability of Forage-Based Animal Enterprises	LEXINGTON	KY
5090-31000-023-00D	Forage Characteristics that Alter Feed Utilization, Manure Characteristics and Environmental Impacts of Dairy Production	MADISON	WI
5090-31000-024-00D	Determining Influence of Microbial, Feed, and Animal Factors on Efficiency of Nutrient Utilization and Performance in Lactating Dairy Cows	MADISON	WI
8042-31000-101-00D	Improving Genetic Predictions in Dairy Animals Using Phenotypic and Genomic Information	BELTSVILLE	MD
8042-31000-103-00D	Developing Genetic Biotechnologies for Increased Food Animal Production, Including Novel Antimicrobials for Improved Health and Product Safety	BELTSVILLE	MD
8042-31000-104-00D	Enhancing Genetic Merit of Ruminants through Genome Selection and Analysis	BELTSVILLE	MD
8042-31630-001-00D	Identification of Biomarkers for Pre and Post Weaning Growth in Swine	BELTSVILLE	MD