

USDA ARS/NIFA Food Animal Production National Workshop Summary Baltimore, MD March 30-31, 2011

The United States Department of Agriculture (USDA) National Workshop for the Food Animal Production was held in Baltimore, Maryland on March 30 and 31, 2011. This workshop was hosted jointly by the Agricultural Research Service (ARS) National Program 101 and the Animal Production Division of the National Institute of Agriculture (NIFA). The Workshop was attended by 153 participants from academia, USDA and related Federal agencies, producers and allied industry stakeholders.

The objectives of the Workshop were:

- A. Provide livestock industry stakeholders with information about current ARS and NIFA programs.
- B. Solicit direction and guidance from livestock industry stakeholders to facilitate development of USDA research, education and extension programs to effectively address existing and emerging commodity-specific, discipline-specific, and cross-cutting issues in food animal production.
- C. Solicit program direction and guidance for emerging food animal production issues impacting the food animal industries over the next 5-10 years.
- D. Explore opportunities for collaboration among ARS, NIFA, allied food animal industry and academia to maximize research capacity and performance by leveraging funding, physical resources and scientific talent.
- E. Develop new ideas to facilitate technology development, transfer and implementation to industry.

Introduction:

Food animal production and product consumption is increasing significantly around the world as consumers gain access to higher quality and more nutrient dense diets. This trend will continue as the world's population grows and as animal production systems increase in efficiencies across varied environments and production systems. Animal production systems fit a unique and valuable niche in global food production by utilizing feeds and forages not appropriate for human consumption and contribute to an environmentally sustainable food supply.

The United States has historically been a leading source of quality animal products and has led the world in technological development and adoption. This has enabled the United States to develop one of the most efficient animal production systems on earth. USDA/ARS and the USDA/NIFA have been a vital part of that achievement. However, we now face the pressure to feed a projected nine billion people by 2050, making the research of the USDA/ARS/NIFA critically important. To remain competitive, the United States must continue to focus on increasing production efficiencies through the development and adoption of scientific



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technologies. Research and application of new tools in genomics, metagenomics, reproductive physiology, nutrition, molecular biology and animal health if we are to continue our long tradition of global competitiveness and sustainability. U.S. systems of animal management and production face formidable challenges. The demands placed on the national system of food animal production by a rapidly increasing population, rising obesity, as well as demands for better nutrition and lower costs, can only be met through research. This work will harness and improve the genetic potential of food animals, increase market competitiveness, sustain small and mid-sized producers, and maintain genetic diversity while maintaining consumer confidence.

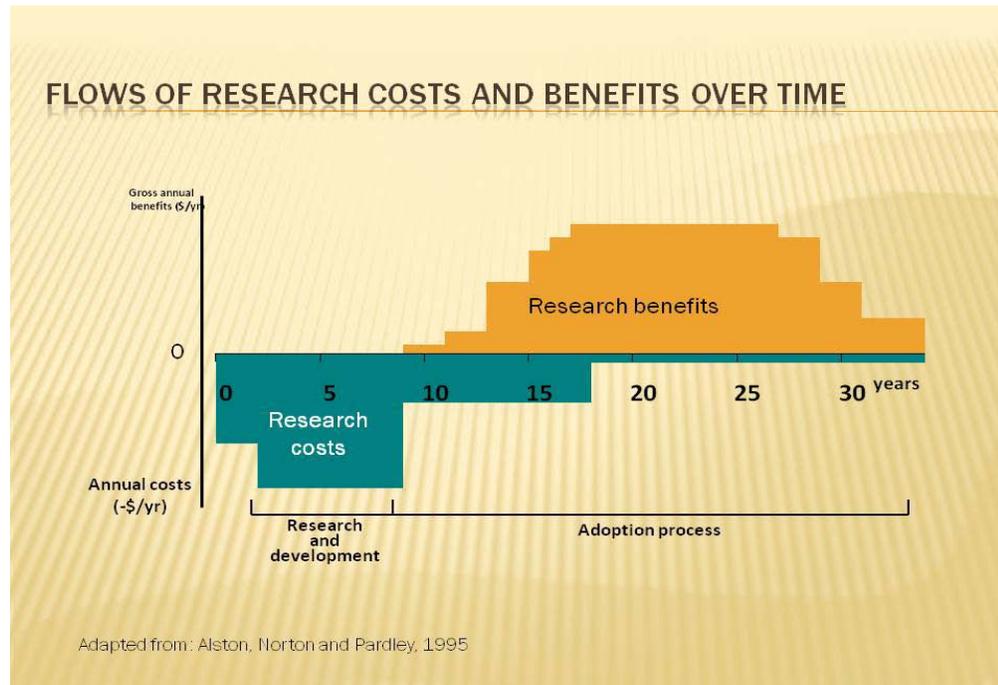
Since the USDA does not have unlimited resources, we must concentrate in areas where maximum impact is possible. While this will restrict the overall scope of the research at NIFA and in NP101, the current priorities within USDA have produced extraordinary results for the livestock industry. This will continue, with ARS/NIFA research directly impacting livestock production agriculture around the world in the areas of genetics, reproduction, nutrition, animal well-being and product quality.

According to the USDA-Economic Research Service, agricultural research has historically produced a remarkable return on investment, with estimates ranging from 20% to 60% annually. In other words, for every \$1 invested in agricultural research \$5 to as much as \$20 is returned in net present value. It is important to consider that the value of applied and translational research is not typically maximized without prior basic research to establish the foundation. Basic and applied research, as well as outreach, are critical to deliver the ultimate value of research. There can be little truly valuable applied research without strong basic research and neither applied nor basic research is of value if the technologies developed are never successfully applied in the field. Basic discovery science often requires a longer time horizon and carries more inherent risk than applied or translational research. However, basic discovery science provides the opportunity for extraordinary scientific benefit by providing the vehicle for scientific discovery and eventual application. That is one of the primary tenets of USDA/ARS/NIFA and NP101 research and will continue to underpin our research programs. The following graphic illustrate these points.



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Figure 1. Flow of resources, research benefits and research costs for public research.



This graphic developed by Alston et al., 1995, displays costs and benefits for public research in agriculture. It illustrates the extraordinary return on investment of 20 to 60% annually, but also underscores the challenge of basic discovery science - that the benefits are typically not realized for many years after the research has been completed. This delay between discovery and application jeopardizes the long term support and commitment required to realize maximum benefit. Funding entities and stakeholders need to clearly understand this delay and the critical need for long term sustained support and investment in basic discovery science.

The challenge for USDA/ARS/NIFA and NP101 is to focus scientific investment where maximum societal value is realized by the research. This requires strong visionary leadership based upon stakeholder input.

Finally, research continues to increase in scientific complexity. The challenges are not simple. They require the multidisciplinary collaborations that now typify much of the research undertaken by scientists in ARS and NIFA.

The USDA/ARS/NIFA has the national capability and demonstrated performance to lead U.S. food animal research and technology development. USDA/ARS and partners conduct a food animal research program that has contributed significantly to national growth and global competitiveness of the U.S. production industries. A strong USDA commitment to food animal production research, technology development, and outreach through ARS and the NIFA, in cooperation with university and private research programs, is critical to enhance the sustainable and economically viable production of food animal products in the United States.



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Background Information: USDA/NIFA Animal & Animal Products Overview

NIFA is the extramural research agency for the USDA, and is one of four agencies that make up the Research, Education, and Economics mission area of the department. NIFA's unique mission is to advance knowledge by supporting research, education, and extension programs in the Land-Grant University System and other partner organizations. As an extramural research agency, NIFA doesn't perform actual research, education, and extension but rather helps fund it at the state and local level and provides program leadership in these areas.

NIFA Mission Statement:

Leading food and agricultural sciences to create a better future for the nation and the world

NIFA Areas of Focus:

NIFA is focusing their investment in five primary challenge areas. These are:

- 1) Climate change
- 2) Bioenergy
- 3) Food safety
- 4) Nutrition and childhood obesity
- 5) Global food security

NIFA is involved in all areas of agriculture, including animal agriculture. Related research, education and extension activities are continually changing to address new challenges and opportunities brought about by advancing technologies, consumer demand, and environmental issues. Efficient, science-based animal agriculture translates into affordable and high-quality food for the consumer. NIFA and its land-grant university partners collaborate with industry to develop and disseminate knowledge to improve agriculturally relevant animal systems.

NIFA animal-related programs which cover beef cattle, dairy cattle, poultry, swine, aquaculture, sheep, goats, and horses encourage multi-disciplinary approaches and the integration of research, education, and extension. These activities are focused on approaches that are economically sound, socially acceptable, and environmentally advantageous. They span the disciplines of animal reproduction, nutrition, genetics, physiology, environmental stress, product quality, management, health, well-being, and security.

Background Information: USDA/ARS and National Program 101

The ARS is the intramural research agency for the USDA. The ARS budget is allocated to research conducted in 22 national program areas. Research is conducted in 108 laboratories by ~2,200 full-time scientists within a total workforce of ~8,000 ARS employees. The ARS national program addressing animal production is NP 101 – Food Animal Production. NP 101 involves research conducted at 20 U.S. locations by 102 full-time scientists and has an appropriated budget of approximately \$46.5 million per annum.



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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.

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.

Strategic Objectives

NP 101 has six strategic objectives:

1. Facilitate highly effective and comprehensive research collaborations with USDA/ARS laboratories, food animal industry stakeholders, academia, and other Federal agencies to best leverage resources and expertise for maximum industry value and impact.
2. Foster academic growth and individual leadership within NP 101 to enhance or create awareness of ARS scientific accomplishment and impact by other agencies, academia, and industry stakeholders.
3. Ensure access to specialized genome sequencing and related technologies and bioinformatic resources and infrastructure for all NP 101 research communities.
4. Develop an integrated collaborative animal and microbial genomics research program.
5. Provide science-based industry-relevant solutions in food animal nutrition, reproduction, animal breeding and genetics, animal well-being, and product quality.
6. Develop a model technology transfer program to achieve the full value and impact of NP 101 research for the food animal industries.

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Session 1: Food Animal Industry Breakout Session Summaries

Introduction

This summary includes a comprehensive list of issues identified, discussed and prioritized by Workshop attendees in the Food Animal Industry Breakout sessions. General comments, issues, and priorities are followed by a summary of the Breakout session for each commodity and recommendations for future program direction and development.

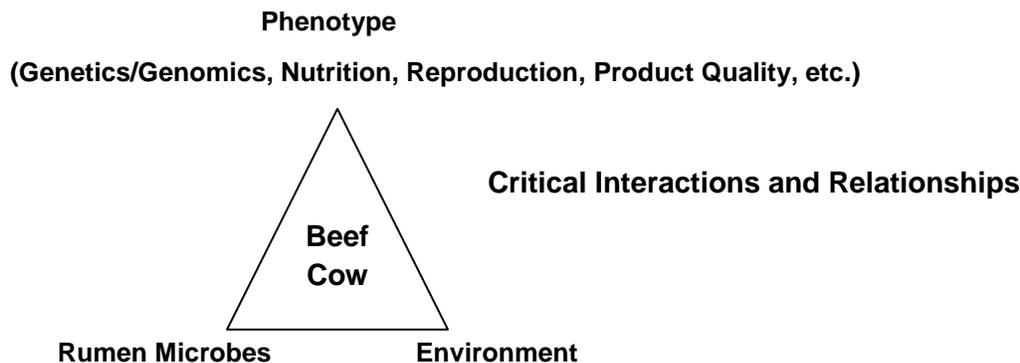
Breakout Session Summaries are included for: Beef, Dairy, Sheep, Goats, Swine, Poultry – Layers, and Poultry – Broilers.

Beef Industry Breakout Session

Top Priority Issue: Elucidate the effects and interplay of host, indigenous microbial communities and the production environment on components of production efficiency, sustainability, and product value (including product healthfulness and safety).

The discussion focused on the relationship between the rumen microbial population, the production environment and the phenotype of beef cattle to better understand this relationship from a systems perspective. A holistic approach for research was prioritized focused on systems optimization to improve (1) forage and feed efficiencies, (2) product quality, product safety and healthfulness, (3) environmental sustainability, (4) economic sustainability, and (5) animal well-being. The ultimate goal is to improve global food security by improving sustainable beef production and production efficiencies.

Production Systems Optimization



In the diagram, **phenotype** represents lifetime forage and feed efficiencies, health, reproductive efficiency, animal well-being and economic sustainability and the relationship between genotype and production traits (phenotype).

Rumen microbes are the critical factor involved in forage and feed utilization and animal health and production in ruminants. Rumen microbes are a unique physiological component of nutrient utilization in ruminant animals and give them an advantage over monogastrics. This is an area that is not well understood and is critically important to beef cattle production efficiencies as well



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as environmental sustainability. Research should focus on metagenomic analyses and the rumen environment as influenced by forages, antimicrobials, production systems, etc.

The **environmental** component represents the relationship between beef cattle and the environment and includes adaptation; forage and feed efficiencies; methane and green house gas production; and associated impacts on range and pasture management relative to sustainability.

Additional High Priority Areas:

1. Improved efficiency of nutrient utilization including forages. Specific research areas for this priority include:
 - NRC data is incorrect and outdated – revision is recommended
 - Understand rumen efficiency, metagenomics and genetics/genomics of the beef animal to improve production efficiencies
 - Improve the genetics/genomics of nutrient utilization to decrease the 45-50 percent of feed that is used for maintenance in cow herds
2. Mitigate antimicrobial usage and better understand their effects. Specific research areas for this priority include:
 - Determine the effects of antimicrobials on animal health and human health (zoonotic disease) as a broad food safety issue. Study antibiotic resistance to better understand and address pre-harvest food safety issues. Determine how pathogens (E. coli, salmonella, etc.) move from animals to people.
 - Understand the function, growth and shedding of pathogenic microorganisms is critically important
 - There is a critical need to find alternatives to traditional antibiotics.
 - Understand effects of antimicrobials on rumen health and ecology, the rumen microbiome, and production traits.
3. Enhance the healthfulness of beef products. Specific research areas for this priority include:
 - Integrate healthfulness of beef products with programs in human nutrition, genomics, food safety and others with a focus on genetic tools and programs to improve the nutritional value of beef.
 - Explore collaborations with human health initiatives (One Health).
 - Define product quality and accurately assess consumer demand and preference for beef.
4. Measurement of, and best management practices for, animal well being across the production system. Specific research areas for this priority include:
 - Focus on economic sustainability as a primary component of animal well-being research to develop production systems that optimize animal care and profitability producers.
 - Understand the genotype x environment interaction and determine the effects of genotype on grazing and other behaviors as well as general animal well being

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- Develop research in animal well being focused on individual animals in the context of industry accepted production systems and production environments to ensure that proper husbandry and systems of husbandry are implemented.
- Enhance the industry's ability to adequately measure an animal's adaptation to the environment

Other Industry Priorities:

- A better understanding of dynamic production systems including how localized production methods and systems impact the industry and environment is needed. Define systems for specific production environments accounting for environmental interactions. One fundamental problem of systems research is the length of time required. Systems implementation and evaluation is long term and it is difficult to show results over the short term.
- Continue and enhance cooperative relationships between ARS and universities. Integrate extension more with education. Tools exist but may need more focus and development for agriculture and beef production.
- Bioinformatics: challenge for ARS and NIFA is to “build a pipeline to interpret and analyze large data sets”. Development of bioinformatic tools is needed to go from descriptive science to productive science including bioinformatics support and infrastructure, funding, expertise, and training. Additional human capital resources are needed for bioinformatics, computational biology, statistics and computer science.
- Enhance mitochondrial efficiency and implications for nutrient utilization and other traits related to beef production and production efficiencies.
- *A major challenge over the next 30 years will be to generate or discover the significant biological production and production efficiency increases and to generate improved economic efficiencies to meet the global demands for meat production and to ensure profitability for producers.*

Recommendations for Extension and Educational Programs:

- None mentioned

Prospective Collaborations/Partnerships:

- Expand collaborative research and programming opportunities with Land Grant Universities and relevant international programs.

Breakout Session Summary

Concerns about shrinking or static research budgets reinforced recommendations to prioritize beef research in areas where maximum impact could be achieved. Beef research programs should continue to address genetic/genomic tools and analysis, animal breeding and selection, nutrition and nutritional efficiency, reproductive efficiency, animal well-being, germplasm preservation and product quality.



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Top Priority Issue: Reproduction and reproductive efficiency as one of the largest drivers of profitability for the dairy industry. Specific research areas for this priority include:

- Elucidate physiological mechanisms responsible for low fertility long lactation dairy cows
- Address inadequate conception rates or non return rates – need better ways to evaluate reproductive success
- Optimize length of lactation to maximize fertility
- Enhance energy partitioning in the transition cow related to metabolic changes associated with lactation – relationship between high metabolic output and reproductive success
- Determine nutritional and environmental impacts on fertility
- Elucidate genetic, genomic and epigenetic effects on fertility
- Identify and improve factors relating to systems biology and reproduction
- Increase development of trait ontology – phenotypic standardization

Additional High Priority Areas:

1. Translational genomics of dairy cattle which impact all phenotypes and production traits associated with dairy cattle. Specific research areas for this priority include:
 - Enhanced phenomic (phenotypic) centralized data collection
 - Improved genomic evaluations and associated data collection – trait recording
 - Evaluation of crossbreeding and synthetic breeds
 - Increased bioinformatic and systems biology support
 - Technology development of induced pluripotent stem cells
 - Development of genetic improvement and selection technologies
 - Evaluation and better understanding of genomic and epigenetic effects
 - Development of high throughput, lower cost genotyping for multiple uses in the dairy industry
2. Improved dairy nutrition and nutrient utilization as a primary factor impacting production costs - feed costs currently representing approximately 70% of the cost of dairy production. Specific research areas for this priority include:
 - Improved feed efficiency and nutrient utilization
 - Understanding the role and function of the ruminant microbiome as related to nutrient utilization and production efficiency
 - Evaluation of alternative feeds and by-products for use in dairy production
 - Evaluation of various nutrient and energy supplies and partitioning
 - Improved efficiency of forage utilization
 - Better characterization of the environmental footprint for dairy as related to dairy nutrition

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3. Animal well-being for the dairy industry, related to dairy production and management and consumer acceptance of dairy products and production practices. Specific research areas for this priority include:
 - Enhanced standardization of dairy well-being phenotypes
 - Enhanced cow care and comfort as related to lifetime productivity
 - Better understanding of the relationships between dairy cow well-being and productivity, health and immunity
 - Decreased young calf morbidity and mortality
 - Enhanced genetic frequency of the “poll” gene to genetically remove horns from dairy cow populations
4. Improving performance for the transition cow as lactation is initiated following parturition. This is the most stressful period in the production cycle for a cow and is a high cost area for dairy producers. Specific research areas for this priority include:
 - Understanding lactation persistency as a heritable trait
 - Improved mitigating risks to animal health, well-being and production during the transition period
 - Identification of key areas for phenotypic data collection to better qualify and quantify factors relating to successful cow transition to lactation

Other Industry Priorities:

- Improved heifer development as related to lifetime production and transition cow challenges.
- Development of research programs that include economic and environmental sustainability and systems development and analysis.

Recommendations for Extension and Educational Programs:

- Programs should be developed and supported to improve consumer perception of animal health and well being in the dairy industry.
- Improved transfer of information for producers, consumers and industry stakeholders through workshops, web sites, etc.

Prospective Collaborations/Partnerships:

- Expand collaborative research and programming opportunities with Land Grant Universities, DMI and other related programs.

Breakout Session Summary

Concerns about shrinking or static research budgets reinforced recommendations to prioritize dairy research in areas where maximum impact could be achieved. It is recommended that dairy research programs continue to address genetic/genomic tools and analysis, animal breeding and selection, nutrition and nutritional efficiency and animal well-being as well as reproduction and reproductive efficiency and issues relating to the transition cow.



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Top Priority Issue: Optimize reproductive efficiency in “easy-care” sheep in low-input sustainable production systems for the sheep industry. Specific research areas for this priority include:

- Mitigate seasonal infertility and seasonality
- Improve embryonic and fetal health, survival and related physiological effects expressed during development and maturity
- Improve lamb survival and vitality
- Development and characterization of an easy-care, white face and hair sheep maternal lines with genetically/genomically improved maternal and wool traits and improved parasite resistance

Additional High Priority Areas:

1. Develop genetic/genomic solutions for sustainable sheep production systems with the objective to maximize profitability by optimizing biological efficiency. Specific research areas for this priority include:
 - Identify and integrate genomic information into quantitative selection systems to increase genetic progress and accuracy for sheep producers for production traits, product quality, health and disease resistance and parasite resistance
 - Develop an understanding of gene expression and association with economically important traits for the sheep industry
 - Develop improved phenomics and comprehensive phenotyping for genome research in the sheep industry
 - Focus research on development of optimized genetic and management programs to best match feed resources to reproductive potential in pasture and rangeland production systems
2. Improve the efficiency of nutrient utilization for forage based and concentrated rations to decrease production costs and increase profitability. Specific research areas for this priority include:
 - Develop and expand research in metagenomics to elucidate the role of the sheep rumen biome in nutritional efficiency.
 - Develop the utility of emerging co-products and by-products in sheep production systems to facilitate the adoption of low cost alternative feed stuffs.
 - Develop a better understanding of the role of minerals and micro-nutrients (including natural sources) and their availability in feeding and forage systems to improve nutrient management and nutritional efficiency
 - Improve the efficiency of forage utilization for production flocks and forage finishing programs to decrease costs and improve performance in forage based production systems
3. Address consumer demand for improved meat products, including carcass characteristics and eating quality, through research to expand our understanding of meat

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and muscle biology for the sheep industry. Specific research areas for this priority include:

- Develop nutritional solutions using genomics and improved management to increase lean meat yield and improve meat quality in lamb carcasses
- Develop genetic and nutritional solutions to optimize the organoleptic qualities (tenderness and palatability) and nutraceutical content in sheep meat including conjugated linoleic acid, omega 3 fatty acids, selenium, etc

Recommendations for Extension and Educational Programs:

- Promote demonstrations and field days for producers and industry stakeholders through traditional extension programs.
- Translation and dissemination of research and educational information for under-represented producers and stakeholders including multi-cultural audiences.
- Expand technology transfer through eXtension, evolving communication technologies and social media.

Prospective Collaborations/Partnerships:

- Expand collaborative research and programming opportunities with Land Grant Universities and the International Sheep Genome Consortium.
- Expand collaboration with breed organizations, regional groups and international research in China, Australia, New Zealand and others.
- Expand awareness and priority for research and extension programming with industry stakeholders including breed organizations.

Breakout Session Summary

Concerns about contracting or static research budgets also reinforced recommendations to prioritize sheep research in areas where maximum impact could be achieved. It is recommended that sheep research programs continue to address genetic/genomic tools and analysis, animal breeding and selection, the development of “easy care” lines of sheep for the sheep industry, as well as the improvement of nutritional and production efficiencies, and our understanding of meat and muscle biology to improve consumer demand for and acceptance of meat products.



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Industry Position: Breed organizations and industry stakeholder groups representing the U.S. goat industry have formed the American Goat Association to address factions within the industry, lack of formal market structure and reporting and to better coordinate research, education and extension programming. Currently, few of these issues or opportunities are being addressed by the goat industry. Research, education and extension efforts are limited and ineffective. Currently USDA-ARS-NIFA sponsor limited research for the goat industry due to the lack of industry or legislative direction.

Top Priority Issue: Comparative physiology and genomics to accelerate technological and genetic progress for the U.S. goat industry. Specific research areas for this priority include:

- Develop comprehensive genetic and genomic evaluation and selection programs for the U.S. goat industry, including conventional production traits and parasite resistance to improve performance and reduced variability
- Develop systems for centralized data collection and phenomic resources for genetic/genomic, production and marketing research programs
- Improve technological advancement in reproductive efficiency, including semen collection, storage and utility, development of artificial insemination techniques; and embryo transfer

Additional High Priority Areas:

1. Conduct studies to develop an economic analysis of the goat industry, promote goat production and foster domestic and international market development. Specific research areas for this priority include:
 - Develop more local production and market options in growing demand centers in the East and Northeastern U.S.
 - Identify opportunities for increased production, marketing, harvest and processing
2. Develop improved meat and milk products to enhance local food security and provide products that are higher quality and more nutrient dense. Specific research areas for this priority include:
 - Improved fatty acid profiles of meat and milk products for human consumption
 - Improved amino acid composition of goat meat and milk products for human consumption
 - Improved safety of goats products
 - Determine the relative value of goat dairy products for the industry
 - Address growing domestic demand that is currently served through imports in ethnically diverse population centers
 - Promote more mainstream demand and consumption of goat products
 - Develop opportunities for expanded organic production of goat products



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Other Industry Priorities:

- Develop more comprehensive sustainable production systems for the goat industry including the evaluation of goats for use in targeted grazing and co-species grazing programs including programs to improve the quality of rangelands and forage systems, to improve production in varying production systems, to deliver ecosystem services and natural resource improvement techniques, and to highlight the utility of goats in silvo pasture systems.
- Development of sustainable, low input, “easy care”, forage based production systems that optimize costs and resources including approaches to address genetic, reproductive and production traits with the goal of maximizing profit.
- Improvement of goat performance on high concentrate rations in confined animal feeding operations with focus on growth, nutrient efficiency and environmental sustainability.
- Develop research programs focused on improved production traits including: health, immunity, growth, efficiency, reproduction, parasite resistance, product quality, and animal well-being, including behavior, handling, housing, transportation and equipment systems.
- Focus on systems to promote reproductive efficiency (out of season breeding) on a year-round basis to facilitate marketing of products.

Recommendations for Extension and Educational Programs:

- Comprehensive programs are needed to develop technologies, disseminate information and provide educational opportunities to producers, consumers and industry stakeholders.

Prospective Collaborations/Partnerships:

- Explore reproduction and genetic collaborative opportunities with ongoing international research programs in China, India and others.
- Collaborations and funding opportunities for research and program development should be explored with the Dairy Herd Improvement Program, Gates Foundation, National Institute for Food and Agriculture and Land Grant and 1890's University research programs.
- Explore market development and economic analyses programming collaborations with the American Goat Federation, industry stakeholders, USDA ERS, NASS, NIFA, US-AID, and IGA.
- Explore product quality improvement research and programming collaboratively with NIH and FDA.
- Explore sustainability research and programming with commercial agriculture forestry stakeholders, NRCS and timber industry stakeholders.

Breakout Session Summary - Program Direction

The USDA ARS and NIFA currently conduct or fund very limited research for the goat industry. The goat industry is focusing on increasing support for research, education and extension



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through the American Goat Association. The Association is also focusing on market and economic development to promote production and profitability for goat industry stakeholders.



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Top Priority Issue: Improved production efficiencies for growing swine post-weaning in response to increasing feed and grain costs. Specific research areas for this priority include:

- Improved nutrient utilization efficiency of common and alternative feedstuffs, including amino acids and energy
- Improved indirect prediction methods for nutrient utilization
- Mitigation of production and carcass issues directly related to seasonality, including the effects of heat and cold stress on transportation, growth and feed efficiency; carcass (lean) composition; and fat quality

Additional High Priority Areas:

1. Improved production efficiencies in the breeding herd to increase (optimize) sow production, longevity and lifetime performance. Specific research areas for this priority include:
 - Improved neonatal pig productivity, including larger and more uniform birth weights, improved pre-weaning growth and improved piglet survival
 - Mitigation of negative effects on sow performance related to seasonal temperature effects, including feed/nutrition strategies, feed quality, reproductive efficiencies and maintenance of pregnancy
 - Improved sow lifetime productivity and longevity to increase pigs marketed per sow per year, reduce sow mortality and minimize forced culling
 - Improved housing and management systems in breeding, gestation and farrowing systems to optimize reproductive efficiencies and lifetime productivity
2. Development of systems based research models to optimize swine production for maximum profitability and competitiveness. Specific research areas for this priority include:
 - Models of commercial production systems that account for interactions between health, nutrition, genetics, environment and animal well-being
 - Models to facilitate improved production marketing to satisfy market preferences.
 - Models of commercial production systems that enhance animal adaptation and well-being in specific production environments including management and animal genetic factors

Additional Medium Priority Areas:

1. Proactive management of issues related to swine production that may affect swine industry competitiveness and profitability. Specific research areas for this priority include:
 - Improved understanding of antimicrobial alternatives affecting growth, production efficiencies and animal health
 - Improved production and management practices relating to animal well-being, including pain management and mitigation, humane techniques for euthanasia



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- Mitigation of issues relating to manure management including odor, nutrient field application rates and manure storage
 - Optimize air and water quality for swine production units including manure management and odor abatement
2. Improved quality and demand for fresh and processed pork products. Specific research areas for this priority include:
- Improved human nutritional value of pork products including protein, nutrient quality and density, fatty acid profiles, sodium and other nutritional characteristics
 - Improved pork quality and consistency, including processing characteristics, yields and sensory characteristics to maximize consumer acceptance and demand
 - Improved pork safety related to chemical, physical and biological food hazards

Other Industry Priorities:

- Adaptation of animals and production systems in response to climate change – temperature, humidity and other potential environmental changes.
- Development of production models that optimize economic and environmental sustainability of the pork industry.

Recommendations for Extension and Educational Programs:

- Programs should be developed and supported with the pork industry to improve consumer perception of the swine industry.
- Leveraging USDA resources to mitigate issues related to swine production and consumer acceptance by developing collaborative research, education and extension programs.

Breakout Session Summary - Program Direction

Concerns about shrinking or static research budgets reinforced recommendations to prioritize swine research in areas where maximum impact could be achieved. It is recommended that swine research programs be enhanced to address reproduction and seasonality issues, nutrition, animal well-being and sow lifetime productivity, as well as systems based optimization of swine production and management and the healthfulness of pork products for human consumption



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Top Priority Issue: Develop expanded research in poultry layer well-being, including alternative housing systems so informed decisions can be made by producers facing pressure from society to modify existing housing. Specific research areas for this priority include:

- Develop alternative cost-effective housing systems that preserve production efficiencies and bird well-being
- Enhanced applied or translational genomics to improve bird adaptability and well-being in alternative housing systems
- Improved pharmaceuticals to preserve and enhance bird health and well-being
- Develop cost effective systems to determine gender pre-hatch that enhance animal well-being
- Improved humane, cost-effective beak treatments that preserve production efficiencies and enhance bird well-being

Additional High Priority Areas:

1. Enhance feed and nutritional efficiencies of broiler breeders and develop alternative feed ingredient options to decrease the cost of feed and production. Specific research areas for this priority include:
 - Identification of alternative feeds and feed ingredients
 - Enhanced development and utilization of novel feed enzymes
 - Improved understanding of the physiology of nutrient utilization, particularly energy
 - Improved feed manufacturing technologies to increase the value and efficiency of feeds and feed ingredients
2. Enhance environmental sustainability and reduce the environmental footprint of the poultry layer industry. Specific research areas for this priority include:
 - Improved efficiency of nutrient utilization while increasing the lifetime egg production of commercial layer hens
 - Decreased levels of nitrogen and phosphorus in poultry manure by increasing the digestibility of nitrogen and phosphorus in optimized poultry rations
 - Identification of technologies to lessen the volume and improve the use of hatchery waste
 - Genomic research programs to characterize the gut microbiome in poultry, facilitate more efficient utilization of endogenous phytase and increase the efficiency and effectiveness of endogenous probiotics
 - Applied or translational genomics programs to increase genetic progress for relevant traits related to environmental sustainability
3. Develop comprehensive programs in functional genomics to enable the prediction of a phenotype from a genotype. Specific research areas for this priority include:
 - Development of phenomics and comprehensive deeply phenotyped population data sets to facilitate genomic associations and delineate genetic function

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- Expand research in metagenomics to improve the efficiency of egg production
- Expand research to improve the efficiency of nutrient utilization for egg production
- Improved well-being of layer hens through research to increase stress tolerance and immune function, optimize bone and skeletal integrity, decrease morbidity and mortality, increase lifetime productivity and reduce cannibalism, feather pecking and related vices

Other Industry Priorities:

- Develop research in poultry reproduction to improve hatchability, fecundity, address management issues associated with feed restriction and satiety and improve the genetics of egg lay and fertility.
- Improve the ability to preserve poultry germplasm through development of improved techniques and technologies - improve the ability to regenerate a specific genetic line from preserved germplasm and improve the ability to maintain current production lines.

Recommendations for Extension and Educational Programs:

- Development information guidelines and best management practices addressing the advantages and disadvantages of conventional cages versus alternative housing systems. These should focus on food safety, environmental sustainability, production costs and bird well-being. Engage relative international partners as needed for program development.
- Engage extension programming to develop guidelines for ethics, producer roles and responsibilities and the economic and social impact of enhancing bird well-being.
- Develop and disseminate consumer based information elucidating the environmental impact of alternative housing systems compared to conventional production.
- Expand programs and opportunities to develop human capital for the poultry industry including formal educational and training programs, fellowships and other programs to provide future industry leaders and expertise.

Prospective Collaborations/Partnerships:

- Expand collaborative research and programming opportunities between NIFA, Land Grant Universities, FASS, PSA, industry stakeholders, breeding companies and commodity groups to promote research in bird well-being and alternative housing systems.
- Explore collaborative research and programming opportunities with international stakeholders including the WPSA working groups, FAO, OIE and related organizations in the EC.

Breakout Session Summary

Concerns about shrinking or static research budgets reinforced recommendations to prioritize layer research in areas where maximum impact could be achieved. It is recommended that layer research programs continue to address:

- Functional genetic/genomic tools



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- Immunology
 - Well-being, including its relationship to behavior, housing and production.
 - Improved feed and production efficiencies to decrease costs and optimize environmental sustainability Improved hatchability and fecundity
 - Management issues associated with feed restriction and satiety
 - Improve the ability to preserve poultry germplasm
-



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Top Priority Issue: Improve pre-harvest food safety to provide wholesome poultry products for end users with maximum attainable shelf-life. Improvements in these areas will result in increased demand for poultry products and improve the profitability and competitiveness of the poultry industry. Specific research issues for this priority include:

- Enhanced Salmonella mitigation, focused on gut microflora manipulation, science-based assessment and economic analysis of pathogen reduction options
- Enhanced Campylobacter mitigation
- Investigation of intestinal microflora and relevant interactions with feed ingredients, AGPs, coccidiostats, probiotics and other direct-fed microbials
- Development of rapid, low-cost pathogen detection methods and informatics

Additional High Priority Areas:

1. Enhance feed and nutritional efficiencies of broilers and develop alternative feed ingredient options to decrease cost of production. Specific research issues for this priority include:
 - Identification of alternative feeds and/or feed ingredients
 - Enhanced development and utilization of novel feed enzymes
 - Improved understanding of the physiology of nutrient utilization, particularly energy
 - Improved feed manufacturing technologies to increase the value and efficiency of feeds and feed ingredients used in the broiler industry
2. Enhance broiler production efficiency to improve the domestic and international competitiveness. Specific research issues for this priority include:
 - Improved housing best management practices, including lighting systems, ventilation, environmental controls, energy usage and stocking density
 - Improved environmental sustainability of broiler production with a focus on litter/manure and resource management, reducing ammonia levels and reducing emissions of green house gases and particulates
 - Develop ecology-based production systems models to improve the environmental sustainability of broiler production by optimizing production inputs
3. Improve the understanding of broiler physiology to optimize bird well-being, productivity and efficiency. Specific research issues for this priority include:
 - Better understanding of heat and moisture production
 - Enhanced understanding of the enteric function of intestinal microflora and their ultimate effect on broiler production and well-being
 - Better understanding of broiler muscle quality factors that determine nutritional value and eating quality for consumers
 - Better understanding of the relationship between bird well-being and skeletal integrity, cardiovascular development, innate immunity, integument and behavior



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Recommendations for Extension and Educational Programs:

- Develop a committee, similar to the National Research Council Nutritional Guidelines Committee, for the assessment of novel feed ingredients to improve feed and production efficiencies for the broiler industry.
- Develop workshops, short courses, distance educational opportunities, state based nutrition conferences and industry meetings/seminars in collaboration with industry stakeholders and the USDA to better disseminate information and technologies to producers and consumers.

Prospective Collaborations/Partnerships:

- Explore collaborative research and programming opportunities with the CDC, ERS, FSIS, FDA, NSF and NIH to promote research in food safety and basic research in genetics and physiology.
- Enhance interagency cooperation, develop regional demonstration projects and enhance collaborations with Land Grant Institutions and State agencies.
- Explore collaborative research and programming opportunities with industry stakeholders and professional scientific organizations.
- Expand opportunities to provide information and education to consumers about meat and poultry safety and prevention of infection etc.

Breakout Session Summary - Program Direction

Concerns about shrinking or static research budgets reinforced recommendations to prioritize broiler research in areas where maximum impact could be achieved. It is recommended that broiler research programs continue to address genetic/genomic tools and analysis and growth biology and nutrient utilization as well as to expand research in physiology to investigate intestinal microflora and their effects, muscle quality and broiler well-being.



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Session 2: Research Discipline Breakout Session Summaries

Introduction

This summary includes a comprehensive list of issues identified, discussed and prioritized by Workshop attendees in the Research Discipline Breakout sessions. General comments, issues and priorities are followed by a summary of the Breakout session for each commodity and recommendations for future program direction and development.

Breakout Session Summaries are included for Genetics, Genomics and Genetic Technologies; Physiology: Reproduction; Physiology: Lactation; Growth Biology and Nutritional Efficiency; Animal Well-Being, Stress and Production; Meat Quality and Muscle Biology; and Forages and Forage Utilization.

Genetics, Genomics and Genetic Technologies

Top Priority Issue: Revise the USDA Blueprint for Animal Genetics to include direction for expanding the bioinformatic and quantitative genomic capacities for research to facilitate manipulation and analysis of large data sets. The critical need for expanded bioinformatic capacity includes the following priorities:

- Development/adaptation of analytical tools and data analysis pipelines
- Enhance comprehensive annotation of food animal genomes
- Improve database management infrastructure, technologies, information and education
- Enhanced genetic evaluation tools for research and industry

Additional High Priority Areas:

1. Focus research programs to cost-effectively increase the genome sequencing of individual animals and organisms. Promote the development of “next generation” genomic and genetic technologies and increase genetic progress through improved breeding and selection programs. Specific research issues for this priority include:
 - Develop programs in metagenomics to better understand the relationship between relevant microbiomes and animal production efficiencies and well-being
 - Develop/enhance programs to further sequence individual animals of significance in deeply phenotyped populations for traits of economic importance to the food animal production industries
2. Expand and coordinate research programs in phenomics, including the development of comprehensive phenotype databases required for genetic characterization. Specific research issues for this priority include:
 - Dissect complex phenotypes into biological components to associate economically relevant traits with genomic components
 - Develop economic analysis tools for production and related traits in food animal systems to quantify the value of genomic tools and information
 - Enhance systems to develop comprehensive phenotypes for novel and/or expensive traits and for traits that are difficult to measure, specifically, develop phenotypes for

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- nutritional components of human health related to food animals; phenotypes related to environmental impact and sustainability; animal health, immune function and production
3. Maintain basic research in genetic modification and genetic engineering of food animals. Specific research issues for this priority include:
 - Produce induced pluripotent stem cells, to increase scientific understanding of genomic effects and to increase genetic progress for economically important traits
 - Enhance transgenetics, to facilitate better understanding of single-gene functional genomics for homologous or orthologous genes in food animal species or independent genes of interest in unrelated species
 4. Maintain research and programming to secure, preserve and collate animal genetic resources to ensure future access to genetic variability for the food animal industries. Specific research issues for this priority include:
 - Expand current germplasm preservation programs for food animal species to limit or manage inbreeding and to ensure that genetic value and variation is maximized in the repository
 - Develop novel germplasm preservation techniques including somatic cell lines and related tissue preservation technologies to increase security and expand opportunities to preserve diverse germplasm domestically and internationally

Recommendations for Extension and Educational Programs:

- Strengthen the interface between genomics/genetics and education and extension efforts to increase the understanding and application of emerging genetic and bioinformatic technologies.
- Enhance the public perception of genetic and genomic technologies and genetically modified organisms through expanded education and information programs for consumers.
- Expand programs to recruit the next generation of scientists in genomics, genetics and bioinformatics in collaboration with Land Grant Universities. Support students by providing expanded opportunities for internships, fellowships, assistantships etc. Strengthen funding for training grants to promote and expand undergraduate opportunities.
- Increase the capacity for technology transfer for genetics through extension, stakeholder education and demonstrated technological application.
- Develop cost-effective commercial platforms for the initial development and application of genomic technologies.

Prospective Collaborations/Partnerships:

- Expand collaborative opportunities with public institutions including NHGRI-NIH, Land Grant Universities and DOE; private institutions including breed associations, breeding companies and DNA technology companies; and international stakeholders including Australian CRC, Asian Genomics Companies, BBSRC, Embrapa and Ag Research.



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Breakout Session Summary**

General consensus from the National Workshop Genomics Breakout Session is that increases in support for research and additional resources for bioinformatics are a critical need for the USDA. Research progress for genomics has been excellent, however, constantly expanding computational and sequencing technologies have created large data sets requiring significant additional resources for data management and manipulation as well as analyses, to best leverage the value of accumulating genomic information. Additional priorities were identified for the development of human capital for genomic science and bioinformatics. It was further recommended that current programs in genetic engineering and germplasm preservation be maintained or expanded.



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Physiology: Reproduction

Top Priority Issue: Optimize fertility in livestock as a primary driver of productivity, production efficiency and profitability for the food animal industries. Research should target highly productive food animals where reproductive efficiency is compromised. Specific research areas include:

- Determine contributions of male and female gametes to embryo quality and viability
- Identify nutritional and metabolic mediators of fertility
- Optimization of ovarian function for fertility, including follicular development and corpus luteum function
- Identify biological and genetic markers for highly fertile animals
- Determine exogenous influences on fertility including seasonality, thermal stress, housing, handling and environmental factors such as ammonia air quality
- Elucidate the role of the hypothalamus/pituitary in control of puberty and estrous cyclicity
- Determine factors regulating conceptus viability and growth in critical stages of development during gestation (i.e, embryonic, placentation, fetal development, parturition)
- Identify relationships and interactions between ovarian function, uterine environment, the placenta and the embryo/fetus during pregnancy

Additional High Priority Areas:

1. Assess the effect of genetic, epigenetic and environmental influences and relationships on reproduction (genotype to phenotype). Specific research issues for this priority include:
 - Address postpartum, nutritional, seasonal and prepubertal effects on estrous cyclicity and ovulation, behavioural anestrus and/or anovulation and pregnancy maintenance
 - Better understand the phenomenon and effects of embryonic, fetal and neonatal epigenetics (imprinting) on development
 - Elucidate the mechanisms of heterosis effects on reproduction and reproductive efficiency
 - Enhance lifetime maintenance of reproductive function for food animals to improve reproductive efficiency
 - Mitigate lactation effects on reproduction as modulated by nutrition for beef, dairy, and swine
2. Develop innovative reproductive biotechnologies to improve reproductive function and efficiency in food animals. Specific research issues for this priority include:
 - Improve techniques and technologies for cloning food animals including pre-natal development, survivability and well-being
 - Improve techniques and technologies for embryo production and quality for embryo transfer in food animals
 - Develop/improve stem cell technologies relevant to food animals focused on improved genetic complement and germplasm preservation



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- Explore opportunities with transgenics to determine the role of genes and gene complexes in improving the production efficiencies of food animals
- Improve techniques and technologies for germplasm collection, preservation, storage and collation

Recommendations for Extension and Educational Programs

- Continue to support commercial production by converting research results in reproductive biology to techniques and strategies that can be used on the farm.

Prospective Collaborations/Partnerships

- Increase collaboration between commercial production systems and research facilities, to improve relevance of research results to commercial animal production.
- Increase opportunities for scientists and representatives from producer organizations to interact and share research results and industry problems related to reproductive efficiency.

Breakout Session Summary - Program Direction

General consensus from the USDA National Workshop Physiology - Reproduction Breakout Session is that reproductive efficiency research in the USDA has been productive and has had substantial impact on animal agriculture given the limited scope of research funding relative to the size and importance of this area to the US agricultural enterprise. The stakeholders felt that research in basic and translational reproductive research should be expanded to best address ongoing research priorities particularly in the area of dairy reproductive efficiency. Improved reproductive efficiency has been identified as high priorities for the food animal industries as a primary component of profitability and production efficiency and it was strongly recommended that additional resources be allocated to research and programming in this area by both ARS and NIFA.

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Top Priority Issue: Optimize or improve lactation performance and lactation efficiency.

Specific research areas to optimize lactation efficiency include:

- Better understand lactation induction and maintenance of lactation
- Elucidate mammary epithelial cell function and role in lactation
- Improved milk composition for neonates and milk products for diverse industry applications
- Enhance management and health of food animals during the dry period (non-lactation) to improve subsequent lactation performance, lifetime production and animal well-being
- Better understand the physiological processes and management of food animals during the periparturient period to improve milk production and reproductive performance
- Enhance immune function to improve health and production, including lowering the incidence of mastitis and improving colostrumogenesis
- Develop/discover genetic and biological markers for economically important traits relating to lactation
- Elucidate environmental influences on lactation performance such as ambient temperature
- Elucidate factors that interfere with nursing by neonatal livestock

Additional High Priority Areas:

Improve understanding of mammary development and growth. Specific research areas for this priority include:

- Determine the role of nutrition on mammary development
- Better understanding of the relationship between stem cell biology and mammary development
- Elucidate epithelial and stromal cell interaction and function
- Better understand the fetal uterine environment and its impact on future mammary development and lactation performance

Recommendations for Extension and Educational Programs:

- Develop workshops that help producers utilize and understand new technology to maximize productive efficiency (milk yield, components or neonatal health).
- Develop interactive tools that allow farmers and producers to evaluate the environmental and economic impacts of various nutritional, reproductive and manure management strategies on milk production or neonatal growth.

Prospective Collaborations/Partnerships:

- Develop opportunities/partnerships to enable large scale trials for market opportunities.
- Continue to enable partnerships that offer diversified research opportunities for the future.
- Enhance partnerships/collaborations with DHIA, milk cooperatives and large industries selling milk or milk components for the future are essential.



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Breakout Session Summary - Program Direction

General consensus from the USDA National Workshop Physiology - Reproduction Breakout Session is that lactation efficiency research in the USDA has been limited. There has been some excellent research on mammary stem cells as well as lactating transgenic animals however the scope of the lactation program seems to be declining. Improved lactation performance has been identified as a priority for the food animal industries as it is important for milk production, neonatal growth, post natal mortality and subsequent productivity. It was strongly recommended that additional resources be allocated to research and programming in this area by both ARS and NIFA.



ARS / NIFA 2011 Animal Production Workshop – Summary Report, March 29-30. Growth Biology and Nutritional Efficiency

Top Priority Issue: Develop means to potentiate nutrient utilization to reduce the relative cost of feed and forages in food animal production systems. Specific areas of research to address this priority include:

- Development and evaluation of alternative feeds, including methods for evaluation of nutritive value and quality factors of emerging and novel ingredients, specifically, real-time and on-site assessment of all feed ingredients to optimize nutritional value and efficiency of nutrient utilization
- Exploit the genetic variation associated with nutrient use efficiency including programs to best exploit the interactions between animal genetics and genomics, the microbiome and physiological factors relating to growth and nutrient utilization
- Determine the optimum use of enzymes to improve nutrient use efficiency
- Enhance nitrogen use efficiency, including urea recycling

Additional High Priority Areas:

Characterize and manipulate the microbiome of the gastrointestinal tract to elucidate the role of the microbiome for growth, nutrient utilization, immune function and green house gas emissions. Specific areas of research to address this priority include:

- Comprehensive characterization of organisms in and functions for the microbiome
- Effect of manipulation of microbiome populations on immune function, growth and nutrient utilization
- Understand the relationship between the host animal and the microbiome, including interactions with effects on immune function, food safety, product quality, growth and nutrient utilization and environmental sustainability

Other Priorities:

- Optimize current population genetics and production systems to maximize food animal product synthesis and quality. Specific areas of research include: nutrition and nutrient partitioning; metabolic modifiers; fundamental biology of productive tissues, including muscle, adipose, mammary gland, liver, wool, etc; and adaptability, including thermal stress in response to climate change and other environmental factors.
- Developmental programming to assess how prenatal and postnatal environment affects lifetime productivity, longevity, product quality and composition and related traits. This information is critical to better develop strategies and mechanisms to manipulate animal development to improve production, efficiency and product quality.

Recommendations for Extension and Educational Programs:

- Enhance communication with industry stakeholders on the value and urgent need for focused research programs to improve growth and nutrient utilization
- Improve communication and linkages between extension, researchers, and allied industry stakeholders



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- Enhance distribution of newsletters, research reports and associated technologies to stakeholders through proactive engagement of extension with the research community
- Develop effective educational and outreach strategies including webinars and other real-time information delivery methods to disseminate information to industry stakeholders, decision makers and consumers.
- Enhance programs to recruit and support future industry leaders and scientists in microbiology and nutritional biochemistry, including extended support for recruitment and training of graduate students through the USDA – ARS, NIFA and Land Grant University systems.

Prospective Collaborations/Partnerships:

- None identified

Breakout Session Summary - Program Direction

General consensus from the National Workshop Food Animal Production Growth Biology and Nutrient Utilization Breakout Session is that animal growth and nutrient utilization research through the USDA has been adequate, but limited in scope. It should be expanded and additional resources applied to address critical needs to improve production efficiencies and feed/nutrient utilization.



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Top Priority Issue: Quantify the relationship between animal well-being, production and economic factors including: genetics/genomics, behavior, housing, health, nutrition, management, production level, profitability, production efficiencies and food safety. Specifically develop objective criteria to assess animal comfort and care within specific production environments. This should ultimately lead to optimization of animal production and efficiencies while ensuring animal health and well-being. Specifically, develop assessments to determine the relationships between animal well-being and the following factors:

- Animal health and immune function
- Production level and production efficiencies
- Affective State status, both positive and negative
- Environmental factors including manure gases and ammonia, temperature, lighting and ventilation rate
- Animal handling and caretaker interaction
- Genomics and genotype to phenotype interactions with production and environmental factors

Additional High Priority Areas:

Evaluate the effect of current management practices and procedures on animal well-being, stress and productivity.

Develop and validate cost-effective alternative management practices and procedures that improve animal well-being.

Specific research focus should be applied to the following factors:

- Evaluation of painful procedures and development of suitable alternatives, including improved techniques and technologies to measure pain and develop pain mitigation strategies
- Improved practices and technologies for euthanasia
- Improved strategies to decrease transportation and handling stress, morbidity and mortality in all classes of livestock
- Develop/improve technologies to aid caretakers in implementing animal care, and animal management practices and procedures that enhance animal well-being
- Develop methods for early identification of animals at risk for disease and other stressors

Other Priorities/Comments:

- Identify alternatives to the use of sub-therapeutic levels of antibiotics in livestock production.
- Strategies to enhance recovery of livestock from stressful events and disease challenges, including management of animals during the recovery period and the nutritional needs of sick and recovering animals.



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- Development of Precision Animal Management techniques to delineate normal animal to animal variation, within animal day to day variation and expand the understanding of normal and abnormal variation in animal behavior and adaptation to stress.

Recommendations for Extension and Educational Programs:

- Develop effective educational and outreach strategies to disseminate information to industry stakeholders, decision makers and consumers.

Prospective Collaborations/Partnerships:

- Enhance and expand opportunities to develop collaborative research programs with USDA, NIH, NSF, FSIS, NRCS, DOD, CDC, FDA, EPA, APHIS, DHS, Land Grant Universities and academia, state governments, state extension programs, AWIC and OLAW.
- Enhance and expand opportunities to develop collaborative research programs with pharmaceutical companies, food retailers, professional societies, private research foundations, producer organizations, consumer groups, AVMA, AAALAC and other industry stakeholders.

Breakout Session Summary - Program Direction

General consensus from the National Workshop Animal Well-Being Breakout Session is that animal well-being research through USDA has been excellent, but limited in scope. It should be expanded to best address critical needs to understand and improve animal well-being while optimizing production and production efficiencies for the food animal industries.



ARS / NIFA 2011 Animal Production Workshop – Summary Report, March 29-30. Meat Quality and Muscle Biology

Top Priority Issues: Enhance food animal meat product quality to increase consumer demand for food animal products. Specific research areas for this priority include:

- Better definition of domestic and international consumer needs and preferences for meat products
- Develop and refine cost-effective efficient technologies to predict product quality
- Elucidate biological mechanisms that control or influence product quality traits
- Improved product preservation and the stability of product quality factors

Additional High Priority Areas:

Assess and enhance the nutritional value and human health benefits of meat products. Specific research areas for this priority include:

- Elucidate biological mechanisms of nutritional components in meat to improve nutritional values
- Determine the effect of management practices on nutrient values
- Design animal protein products to improve human health
- Develop strategies to increase meat as part of a healthful diet recognizing the opportunities and challenges

Other Priorities:

- Increase saleable product yield from food animals, including increased lean deposition and increased yield of high value meat cuts.
- Enhance meat product value through development and investigation of novel technologies and their applications to the meat industry.

Recommendations for Extension and Educational Programs:

- Improve communication and linkages between federal agencies, extension, industry experts, production companies, researchers and industry stakeholders.
- Development of emerging communication technologies including webinars and other real-time training and information delivery approaches for producers and industry stakeholders.
- Develop effective educational and outreach strategies to disseminate information and implement technologies to industry stakeholders, decision makers and consumers.

Prospective Collaborations/Partnerships:

- Expand collaborative research and programming opportunities with Land Grant Universities, within ARS, NIFA and other relevant federal agencies.
- Expand collaborative research and programming opportunities with food animal commodity groups, genetic companies, production companies and associated industry stakeholders both international and domestic.



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Breakout Session Summary - Program Direction**

General consensus from the National Workshop Meat Quality and Muscle Biology Breakout Session is that meat quality and muscle biology research in the USDA has been excellent and impactful, but limited in scope. It should be expanded and given additional resources to best address ongoing research priorities for product quality and value and to address the critical emerging need to improve the healthfulness of animal products.



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Top Priority Issues: Enhance basic rumen ecology through improved understanding of the following priorities:

- Enhanced nitrogen utilization in the rumen and post ruminally
- Elucidate the role and function of the rumen microbiome in forage digestion
- Elucidate the role and function of fatty acids in health and production efficiencies of ruminant food animal species

Additional High Priority Areas:

1. Develop comprehensive, systems based, applied or translational sustainable forage systems to increase the production efficiencies of ruminants. Work should address all facets of production from breeding through the end product. Specific research areas for this priority include:
 - Develop/improve sustainable pasture management systems focused on grazing management, stocking density and animal movement to improve pasture and rangeland productivity
 - Improved pasture and rangeland ecology including assessment of the environmental impact of grazing systems
 - Conduct comprehensive analyses of factors affecting sustainable forage systems including: animal genetics; parasite control; risk assessment of varying production factors; forage stockpiling; strategies to extend the grazing season; methods to improve the utility of low quality forages and develop a better understanding of plant-animal interactions on pasture and rangelands
 - Develop strategies for pasture renovation, including factors to address animal intake and the rate of plant re-growth
 - Elucidate the basic metabolism of forage utilization in ruminants
 - Forage species and parasite control
 - Improved utilization of stored forages
 - Develop risk assessment tools to evaluate the production and economic risks and rewards of forage-based systems including factors to be considered should include those associated with seasonal variation, species selection (cool versus warm season grass), fertilizer application, forage growth regulators and changes in animal requirements driven by stage of growth, lactation or other production demands
2. Improved forage utilization efficiency – on farm. Specific research areas for this priority include:
 - Develop comprehensive data sets for relevant grazing systems to determine best management practices and strategies to optimize grazing systems
 - Determine cost-effective strategies to accurately estimate forage intake for individual animals grazing diverse open pasture and rangelands
3. Forages with improved vegetative quality and nutrient availability in an integrated plant and animal system. Specific research areas for this priority include:



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- Improved phenology of forage species (the annual cycle of the plant in response environmental changes) including:
 - Identify and develop plants that best fit integrated plant and animal systems. Include research in: flowering, tillering, vegetative growth, overall forage quality, and genetics of forage species to improve plant breeding programs and enhance the yield and quality of forages
 - Collaborative research with the turf industry to expand the early vegetative phase and delay maturity in forages
- Improved water use efficiency, disease resistance and pest resistance in forage plant species

Recommendations for Extension and Educational Programs:

- Enhance collaboration with USDA and Land Grant Universities, community colleges, junior colleges, industry stakeholders (turf and bio-fuel industries) and relevant international programs.
- Internships for students that enable them to acquire hands-on experience necessary for success within industry and academic ranks.
- Programs that attract and engage the “next generation” of scientists focused on forages and forage utilization.

Prospective Collaborations/Partnerships:

- Enhance collaborative ties with other plant focused research groups (e.g. turf, biofuels).
- Enhance and expand opportunities to develop leaders and industry scientists through internships, student recruitment and other related activities.
- Expand programs to disseminate research findings and information and educational opportunities to producers to better transfer technologies to forage production.

Breakout Session Summary - Program Direction

General consensus from the National Workshop Forage and Forage Utilization Breakout Session is that research in forages for ruminant species should be focused on rumen ecology, forage efficiencies and optimized grazing/forage systems to maximize production efficiencies and competitiveness. Research progress for forage utilization in the USDA has been excellent, but limited in scope and needs to be expanded.

**ARS / NIFA 2011 Animal Production Workshop – Summary Report, March 29-30.****Session 3: Emerging Issues in Food Animal Production Session Summaries****Introduction**

This summary includes a comprehensive list of issues identified, discussed and prioritized by Workshop attendees in Session 3: Emerging Issues in Food Animal Production. Specific issues and priorities are followed by a summary of the comments from each Breakout session.

Breakout Session Summaries are included for Environmental Aspects of Sustainability; Alternatives to Antimicrobials for Production; International Food Animal Production; Food Animal Production and Energy Evolution; Current and Promising Technologies in Genomics and Bioinformatics; and Food Animal Products.

Environmental Aspects of Sustainability: climate change, greenhouse gases, manure management, water, and air quality

Top Priority Issue: *Define impacts of pollutants and mitigation practices through use of comparative Life Cycle Assessment (and other tools) for various production systems.*

Focus on understanding animal grazing consumption, minimizing and managing nutrients (pollutants) and maximizing societal benefits and understanding of environmental interactions. Specific research areas include: understanding animal grazing and consumption and the interaction of ruminants and their grazing environments (e.g., forages, soils, water, air); effects of animal production on animal and human health; effects of animal production on ecosystems; relationship between production system pollutants and economic sustainability; mitigation of societal concerns about dust, odor, and flies and the development of scalable models to address environmental impact of animal production for individual producers at local, regional, national and international levels.

Additional High Priority Areas:

Characterizing, quantifying and mitigating air and water pollutants, including greenhouse gases, from livestock and poultry operations.

Define the environmental impact of food animal production and assess the effectiveness of pollution mitigation techniques and technologies. Specific research areas include: standardization of protocols and methods for measuring and modeling water pollutants and emissions; characterizing water and air quality issues; measuring and characterizing greenhouse gas emissions; characterizing any other biological or chemical agents associated with food animal production; improved technologies for mitigation of pollutants and greenhouse gases; effective management of particulate matter as a carrier of microbes and odors; and cost-effective alternative feeding and nutrient management strategies.

Develop improved beneficial uses of agricultural byproducts.

Capture full value of agricultural products by turning potential environmental liabilities into assets. Specific research areas include: systems to convert animal biomass to energy or fuel; improved use of animal byproducts as soil amendments; co-digestion of animal manure and other substrates into economically valuable products; and enhanced nutrient preservation and utilization of feed ingredients in animal production.



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Recommendations for Extension and Educational Programs:

- Communicate research findings with regulatory agencies, producers, consumers, retailers, and all collaborators.
- Disseminate information to producers through newsletters, workshops, etc.
- Utilize best/emerging technologies including webinars, social media, eXtension, etc.
- Consolidate information into centralized learning centers.
- Verify research translates into practice effectiveness (test applicability in real-world) and develop best management practices for producers.

Prospective Collaborations/Partnerships

- Public: EPA, NIH, DOE, USDA-NRCS, State and Regional Environmental Agencies, Universities, USDA-ARS, CDC, Conservation Districts, NOAA, Fish and Wildlife, USDA-NIFA, State Public Health, DoD, DHS.
- Private: Commodity Organizations, Retailers, Consultants, Individual Producers, Professional Organizations, Scientific and Professional Societies, Allied Industries, NGOs, Energy Companies, Consumers.
- International: FAO, World Bank, EC.

Summary Comments:

General consensus from the Environmental Aspects of Sustainability Breakout Session for Environmental Aspects of Sustainability is that continued improvement is needed to address the social and environmental impact of animal production. Continued research is needed to improve the production efficiencies of animal production and to better mitigate air and water particulates and pollutants. Research is also needed to improve the utility and management of feeds and forages as well as animal biomass and manure.

Alternatives to Antimicrobials for Production

Top Priority Issue: *Conduct comprehensive risk/benefit analysis of the use of antimicrobials for specific application in food animal production.*

Specific research areas for this priority include: parameters to include/measure in risk analysis; risk/benefit to food safety and food security; risk/benefit to public health; risk/benefit to animal well being and health and profitability; as well as research to address knowledge gaps identified in these analyses.

Additional High Priority Areas:

Identify or discover new technologies, compounds or agents to promote animal health and well-being in the absence of conventional antimicrobials.

Specific research areas include: microflora genomics and their role in production and immunity; physiology, immunology and nutrition of animals in context of conventional pharmaceuticals and

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the microbiome; identification of alternatives to conventional antimicrobials, e.g., phage, innate immune molecules, recombinant antibodies, prebiotics, probiotics and phytochemicals.

Physiology of animals and bacteria: Better understand how commonly used sub-therapeutic antibiotics work in the context of food safety, animal well being, health and profitability.

Specific research areas include: physiology, immunology and nutrition of animals in the context of pharmaceuticals and the microbiome; exploration of gut flora across food animal species; standardization of measurements; and harmonization of data end point interpretation across animal species.

Recommendations for Extension and Educational Programs:

- Additional activities are recommended to better educate the public, congress and regulatory agencies. Additional outreach is recommended through the Extension service.

Prospective Collaborations/Partnerships:

- Opportunities for collaboration should be developed or expanded with the Center for Disease Control, Federal Drug Administration, National Institute of Health and with Land Grant Universities. Additional collaborations should be explored with private universities, and corporate industry stakeholders.

Summary Comments:

General consensus from the Alternatives to Antimicrobials for Production Breakout Session for Alternatives to Antimicrobials is that a comprehensive program should be developed to address the issues associated with antimicrobials fed to food animals. Research is needed to better understand the physiology of the antimicrobial effect and to identify effective alternatives to conventional antimicrobials that preserve or enhance production efficiencies and ensure animal health and well-being. The USDA/ARS/NIFA were identified as a logical choices to conduct this program because of their association with other federal agencies of interest, their working relationship with the food animal industries and their positions as an independent and unbiased research institutes.

International Food Animal Production

Top Priority Issue: *Maintain the U.S. competitive edge for food animal production.*

Specific research areas include: development of technologies to reduce costs of production; increase importation and evaluation of exotic germplasm; continued improvement of existing U.S. germplasm; and increasing the efficiencies of production.

Additional High Priority Areas:

Reduce and Eliminate Non-Tariff Barriers Using Science Based Information.

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Specific research areas include: scientific support for genetically modified organisms and meat animal production; scientific support for policies related to transfer of genetic materials; and science-based standards for food safety, human health, etc.

Bio-fuel impacts on competitiveness of livestock production.

Specific research areas include: efficiency of forage utilization; utilization of nutrients from co-products; and alternative feedstocks for bio-fuels production.

Improve world food security through improved livestock production.

Specific research areas include: low tech/ low input methods to improve production and production efficiencies; and programs to improve and adapt indigenous species and breeds.

Recommendations for Extension and Educational Programs:

- Expand opportunities for extension and outreach. Explore participation in the International Livestock Conference.

Prospective Collaborations/Partnerships:

- Opportunities for collaboration should be developed or expanded with: FAPRI, Land Grant Universities and Academia, USDA Agencies, Gates Foundation, Winrock International, FAO, ILRI, and the World Bank.

Summary Comments:

General consensus from the International Food Animal Production Breakout Session for International Food Animal Production is that there are many underdeveloped opportunities to expand meat animal production and international research collaborations. However, the United States is in danger of losing the historic competitive edge that the meat animal industries have enjoyed due to rising production costs and increased international competition. Research is needed to continue to improve production efficiencies and competitiveness of U.S. animal industries.

Food Animal Production and Energy Evolution

Top Priority Issue: *Ensure economic and environmental sustainability of livestock enterprises by characterizing energy partitioning and evaluating opportunities for energy alternatives and more efficient use.*

Specific research areas include: measuring energy uses across systems including production, transportation, processing and marketing; developing common language when comparing energy systems (BTUs/lb., CWT); and characterizing and improving bioenergetics (i.e. cost of feed, feed milling, cost of power).

Additional High Priority Areas:

Close energy loop in animal production and increase efficiency to minimize energy impacts on profitability.



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Specific research areas include: alternate methods of energy production; and identification and development of new methods of energy production for animal systems.

Develop technologies and methods needed to improve efficiency in food animal production.

Leverage knowledge for improvement in the efficiency of animal production systems. Specific research areas include: optimizing production systems for livestock including complete operation and supply chain evaluation; improvement of control systems and retrofits for housing, equipment; adapting Leadership in Energy and Environmental Design (LEED) certification to agriculture applications; and development of decision support tools.

Recommendations for Extension and Educational Programs:

- Expand opportunities for training in agriculture for those conducting energy audits.
- Develop programs to facilitate the implementation of decision support.

Prospective Collaborations/Partnerships:

- Opportunities for collaboration should be developed or expanded with: NIST, DOE, NRCS and EPA.

Summary Comments:

General consensus from the Food Animal Production and Energy Evolution Breakout Session for Food Animal Production and Energy Evolution is that energy use in food animal production is not well characterized. Vast potential exists to improve efficiencies across food animal systems from production through marketing. An analysis of system wide energy efficiencies is needed to optimize energy use and costs.

Current and Promising Technologies in Genomics & Bioinformatics

Note: The general topics addressed by the Current and Promising Technologies in Genomics and Bioinformatics Breakout Session were focused primarily on bioinformatic needs for research and industry stakeholders – as directed by the attendees. Very little discussion was provided for current and promising technologies.

Top Priority Issue: *Develop animal agriculture specific tools for biological information, including software to manage large complex data sets, across multiple species. Deploy relevant applications in order to improve data integration and visualization from disparate sources to support evidence-based functional genomics.*

Specific research areas include: better storage, handling, and movement technologies for large data sets; improved efficiency of data processing to improve data integration and visualization.

Additional High Priority Areas:

Improved sampling and data collection procedures and protocols for metagenomics.

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Specific research areas include: improved bioinformatics for metagenomics; standardized sampling procedures for microbial populations; and access to and application of improved gene sequencing technologies featuring longer read lengths, etc.

Train and develop human capital to serve as next generation scientists in genetics, biology and bioinformatics.

Specific and critical needs for bioinformatic support personnel and expertise is growing within the USDA, academia and industry.

Develop low-plex, low cost, cost-effective genotyping technologies.

Specific need exists for cost-effective tools for applications such as parentage or relatedness.

Recommendations for Extension and Educational Programs:

- See expanded educational opportunities relating to priorities above.
- Improved extension and information systems are needed to deliver and disseminate information and technologies to professional food animal breeders in the field.

Prospective Collaborations/Partnerships:

- Expand collaborative opportunities with NIFA, Land Grant Universities and other agencies.

Summary Comments:

General consensus from the Current and Promising Technologies in Genomics and Bioinformatics Breakout Session is that genotyping, computing and bioinformatics resources and infrastructure are a critical need for USDA, academia and industry stakeholders. A need was identified to improve the interface with professional breeders to share emerging technologies and educational information. An additional priority was identified for the development of next generation expertise, including scientists and support staff for bioinformatics and the animal sciences.

Food Animal Products: Nutritional Value, Healthfulness, Emerging Consumer Trends

Top Priority Issue: *Enhance the healthfulness of animal products and identify factors that control variation in nutritive value of animal-source food products.*

Population demographics are changing (i.e., socio-economically, by age, culturally), which affects consumer food choices. Research is needed to improve human health with animal products within this framework. However, in order to manipulate composition of food products, the sources of variation and controlling mechanisms (targets) need to be identified and understood. Specific research areas include: targets within animal-source products that impact human health; variation of targets within animal-source products; technologies to rapidly identify phenotypic variation in animal-source products; technologies to manipulate/incorporate targeted



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components; and strategies to maximize or alter nutritive value of animal products for human benefit.

Additional High Priority Areas:

Identify ramifications of changing nutritive value of animal-source products on human health.

Specific research areas include: collaborative human nutritional studies to determine whether changes in animal-source products affect human health.

Recommendations for Extension and Educational Programs:

- Comprehensive consumer surveys are needed to best identify consumer needs, perspectives and opportunities for product development and enhancement.
- Communicate research findings to allied federal agencies (i.e., NIH, NCI, FNS) and consumers.

Prospective Collaborations/Partnerships:

- Expand collaborative opportunities with human nutritionists and medical community (academic and federal) and animal scientists, food scientists, commodity groups (domestic and international), NZMA, Canadian Beef Information Centre, MLA, International Dairy Federation, International Egg Commission, International Meat Secretariate, FAO, Gates Foundation, USAID.

Summary Comments:

General consensus from the Food Animal Products Breakout Session is that the food animal industries should be proactive in developing research and programming to support inclusion of animal-source products as healthy options for human diets. Specifically, the food animal industries should be both reactive to public demands and proactive in better educating the public and developing more healthful food alternatives. The food animal industries should also be proactive in providing support for determining the accuracy of food labeling for individual products (i.e., variation in specific nutrients, variation in specific cuts of meat, effects of specific feeding conditions, animal genetic effects).



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United States
Department of
Agriculture

National Institute
of Food and
Agriculture



**ARS – NIFA Stakeholder Workshop Agenda
Food Animal Production, March 29 and 30, 2011**

*Marriott Baltimore/Washington International Airport Hotel, 1743 West Nursery Road
Baltimore, Maryland 21090*

Planning Committee:

Mark Boggess, USDA-ARS National Program Leader – Food Animal Production
Adele Turzillo, USDA-NIFA National Program Leader – Division of Animal Systems
Steve Smith, USDA-NIFA National Program Leader – Division of Animal Systems
Mark Mirando, USDA-NIFA National Program Leader – Division of Animal Systems
Rich Reynnells, USDA-NIFA National Program Leader – Division of Animal Systems
Charlotte Kirk-Baer, USDA-NIFA National Program Leader – Division of Animal Systems
Jeff Silverstein, USDA-ARS National Program Leader – Aquaculture

Workshop Objectives:

A strategic plan for USDA-ARS National Program 101 Food Animal Production and USDA-NIFA will be developed from the following objectives:

- A. Provide livestock industry stakeholders with information about current ARS and NIFA programs and solicit input from livestock industry stakeholders regarding existing and emerging issues affecting food animal production.
- B. Solicit direction and guidance from livestock industry stakeholders that will facilitate the development of USDA research, education and extension programs to effectively address commodity-specific, discipline-specific, and cross-cutting issues in food animal production.
- C. Solicit program direction and guidance for emerging issues relating to food animal production that might relate directly or indirectly to production over the next 5-10 years.
- D. Explore opportunities for collaboration and cooperation among ARS, NIFA, industry and academia to maximize research capacity and performance by leveraging funding, physical resources and scientific talent.
- E. Develop new ideas to facilitate technology development, transfer and implementation to industry.



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Schedule and Agenda: March 29 - Day One

- 7:00 am** **Continental Breakfast**
- 8:00 am** **Introductions and Orientation**
- 8:05 am** **Welcome – Steven Kappes**, USDA-ARS, Office of National Programs, Deputy Administrator and **Deborah Sheely**, USDA-NIFA, Assistant Director, Institute of Food Production and Sustainability
- 8:15 am** **Keynote Address: Dr. Ann Bartuska**, USDA, Deputy Under Secretary for Research, Education, and Economics, *A Vision for the USDA/REE for the next 5-10 years.*
- 9:00 am** **USDA-NIFA Update: Dr. Roger Beachy**, Director, USDA-NIFA
- 9:15 am** **USDA-ARS Update: Dr. Judy St. John**, Associate Administrator, Office of National Programs, USDA-ARS
- 9:30 am** **Retrospective Review Report and Land Grant Perspective: Dr. Maynard Hogberg**, Iowa State University
- 10:15 am** **Break**
- 10:45 am** **USDA Research Direction and Breakout Charge: Mark Boggess**, USDA-ARS-Office of National Programs
- 11:00 am** **Breakout Session 1 – Animal Industry Priorities**

Breakout Session 1 – Animal Industry Priorities:

Food Animal Group:

Facilitator:

- Beef
- Dairy
- Sheep/Goats

- Swine
- Poultry – layers
- Poultry – broilers

- Ronnie Green**, University of Nebraska
- Paul Fricke**, University of Wisconsin
- Paul Rodgers**, American Sheep Industry
- Sandra Solaiman**, Tuskegee University
- Paul Sundberg**, National Pork Board
- John Carey**, Texas A&M University
- Sam Pardue**, NC State University

Charge: Identify and prioritize the top 3-5 commodity-specific, researchable issues for food animal production over the next 5-10 years.

- 12:00 pm** **Lunch Break**
- 1:00 pm** **Resume Breakout Session 1**
- 3:00 pm** **Break and Breakout Session 1 Summary Preparation**
- 3:30 pm** **Breakout Session 1 Reports**
- 4:15 pm** **Breakout Session 2 – Research Discipline Priorities**



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Breakout Session 2 – Research Discipline Priorities:

Research Discipline:	Facilitator:
Genetics, genomics and genetic technologies	John Pollak , USDA – ARS/USMARC
Physiology: reproduction, lactation	Milo Wiltbank , University of WI
	Karen Plaut , Purdue University
Growth biology and nutritional efficiency	Deb Hamernik , University of NE
Animal well-being, stress and production	Janice Swanson , Michigan State
Meat quality and muscle biology	Dave Gerrard , Virginia Tech
Forages and forage utilization	Margaret Benson , Washington State University

Charge: Identify and prioritize the top 3-5 discipline-specific, researchable issues for food animal production over the next 5-10 years.

5:00 pm Adjourn Day 1

Schedule and Agenda: March 30 - Day Two

7:00 am	Continental Breakfast
8:00 am	Day One Review and Day Two Orientation: Adele Turzillo, USDA-NIFA; Mark Boggess, USDA-ARS-ONP
8:15 am	Keynote Address: Dr. Paul Heisey , Agricultural Economist, USDA Economic Research Service, <i>Trends in U.S. and global food animal production and trade: opportunities and challenges for food animal research.</i>
9:00 am	Resume Breakout Session 2 – Research Discipline Priorities
10:00 am	Break
11:30 am	Lunch and Breakout Session 2 Summary Preparation
12:30 pm	Breakout Session 2 Reports
1:15 pm	Breakout Session 3 – Emerging Issues in Food Animal Production

Breakout Session 3 – Emerging Issues in Food Animal Production:

Emerging Issues:	Facilitator:
Environmental aspects of sustainability: climate change, greenhouse gases, manure management, water and air quality	Frank Mitloehner , Univ. CA-Davis
Alternatives to antimicrobials for production International food animal production:	Jeffrey Gilbert , FDA



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competition, emerging demand/markets, trade,
production issues

Gary W. Williams, Texas A&M

Food animal production and energy evolution

Jeffrey Steiner, USDA - ARS

Current and promising technologies in genomics
and bioinformatics

Curt Van Tassell, USDA – ARS

Food animal products: nutritional value, healthfulness
emerging consumer trends and preferences

John Finley, USDA – ARS

Charge: Identify and prioritize the top 3-5 emerging issues in food animal production over the next 5-10 years.

- 3:30 pm** **Break and Breakout Session 3 Summary Preparation**
- 4:00 pm** **Breakout Session 3 Reports**
- 4:40 pm** **Industry and Academic Perspectives – Invited**
- 4:50 pm** **ARS-NIFA Wrap Up: Mark Boggess and Adele Turzillo**
- 5:00 pm** **Adjourn**

6:00 pm - 8:00 pm **ARS Scientists Meeting** Salon G&H