



USDA ARS/NIFA

**Food Animal Production
Stakeholder Listening Sessions
Summary**

May 2016

Table of Contents

Executive Summary.....	2
Introduction.....	2
Background	2
USDA-NIFA and the Animal Health, Production & Animal Products Program	3
USDA-ARS and National Program 101.....	3
Discussion Topics for Stakeholder Listening Sessions.....	5
Topic Summaries.....	6
Animal Genetics, Genomics and Bioinformatics.....	7
Applications of Biotechnology to Animal Production	8
Animal Well-Being, Stress and Production	9
Animal Reproductive Biology	10
Quality, Nutritional Value and Healthfulness of Animal Products	12
Lactation Biology and Nutritional Efficiency of Animals	13
Animal Growth Biology and Alternatives to Antimicrobials for Growth Promotion	14
Forages and Forage Utilization for Animal Production	15
Reducing Environmental Impacts of Animal Production	16
Appendix A: Profile of Participants.....	19
Appendix B: Stakeholder Comments by Topic	21
Animal Genetics, Genomics and Bioinformatics Stakeholder Comments	21
Applications of Biotechnology to Animal Production Stakeholder Comments.....	26
Animal Well-Being, Stress and Production Stakeholder Comments.....	32
Animal Reproductive Biology Stakeholder Comments	39
Quality, Nutritional Value and Healthfulness of Animal Products Stakeholder Comments.....	45
Lactation Biology and Nutritional Efficiency of Animals Stakeholder Comments.....	47
Animal Growth Biology and Alternatives to Antimicrobials for Growth Promotion Stakeholder Comments	53
Forages and Forage Utilization for Animal Production Stakeholders Comments	58
Reducing Environmental Impacts of Animal Production Stakeholder Comments.....	66

Executive Summary

In 2016, the United States Department of Agriculture (USDA) Agricultural Research Service (ARS) and the USDA National Institute of Food and Agriculture (NIFA) held a series of workshops and listening sessions focused on food animal production.¹ The objective of this joint effort was to solicit input from a broad array of stakeholders to inform the development of USDA research, education and extension programs to address existing and emerging commodity-specific, discipline-specific, and cross-cutting issues in food animal production over the next 5-10 years. Input was gathered through three coordinated activities: (1) regional workshops held at ARS locations in Clay Center, Nebraska; Beltsville, Maryland; and Lexington, Kentucky; (2) joint ARS and NIFA National Stakeholder Listening Sessions; and (3) an online “ideas engine” (CoDigital; <http://www.codigital.com/>). The joint Listening Sessions, held on May 23 and 25, 2016, were conducted as webinars and engaged 23 universities, 10 professional organizations, 12 businesses (including farms), two advocacy groups and five federal agencies/groups (Appendix A). Total participation during both sessions was 149 people, with 92 participating on May 23 and 57 on May 25. The CoDigital ideas engine engaged 290 participants. Input was solicited within nine animal-related topic areas. In total, 539 unique ideas were provided by participants. Common themes across all topic areas included the need for investment in systems-level research; the development of new tools and resources; models development and decision support; workforce development and training the next generation of scientists; technology transfer and outreach; and consumer engagement and education. All stakeholder ideas from all sources were sorted and summarized for each topic by common theme and are presented within this report. All individual ideas can be found in Appendices B.

Introduction

Background

Consumption of food animal products is increasing significantly around the world as more consumers gain access to higher quality and more nutrient dense diets. This trend will continue as the world’s population grows and incomes and urbanization increase. Animal production systems can fill a valuable niche in global food production by utilizing feeds and forages not appropriate for human consumption and, through further increases in efficiency, contribute to an environmentally sustainable food supply.

Historically the U.S. has been a preeminent source of high quality animal products, and it is a world leader in technological innovation. Application of these technologies has enabled the U.S. to develop one of the most efficient animal production systems on earth, and USDA-ARS and the USDA-NIFA programs have played vital roles in that achievement. In light of current pressures to feed a projected global population that will approach ten billion people by 2050, investments by USDA-ARS and USDA-NIFA in all areas of food production will continue to be critically important. To remain competitive in

¹ The stakeholder input described in this report is limited to terrestrial food animals. Stakeholder input pertaining to aquaculture species can be found at <https://www.ars.usda.gov/animal-production-and-protection/aquaculture/docs/workshops/>.

the global marketplace for food animal products, the U.S. must continue to focus on increasing production efficiencies through the development, refinement, and adoption of scientific technologies.

In the absence of unlimited resources, USDA must concentrate its investments in areas of greatest priority, as identified by stakeholders, with the goal of achieving the most significant impacts possible. USDA programs have produced extraordinary results for the livestock industry, and much of this success has been achieved through collaboration with universities, private industry, and other entities. A continued strong USDA commitment to food animal production research, extension, and education through ARS and NIFA programs, in cooperation with universities and other partners, will enhance the sustainable and economically viable production of food animal products in the U.S. and have positive impacts on livestock production agriculture around the world.

USDA-NIFA and the Animal Health, Production & Animal Products Program

NIFA is the extramural research agency for the USDA, and is one of four agencies that make up USDA's Research, Education, and Economics (REE) mission area. NIFA does not conduct research, but invests in and advances research, education and extension to help solve national challenges in agriculture, food, the environment, and communities. The annual budget for all NIFA programs is approximately \$1.5 billion. Of this, approximately \$115 million is invested annually in research, education and extension activities related to animal production and animal products.

NIFA administers its programs in animal health, production and animal products through its Division of Animal Systems. The overall goal of the Division of Animal Systems is to support livestock, poultry, and aquaculture production systems that are efficient, economically competitive, and environmentally sound. Programs are designed to help ensure high quality, quantity, and diversity of animal products as components of healthful diets; improve the security, safety, and resilience of the food supply; and improve the competitiveness and sustainability of animal agriculture.

The goals of the NIFA Division of Animal Systems is to support research, extension and education programs to address high priority issues in the following areas:

- Health and disease
- Well-being
- Reproduction
- Genetics and genomics
- Nutrition, growth and lactation
- Biosecurity
- Veterinary education, extension and training
- Veterinary services, especially in rural areas

USDA-ARS and National Program 101

The ARS is the intramural research agency for the USDA. The ARS budget of \$1.1 billion is allocated to research conducted in 17 national program areas. Research is conducted in over 90 laboratories by 1,700 full-time scientists within a total workforce of 7,700 ARS employees. Research in support of the ARS national program (NP) addressing animal production, NP101 – Food Animal Production, is conducted at 13 U.S. locations by 100 full-time scientists and has an annual budget of approximately \$48 million.

NP101 Vision Statement: A food animal production system that meets public demand for healthy and healthful animal products at a low cost, provides benefits to the environment, and raises food animals in a humane way.

NP101 Mission Statement: Conduct research to improve food animal production efficiency, industry sustainability, animal welfare, product quality and nutritional value while safeguarding animal genetic resources.

NP101 Strategic Objectives

1. Provide science-based, industry-relevant solutions in food animal nutrition, reproduction, breeding and genetics, well-being, product quality and natural resource use.
2. Engage and partner with members of the food animal industries to facilitate transfer of technologies and research products to ensure that the full value and impact of research activities reaches American consumers.
3. Develop an integrated animal and microbial genomics research program that will help identify alternatives to antibiotics for enhancing production efficiency.
4. Ensure access to specialized animal genomics capacity and related technologies for all food animal production research communities.
5. Foster scientific growth and individual leadership to enhance awareness of ARS scientific capabilities and accomplishments by other agencies, academia and industry stakeholders.
6. Facilitate highly effective comprehensive research collaborations between ARS laboratories, food animal industry stakeholders, academia and other federal agencies to best leverage resources and expertise for maximum industry value and impact.

NP101 Program Components

Component 1: Increasing Production and Production Efficiencies while Enhancing Animal Well-Being across Diverse Food Animal Production Systems

- Research in animal nutrition, animal reproduction and animal welfare.

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

- Research to develop genomic and metagenomic tools, characterize functional genomic pathways in animals, preserve animal genetic resources to support genetic diversity, and use genomic information to improve genetic selection and improve livestock gene editing technologies.

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

- Research to improve quality, nutritional value and healthfulness of animal products.

Discussion Topics for Stakeholder Listening Sessions

Nine topics were identified for discussion at the 2016 USDA-ARS & NIFA Food Animal Production Stakeholder Listening Sessions and the CoDigital online ideas engine. Both the live and online discussion of each topic is summarized in this report and stakeholder comments from each session are included in Appendix B.

Topic	Discussion Leaders	Leader Title and Affiliation
Animal Genetics, Genomics and Bioinformatics	Holly Neibergs	Associate Professor, Department of Animal Sciences, Washington State University
	Erin Connor	Research Molecular Biologist, USDA-ARS, Animal Genomics and Improvement Laboratory, Beltsville, MD
Applications of Biotechnology to Animal Production	Bhanu Telugu	Associate Professor, Department of Animal & Avian Sciences, University of Maryland
	David Donovan	Research Molecular Biologist, USDA-ARS, Animal Biosciences and Biotechnology Lab, Beltsville, MD
Animal Well-Being, Stress and Production	Susan Eicher	Lead Scientist, USDA-ARS, Livestock Behavior Research Unit, West Lafayette, IN
Animal Reproductive Biology	Tom Spencer	Professor, Division of Animal Sciences, University of Missouri-Columbia
	Jeff Vallet	Research Leader, USDA-ARS, U.S. Meat Animal Research Center, Clay Center, NE ²
Quality, Nutritional Value and Healthfulness of Animal Products	Chris Hostetler	Director, Animal Science, Science & Technology, National Pork Board, Des Moines, IA
Lactation Biology and Nutritional Efficiency of Animals	Brian Kerr	Research Leader, USDA-ARS, National Laboratory for Agriculture and the Environment, Ames, IA
	Wendie Cohick	Professor and Department Chair, Department of Animal Sciences, Rutgers University
Animal Growth Biology and Alternatives to Antimicrobials for Growth Promotion	Bryan White	Professor, Department of Animal Sciences and Carl R. Woese Institute for Genomic Biology, University of Illinois
Forages and Forage Utilization for Animal Production	James Russell	Professor, Department of Animal Science, Iowa State University
Reducing Environmental Impacts of Animal Production	Joseph Purswell	Agricultural Engineer, USDA-ARS, Poultry Research, Mississippi State University
	Ermias Kebreab	Professor, Sesnon Endowed Chair, Deputy Director - Agricultural Sustainability Institute, Department of Animal Science, University of California, Davis

² Currently National Program Leader, Food Animal Production, USDA-ARS, Beltsville, MD

Topic Summaries

Method used to summarize Stakeholder Input

Input was gathered through three coordinated activities: (1) regional workshops held at ARS locations in Clay Center, Nebraska; Beltsville, Maryland; and Lexington, Kentucky; (2) joint ARS and NIFA National Stakeholder Listening Sessions; and (3) an online "ideas engine" (CoDigital; <http://www.codigital.com>).

The joint Listening Sessions, held on May 23 and 25, 2016, were conducted as webinars and engaged 23 universities, 10 professional organizations, 12 businesses (including farms), two advocacy groups and five federal agencies. Total participation during both sessions was 149 people, with 92 participating on May 23 and 57 on May 25. All sessions were recorded and transcripts were generated.

Over 1000 animal production stakeholders were invited to participate in an "ideas engine" input mechanism, Codigital. This online platform facilitates large scale collaboration, allowing many ideas to evolve in real time. The system enables entire groups' suggestions to emerge and opinions to be captured. Over a period of several weeks, participants continually processed and edited each other's ideas until consensus was achieved. The process involves (1) adding ideas, (2) voting on ideas, (3) editing ideas and (4) voting on edits. A total of 290 stakeholders chose to participate. Ten groups, comprised of 20-40 participants each, developed in rank order their best ideas on the most promising opportunities for USDA-ARS and NIFA animal programs to address animal production stakeholder needs. In total, 539 unique ideas were provided by participants.

All stakeholder input, from all sources, was consolidated by discussion topic. Summaries for each discussion topic were written to reflect the highest ranking stakeholder priorities for each topic. The following describes the process used to define those priorities.

1. The transcript of each webinar session was converted into a listing of individual comments for each discussion topic (see Appendix B).
2. CoDigital comments and rankings for each discussion topic were merged with corresponding webinar comments.
3. Common themes were identified within each list and all comments were assigned to one of those common themes.
4. Each list was sorted by theme.
5. Top ranked 5 or 6 themes identified through the CoDigital process were chosen for inclusion in the Topic Summaries. These are not the same as the top 5 Codigital comments because many of the top comments were grouped within the same theme.
6. Themes with lower rankings that are not included in the summaries can be found in Appendix B.

Animal Genetics, Genomics and Bioinformatics

A total of 47 unique, individual comments regarding the *Animal Genetics, Genomics and Bioinformatics* discussion topic were captured during the webinar and from the CoDigital ideas engine. Based on the analysis, these comments were found to cluster around five common themes, listed below in rank order.

1. Genetics and environment

Stakeholders expressed strong support for funding to investigate the overall phenotype of animals as influenced by genetics and environment, asserting that genetics could be used to select animals suited for a specific environment. Participants stated that animal management practices are part of the animal's environment and should be considered in this work. Other research areas supported by stakeholders included influence of the environment on gene expression and epigenetics with the goal of improving animals' ability to adapt to different environmental conditions.

2. Tools and resources

Contributors asserted that the animal genomics community needs new tools and systems-based approaches for dynamic, integrative genomic analysis of large sets of "-omics" data from experiments involving multiple treatments and multiple tissue/cell types. Stakeholders also supported investment to develop good documentation of bioinformatics software and easy-to-use pipelines for genetic/genomic data analysis. Participants stressed the need to store data as publicly available, quantified data sets. They also stated that genomic tools and application of genomics for animal selection are still lacking in some minor species such as sheep, and additional funding is needed to address these gaps.

3. Animal health

Participants stressed that research to address the potential for creating populations of animals resistant to foreign animal disease pathogens is a high priority. Stakeholders also expressed the need to develop new phenotypes and phenotyping tools to measure resistance and susceptibility to disease, including phenotyping and genotyping to help identify genes/markers for disease resistance. They recommended development of breeding indices based on health and welfare traits. Among the diseases specifically mentioned were bovine respiratory disease and osteochondritis dissecans (OCD) in horses. Stakeholders also emphasized the need for genomic surveillance of disease. Several participants pointed to a need for more research on disease resistance in small ruminants.

4. Functional genomics

Stakeholders noted the importance of investment in the functional annotation of livestock, poultry, and aquaculture genomes with multiple features - such as RNA and DNA binding elements, methylation, and acetylation - for understanding the genetic basis of traits, including the role of epigenetics. They asserted the development of computational/database infrastructure is also needed to fully utilize the data. They also encouraged investment to understand the role of genomics in defining various traits, and stressed the value of collaborative work involving multiple species for analysis of functional genomics data.

5. Microbiome

Participants expressed a strong need for a better understanding of the role of host-metagenome interactions to address greenhouse gas emissions, feed efficiency, and antimicrobial resistance. In addition, they asserted that intestinal microbiome characterization in equids is needed to gain insight into intestinal interruptions and imbalances.

Applications of Biotechnology to Animal Production

Thirty-seven individual comments were captured by the webinar on *Applications of Biotechnology to Animal Production* and the CoDigital idea engine. Based upon the consensus achieved within the CoDigital framework, the following six themes emerged as top priority areas.

1. Commercialization and consumer acceptance

Stakeholders shared many comments regarding the challenges associated with commercialization of biotechnology in general, and gaining acceptance of biotechnology by the general public. They stressed that uncertainty surrounding regulation of genome-edited animals is a bottleneck for funding, and is particularly challenging for public institutions. There was also agreement that many useful biotechnological tools are available, but if consumers won't accept them, commercialization of resulting products will be extremely difficult. Participants encouraged investment to quantify the benefits of biotechnology in animal production and to continue studying potential risks to the environment and human health, while developing a system to approve the use of biotechnology in animal products consumed by humans. This may help consumer acceptance. They specifically mentioned the impact of social media on consumer acceptance, noting that when embryo transfer, artificial insemination, and pasteurization were introduced there was consumer pushback, but social media did not exist to amplify those message. They stressed the need to utilize social media tools to share factual information.

2. Functional genomics

Contributors identified research on gene editing techniques as an important area for investment, especially methods to identify putative causal variants for traits of interest. They identified a need to develop high-throughput systems to test causality of these variants, suggesting a biotechnology-based approach may be the best way to accomplish this. Stakeholders also cited a need for infrastructure to support genome editing trials in large animals.

3. Animal Health

Stakeholders expressed their support for the application of biotechnology tools to address animal health problems. Specific examples included the development of DNA vaccines for control of parasites in ruminants (especially small ruminants); strip-style tests to identify viral infections in horses; and alternatives to antimicrobials, especially in the area of animal-derived antimicrobial polypeptides.

4. Workforce Development

Participants recommended increased funding and additional programs to support development of the animal agriculture workforce. They encouraged new investment in innovative, project director-initiated, K-12, undergraduate, graduate, post-doctoral and career transition programs.

5. Outreach

Contributors asserted the need to balance funding between research and development of biotechnology tools and their actual application in the production arena. Many stakeholders stressed their interest in working with industry partners to communicate the science of biotechnology, underscoring that the research is vital to producers who, in turn, also need extension/outreach activities to communicate how biotechnology research is applied in the field.

6. Regulatory Issues

Stakeholders stated that regulatory issues are the biggest hurdle for public sector scientists trying to use biotechnology to improve public animal breeding programs, citing the tens of millions of dollars required to move a gene-edited or genetically modified animal through the regulatory clearance process. They identified this as the most fundamental problem that needs to be solved, because if these animals cannot be marketed, then it doesn't make sense to invest in their development. The porcine respiratory and reproductive syndrome (PRRS)-resistant pig may be the first test case for whether it's possible to bring one of these gene edited products to market. Participants also expressed strong concern about the FDA requirement to incinerate dams used as surrogates in gene editing trials. This dramatically increases the cost of doing this research and places a heavy, cost prohibitive burden on large animal research for agricultural purposes.

Animal Well-Being, Stress and Production

Sixty-nine unique individual comments were captured by the webinar on *Animal Well-Being, Stress and Production* and the CoDigital idea engine. Based upon the consensus achieved within the CoDigital framework, the following six themes emerged as top priority areas.

1. Technology transfer

Stakeholders shared many comments regarding education of producers and the public about animal welfare and stress. They noted that the public has little understanding of proper methods of care of livestock, and asserted the need for new methods to communicate this information. They specifically mentioned that with the urbanization of the U.S. population, fewer people are trained in animal husbandry, and there is a need to develop training programs that highlight the importance of animal behavior and animal husbandry in food production systems. Contributors also noted that in spite of the substantial body of research that has been conducted in animal welfare science, there is still a problem disseminating this knowledge to producers. They stated that one limiting factor may be that there are few extension agents or university faculty with animal welfare training.

2. Economic analysis

Only a few comments were received underscoring the need for economic analysis, but these comments gained broad support. Stakeholders asserted that if producers are to adopt new practices to improve animal welfare, it is critical to demonstrate the benefit or cost associated with adopting these practices, and that a cost-benefit analysis should be a key component of all animal welfare research.

3. Models/tools

Contributors cited the need for objective measures of animal welfare. They specifically encouraged investment to develop software and tools to measure animal well-being, on-farm and in real time, to help producers identify problem areas immediately and address them quickly. They asserted that such tools can enable producers to self-evaluate the state of animal welfare on their farms. Stakeholders also expressed support for basic research to discover minimally invasive, more accurate and sensitive markers of acute and chronic stress in animals. Contributors also valued the development of tools for tracking individual animal care on farms, with the ability to note the animal's response to treatment and the need for timely euthanasia, when necessary. They stated that this information needs to be included in audits and assessments.

4. Genetics and genomics

Stakeholders asserted that animal adaptability is vital to the sustainability of diverse production environments and systems. They stressed the need for research to define genomic factors associated with adaptability. They stated that studies linking the animal with environmental influences to support decision-making in production systems are vital. They also cited the need for strategies to manage aggressive and damaging behaviors such as ear, flank, and tail biting, specifically based on genomic factors that influence them.

5. Training the next generation of scientists

Contributors asserted that USDA should increase investment in training the next generation of animal welfare scientists. They stressed that this is a key area, and there should be a fellowship scheme that provides full funding for Ph.D. students, including stipend and research costs.

6. Environment

Stakeholders stated that environmental stress is an animal production and welfare concern with differing impacts depending on region, and that more resources should be dedicated to promote long-term research on genomics, breeding, and management to address this issue.

Animal Reproductive Biology

Forty-seven unique comments were captured by the webinar on *Animal Reproductive Biology* and the CoDigital idea engine. Based upon the consensus achieved within the CoDigital framework and the webinars, the following five themes emerged as top priority areas.

1. Reproductive Losses and Embryonic Mortality

Stakeholders expressed strong support for funding to investigate and solve reproductive losses and embryonic mortality in all agriculturally relevant species. They stated that consideration of embryonic mortality should be quite broad and actually include all facets of reproduction that lead to establishment and maintenance of pregnancy. Among these facets they included the impact of stress and how the environment (*e.g.*, climate and chemical exposures) influences physiological mechanisms.

2. Systems and Modeling

Contributors asserted that reproduction is part of a much larger physiological system. They stressed the need for more group efforts with full data set sharing, strongly encouraging cross-discipline approaches to include reproductive physiologists, genetics/genomics experts, and nutritionists. They also asserted the need for more integration and use of models, stressing that fertility is a function of many processes and should be studied in that way. Stakeholders specifically stated the need for more crosstalk between bioinformatics researchers and physiologists.

3. Seasonality of Reproduction

Participants stressed the need for funding of research to address the seasonality of reproduction in all species and viewed this as a universal problem. For example, in the swine industry seasonality of boar fertility results in high semen discard rates during the hot summer months. Among sows, it results in increased culling rates during the months of October, November, and December because females that were bred during the hot summer months are found to be not pregnant. Stakeholders noted similar problems in the dairy, beef and small ruminant industries, stressing that the summertime depression in breeding efficiency causes a problem with reproductive longevity in the herds due to the involuntary culling resulting from reproductive failure.

4. Technology Transfer/Outreach

Stakeholders noted the importance of extension for delivering and translating research based information to livestock producers. Discussion focused on the variety of ways that producers receive scientific information that is important to the success of their operations, and extension is one of them. Comments on this topic indicated that extension programs at some Universities on some topics are excellent, while at other universities, or for some topics, programs may not be as useful. A comment was made that for small ruminants much of the research information available to producers originates from Australia, either directly or translated through extension or other information sources. Despite these comments, participants indicated that financial support for extension activities should continue and be broadened. In addition, the discussion focused on improved support for producer-specific meetings and for regional projects that have as a goal the delivery and translation of research information to producers.

5. Training the Next Generation of Scientists

Participants stated that there is a very urgent need for continued support of graduate student training in livestock reproduction. Several participants expressed concern that the number of scientists with training and research interest in various aspects of reproduction has dwindled due to lack of funding

and continues to do so. Concern was expressed that if this trend is not reversed there will be inadequate numbers of trained personnel to perform agriculturally relevant research in the future. The reduction in scientist numbers is consistent across disciplines, but may be particularly acute in male reproductive physiology in livestock. Some expressed concern that it is already difficult to hire trained Ph.D.-level personnel, and that this trend is likely to get worse without a significant increase in funding specifically aimed at supporting agricultural research in reproductive biology.

Quality, Nutritional Value and Healthfulness of Animal Products

Thirty unique comments were captured by the webinar on *Quality, Nutritional Value and Healthfulness of Animal Products* and the CoDigital idea engine. From the consensus achieved by the CoDigital framework and the webinar, these three themes emerged as top priority areas:

1. Improved Healthfulness of Animal Products

Stakeholders expressed strong support for funding to improve the healthfulness and safety of animal products through pre- and post-harvest management practices that optimize nutritional value. They specifically expressed the need to continue research on the most efficient technologies to make animal products more nutritious and appealing for the public. They further refined this idea by stating the need to optimize the complete nutrient content of animal products to better meet daily requirements in the human diet, without creating detrimental effects on other traits such as product shelf life. Many stakeholders asserted the need for more study of the fatty acid composition of animal products, including omega-6 to omega-3 ratios and polyunsaturated fatty acids, asserting that they are the main factors for improving quality, nutritional value and healthfulness. These comments spanned products from both ruminant and non-ruminant species.

2. Pre-Harvest Impacts on Product Quality

Contributors asserted the need to invest in work to optimize production parameters associated with genetics, environment, and management practices, including alternative production methods to determine their impacts on the quality and safety of animal products. They asserted that the quality of animal products is not defined separately from efficiency of animal growth. They stressed that more work is needed to understand how animal growth and efficiency can both enhance and detract from product quality, underscoring the need for integrative work in this area. With this information, the industry could balance production and quality.

3. Post-Harvest Impacts on Product Quality

Participants stressed the need for research to develop methods to extend shelf-life and retain the nutritional value and safety of animal products. They stated that shelf-life limitations affect both product quality and sustainability, and recommended development of food safety technologies, including novel antioxidants and antimicrobials.

Lactation Biology and Nutritional Efficiency of Animals

Sixty-seven unique comments were captured by the webinar on *Lactation Biology and Nutritional Efficiency of Animals* and the CoDigital idea engine. Based upon the consensus achieved within the CoDigital framework, six themes emerged as top priority areas:

1. Multidisciplinary Work

Stakeholders expressed support for funding to promote both basic and applied research to improve our understanding of nutrition, lactation, and growth. They stated that many key applied and basic questions are best addressed with an integrative, whole animal approach. Contributors stressed the need for large scale, integrative, multidisciplinary work in nutrition and genetics to describe the complex interaction of genetic selection, nutrient availability and production efficiency.

2. Efficiency

Contributors asserted that the foundation of nutritional efficiency is nutrient digestion, absorption and metabolism, as well as animal health. They expressed strong support for basic biochemical (molecular and cellular) research as well as applied nutritional studies to improve efficiency. Stakeholders further asserted that nutritional efficiency is dependent on intake, digestion and absorption, incorporation (tissue/product), and energy expenditure, strongly encouraging funding for genetic, feed processing, nutrition and physiology research to improve efficiency through these variables. Participants also stressed the need for additional information regarding nutritional efficiency and nutrient requirements related to animal body size. Specific examples used were (1) the efficiency of smaller framed cows versus large cows, and (2) nutritional requirements and efficiency of pigs greater than 275 pounds.

3. Genetics/Genomics

Participants supported funding of research on nutrient-gene interactions (nutrigenomics) to exploit the capability of nutrients to improve the physiological conditions of the lactating animal. They also supported investment to determine underlying mechanisms and causative genes for single nucleotide polymorphisms (SNP) and quantitative trait loci (QTL) that alter growth and efficiency. They recommend translating the wealth of information produced by whole genome work into strategies to increase efficiency. Other contributors asserted that nutritional efficiency could be sorted based on specific herd pedigrees to identify genetic influence. They stressed the need for more data analysis to determine which genetic markers are resulting in higher milk production and efficiency.

4. Microbiome

Stakeholders noted that the ³veterinary feed directive is precipitating a need for a better understanding of the impacts of intestinal health and the microbiome on the efficiency of nutrient utilization. They supported basic research to understand the microbiome and to gain fundamental knowledge of the microbiome and how it changes in response to dietary factors.

³ <https://www.fda.gov/AnimalVeterinary/DevelopmentApprovalProcess/ucm071807.htm>

5. Nutritional/Product Quality

Contributors recommended funding to promote integrative work that links nutritional efficiency and growth to product quality. They stressed the need to understand whether improved growth and efficiency yields a negative effect on meat quality.

6. Lactation Biology

Participants underscored the need to understand mammary development in ruminants and the role of mammary stem cells. They specifically encouraged work to determine how fetal reprogramming and diet early in life affect the biology of mammary stem cells.

Animal Growth Biology and Alternatives to Antimicrobials for Growth Promotion

Fifty-five unique comments were captured by the webinar on *Animal Growth Biology and Alternatives to Antimicrobials for Growth Promotion* and the CoDigital idea engine. Based upon the consensus achieved within the CoDigital framework, five themes emerged as top priority areas:

1. Disease Resistance

Stakeholders stated that the use of antimicrobials in livestock can contribute to public and animal health directly by controlling pathogens and contributing to the overall health of the animal. They also recognized the conflict between animal and human use and identified key issues including shared use and cases where human-use-only compounds are the only antibiotics that will treat certain animal diseases. This led to questions, including “How do we deal with not being able to treat an animal disease?” and “How do you treat when the antibiotic that you need to use falls into the human-only classification?”

To address these and other questions, contributors strongly supported investment in research. They placed a high priority on the investigation of nutrient-gene interaction (nutrigenomics) to improve the immune resistance of animals, recognizing that this will require extensive fundamental research using molecular biology tools. Stakeholders also recommended funding to explore the use of both typical and novel plant materials for their potential to strengthen resistance to disease and pathogenic bacteria. In addition, they prioritized the idea of breeding for resistance to the diseases antimicrobials are used to suppress, and suggested genetic modification of animals for disease resistance. Translation of the results of these approaches into efficacious practical applications was also stressed.

2. Microbiome

Participants stressed that a better understanding of the microbiome is required to find alternatives to growth promoting antimicrobials. Stakeholders asserted the need for research into the role of the respiratory and gastrointestinal metagenomes in growth and disease, suggesting that manipulation of the metagenome may be used to stimulate growth and production of livestock. Contributors also voiced support for investment to explore the role of hormones and factors in the embryonic stages of animal growth to discover methods to turn on gene signals that help create a desirable microflora balance.

3. Feed Additives

Stakeholders acknowledged that to overcome the loss of antimicrobial growth promoters in livestock production, other therapies or treatments will be needed to avoid the expected decrease in performance. They stressed the need to support research on supplementation with antimicrobial peptides (AMP) which have been found to improve performance while reducing gut inflammation and disease incidence. They suggested that recombinant AMP and AMP-expressing probiotics could be used to promote growth and disease resistance. Contributors also stressed support for development of direct-fed microbials, such as those producing butyrate, for use in the prevention of pathogen colonization and to reduce pathogen load. However, to determine if any of these approaches are practical, contributors identified the need for a cost-benefit analysis comparing the relative costs of antimicrobial growth promoters versus any alternative approach.

4. Growing Environment

A few comments were received underscoring the need for investment in research into the growing environment, but the few gained broad support. Stakeholders stressed the need to explore how environmental conditions related to the need for antimicrobial use. Contributors strongly supported research to determine if better animal husbandry, housing, welfare, and manure handling techniques could reduce or eliminate the need for sub-therapeutic antimicrobial use.

5. Breeding/genetics

Stakeholders supported research into animal genomes, and better annotation of those genomes, to gain understanding of genome-environment-microbiome interactions.

Forages and Forage Utilization for Animal Production

One hundred and three individual comments were captured by the webinar on *Forages and Forage Utilization for Animal Production* and the CoDigital idea engine. Based upon the consensus achieved within the CoDigital framework, five themes emerged as top priority areas:

1. Systems

Stakeholders stressed the need for development and evaluation of systems integrating forage-based livestock production with crop production and other land uses to maintain farm/ranch productivity and reduce environmental impact. This need was stressed for all ruminant species and stages of production. Specifically mentioned were beef cow/calf operations, finishing animals on pastures, grass fed dairies, and small ruminants. Contributors stressed proper supplementation within site-specific grazing systems, focusing on grazing management to extend the grazing season while minimizing purchased or farm-produced stored feed. Stakeholders also encouraged investment to develop year-round, regionally-specific forage systems for beef cattle, matching cultural practices and forage management that would maintain soil health.

2. Cultivars

Carrying forward the sub-theme related to the environment, stakeholders encouraged the development of methods to improve persistence and nutritional characteristics of legume forage species to improve animal production while reducing methane and nutrient loading. Further, contributors encouraged investment to develop forage varieties and appropriate management practices to allow pasture production to transition from high input systems to sustainable, ecologically based systems utilizing increased plant diversity including adapted legumes. They placed a high priority on discovering methods to lengthen the grazing season to the fullest extent possible, particularly in northern and high altitude farms, by formulating mixes of annual and perennial forages adapted to those areas.

3. Models/decision support

Stakeholders stressed the need to develop decision support systems to bridge research and extension so that land owners can make wise choices among their limited resources. They stressed the need to focus on the balance of individual nutrients within the rumen from forages only and develop an interactive forage digestion model to inform farmers regarding the amount, type and quality of forage needed. Stakeholders also encouraged investment to build real-time grazing management tools that target specific animal production goals. These tools should allow farmers to make daily management and supplementation decisions to achieve desired levels of production. They also stress the need for better estimates of intake for grazing livestock and suggested the models comprehensively address nutrient cycling, water use efficiency, and sustainability indices.

4. Tools

Contributors encouraged the development of a new generation of technologies that would improve measurement of feed intake, nutritional requirements, nutrient use, and gaseous emissions from grazing cattle and small ruminants. They stressed that our current forage energy values are derived from equations based on long-past history, arguing for the determination of more accurate energy values for the newer forage cultivars so that forage testing more accurately reflects true energy values.

5. Nutrition

Stakeholders encouraged support of research to determine the best supplementation strategies to maximize animal performance from different forage bases, and to minimize conflict with humans for crops that could directly enter our food systems. They also encouraged USDA to support integrated research to better match forage composition and yield with animal requirements and overall water/fertilizer/equipment use, seeking an optimum solution from a business, societal and environmental perspective.

Reducing Environmental Impacts of Animal Production

Eighty four unique comments were captured by the webinar on *Reducing Environmental Impacts of Animal Production* and the CoDigital idea engine. Based upon the consensus achieved within the CoDigital framework, five themes emerged as top priority areas:

1. Efficiency

Stakeholders recognized the environmental benefit of our historical successes in improving the efficiency of animal agriculture. They encouraged research to further advance efficiency and reduce the potential pollution attributable to livestock production through genetics and management. They stressed the need for ruminant host/microbiome genomic and feed/nutrient interaction studies to enhance the efficiency of conversion of feed to nutrients for the animal as a method to reduce enteric methane emissions. Similarly, contributors stressed the need for research to enhance feedstuff quality and ingredient usage to improve feed efficiency as another method to reduce methane emissions.

2. Systems

Stakeholders asserted that a systems approach is required to make meaningful improvements in the environmental footprint of animal agriculture. They stressed the need for investment in research exploring systems approaches to increase nutrient use efficiency and the overall use of all resources to reduce livestock's environmental impact. Contributors further underscored the need for research that addresses all phases of production. They specifically called for support to develop and evaluate integration of feeding systems with genetic feed efficiency of ruminant animals and their microbiome to minimize methane emissions and nutrient loading of the environment. They also encouraged optimization of the food, energy and water systems nexus beyond processing to engage the broader continuum of plant and livestock-based agriculture, with the goal of increasing existing food production on existing farmland while minimizing environmental impacts. All ultimately wish to minimize the flow of nutrients and other potential pollutants from production systems.

3. Modeling/Decision Support

Contributors encouraged investment to develop the next generation of process-based modeling that can be adapted to different climates. They particularly valued research to support ration formulation systems for livestock that predict both animal performance and nutrient excretion with more complete feed and animal measurements than currently available. They further encouraged USDA support for the development and evaluation of livestock environmental performance indicators and metrics for informing sustainability discussions, as well as better environmental stress assessment and mitigation models for livestock in support of sustainable intensification.

4. Tools

A few comments were received underscoring the need for new tools or equipment, but the few gained broad support. Stakeholders stressed the need to develop new equipment to reliably measure methane production by individual animals under different management systems and in different environmental conditions. They considered this essential to assess the impact of an animal on the environment.

5. Manure Management

Contributors strongly supported investment in research in the area of manure management, particularly alternative practices for manure handling and land application technologies. Stakeholders specifically identified the need for effective and affordable manure storage - for operations of all sizes -

to manage manure applications to cropland with sound consideration of potential climate impact. They also stressed the need for manure solid and nutrient separation technologies that capture more solids and nutrients from liquid manure, leading to better manure nutrient utilization, less odor and gas emissions, and lower water pollution potential. Contributors also placed a priority on development of best management practices for riparian pastures, limiting access to streams, ponds, and lakes, while using rotational grazing schemes and watering systems to minimize direct contamination of surface waters by animal waste.

Appendix A: Profile of Participants

May 23 and 25, 2016

Total attendance for both days = 149 people

92 on May 23

57 on May 25

Type of Organization	Name of Organization	Total Number
University	Auburn University	
	Colorado State University	
	Iowa State University	
	Michigan State University	
	Middle Tennessee State University	
	North Carolina State University	
	Pennsylvania State University	
	Purdue University	
	Rutgers University	
	South Dakota State University	
	Texas A&M University	
	Texas Tech	
	University of Arkansas	
	University of California Davis	
	University of Connecticut	
	University of Florida	
	University of Georgia	
	University of Illinois	
	University of Missouri	
	University of Nebraska Lincoln	
	University of Washington	
	Utah State University	
	Virginia Polytechnic Institute and State University	
	University Total	23
Professional Organization	American Angus Association	
	American Dairy Science Association	
	American Goat Federation	
	American Sheep Industry Association	
	Council for Dairy Cattle Breeding	
	Innovation Center for U.S. Dairy	
	National Association of Animal Breeders	
	National Cattlemen's Beef Association	
	National Pork Board	
	North American Meat Institute	
	Professional Organization Total	10
Business	Acceligen, Inc	
	Agsources Cooperative Services	
	Angus Genetics, Inc.	

Type of Organization	Name of Organization	Total Number
	Beam Ranch Club Lambs	
	Chalk Creek Boers	
	Cal Main Foods	
	Diary Management, Inc.	
	Elanco	
	Genus plc	
	Ridley Food Ingredients	
	Select Sires, Inc.	
	Superior Farms	
	Business Total	12
Advocacy Group	Animal Agriculture Alliance	
	Foundation for Food and Agriculture Research	
	Advocacy Group Total	2
Federal Agency or Group	U.S. Department of Energy	
	USDA Agricultural Research Service	
	USDA Foreign Agricultural Service	
	USDA National Institute of Food and Agriculture	
	USDA Regional W2112 (Cooperative Research Group)	
	Federal Total	5
	GRAND TOTAL	52

Appendix B: Stakeholder Comments by Topic

Animal Genetics, Genomics and Bioinformatics Stakeholder Comments

Source	Comment	Theme	CoDigital Rank
CoDigital	The largest animal health disaster in the history of the USA occurred in 2015. Addressing the potential for populations of animals resistant to or capable of withstanding Foreign Animal Disease pathogens should be a priority.	Animal Health	3
CoDigital	Disease resistance with test methods to gauge levels of susceptibility and resistance	Animal Health	16
CoDigital	Basic beef cattle research to further aid genetic identification and selection for resistance to BRD complex.	Animal Health	18
CoDigital	Definitive research is needed in the inheritable nature of diseases and disease susceptibility along livestock bloodlines.	Animal Health	20
CoDigital	Genomics for Osteochondritis Dissecans (OCD) in Horses. OCD is a common developmental disease that affects the cartilage and bone. It causes clinical signs of disease in 5-25% of all horses, at great cost and loss to the entire industry.	Animal Health	21
Webinar	More efficient phenotypes such as genetics with less antibiotics	Animal Health	
Webinar	Health and Welfare oriented EPDs	Animal Health	
Webinar	Genomic surveillance for disease	Animal Health	
Webinar	Improved host immunity for BRD	Animal Health	
Webinar	Genetics of the immune functions	Animal Health	
Webinar	Isolating genes in cattle that are more resistant to diseases	Animal Health	
Webinar	Genetic selection for endophyte tolerance	Animal Health	
Webinar	Investigations of genetic different differences in cattle that can tolerate fescue over those that cannot. "How does one breed experience fescue toxicosis more than other breeds? Also, can this gene be inserted in others to prevent illness?"	Animal Health	
CoDigital	Biodiversity is the key to adaptability. Current production animals are sourced from limited breeds. Survey of available diversity for all breeds/species is needed.	Biodiversity	10
CoDigital	The US needs to further develop a viable conservation program to identify and maintain genetic diversity, particularly for all species. This would allow access to this biodiversity as needs change.	Biodiversity	12

Source	Comment	Theme	CoDigital Rank
Webinar	Mixed breeds and genetic non-uniformity makes technology implementation for bull selection difficult. Also no incentive for premium animals with superior genetics	Breeding	
Webinar	* Identifying markers for the important traits that are hard to measure	Breeding	
Webinar	Better decision support tools for genetic selection	Decision Support Tools	
Webinar	Although traits are measured, no integration between genetic data and daily operations decision making and management	Decision Support Tools	
Webinar	Adoption of genetics/genomics by producers and companies	Extension	
Webinar	Lack of trickle down of genetic discovery to beef industry, require extension support	Extension	
CoDigital	Functional annotation of livestock, poultry and aquaculture genomes - development of the computational/database infrastructure needed to fully utilize the data	Functional Genomics	4
CoDigital	Functional Annotation of livestock, poultry, and fish genomes - RNA, DNA binding elements, methylation, acetylation, etc. - collection of the raw data.	Functional Genomics	7
Webinar	Sequencing for discovering functional traits that can be applied to multiple breeds	Functional Genomics	
Webinar	Genotype to phenotype for various traits	Functional Genomics	
CoDigital	Animal adaptability and the influence of the environment on gene expression and overall phenotype is vital to the sustainability of production systems. Investment in epigenetic effect of the environment on the genome of livestock species is vital.	Genetics and Environment	1
Webinar	What impact does the G x E interaction have on cow and calf immunity? Can we identify genetics and environment that improves immunity from what we have now?	Genetics and Environment	
Webinar	Selecting Animals to fit the environment – Behavior and Genetics	Genetics and Environment	
Webinar	Genetics x Environment	Genetics and Environment	
Webinar	Genetics x Environment x management interactions	Genetics and Environment	

Source	Comment	Theme	CoDigital Rank
CoDigital	We have some start on this, the NANP 0009 research support committee maintains a website for data, and genetics and nutrient use is part of it. fund more and larger integrated studies reward integrative work address the multiple overhead cost issues	Integrated Research	17
CoDigital	We 'know' how to do the science how to encourage collaborative work? Reward it? Promote and tenure for it? Other fields do this, why are we so reticent?	Integrated Research	19
CoDigital	Host-metagenome interactions - there are many big challenge areas that involve both the genetics of the host as well as the genetics of the metagenome, e.g. greenhouse gas emissions, feed efficiency, anti-microbial resistance, etc.	Microbiome	6
CoDigital	Develop a genome for the intestinal micro biome in equids, which are exceptionally impacted by intestinal interruptions and imbalances.	Microbiome	22
CoDigital	One of the easiest things NIFA can do for the Animal Ag research is provide a consistent, predictable, timeframe to the RFA release and proposal due dates. You'll get more impactful proposals if given more than 4 weeks to plan and organize.	NIFA Procedures	5
Webinar	For genetic improvement in the near term the main opportunity or challenge is in the health and wellness area. For the long term it would be more of the feed efficiency and carbon foot print area. (productivity and efficiency are currently addressed)	Selection	
Webinar	Breeding criteria needs to be re-evaluated for desired benefits, some traits features are not useful?	Selection	
Webinar	Prioritize traits than simply adding new traits	Selection	
Webinar	Genomic technology to measure and control inbreeding with large animal counts currently lacking	Selection	
Webinar	Diversity of mating selection tools required for individual as well as co-herd basis	Selection	
Webinar	Primary breeders select for ~30 traits in poultry. Selecting for one can negatively impact others.	Selection	
Webinar	Integrate genomics and feed intake	Selection	
Webinar	Region based Animal selection to find the best fit	Selection	
Webinar	AI linking genetics across geographic regions	Selection	
Webinar	National Sheep Improvement program is underutilized by the sheep industry	Sheep	
Webinar	More precise data needed to improve breeding indices	Sheep	

Source	Comment	Theme	CoDigital Rank
Webinar	In sheep genetic marker development required for traits such as maternal behavior, health, disease resistance, lamb survivability, litter size, reproductive longevity, fertility.	Sheep	
Webinar	Collaboration between ARS and land grant universities to prioritize genomic efforts in sheep, develop a comprehensive long term plan to accomplish genomics goals cooperatively	Sheep	
CoDigital	New approaches and tools for dynamic integrative genomics analysis allowing to analyze and integrate large omics data from time course or multiple-treatments experiments with multiple tissues/cells, i.e., integrative systems biology.	Tools and Resources	2
CoDigital	Tools, tools, and tools, with better documentation. CyVerse is a start but most of the tools have little or no documentation and there are no established pipelines. Bioinformatics is not plug-and-play but just providing software is not the answer.	Tools and Resources	9
CoDigital	Development of database resources to re-use "omics" data. A rate limiting step to using data in the SRA/ENA is the need to reprocess raw data to quantify it. Data needs to be stored as publicly available quantified data sets.	Tools and Resources	11
CoDigital	Funding of a project to gather thousands of complete genomes of agriculturally important species, and of some wild species that are important disease reservoirs	Tools and Resources	14
CoDigital	Statistical and bioinformatics approaches for GWAS and Genomic Selection in an era of large scale sequence data	Tools and Resources	15
Webinar	Opportunities to collect data from dairy cattle with sensors, managing data overflow from sensors	Tools and Resources	
CoDigital	Increase funding for programs supporting development of the animal ag workforce. Current efforts should be increased 5-fold & new programs for innovative PD initiated K-12, undergrad, grad, post-doc and career transition programs should be developed.	Training Next Generation of Scientists	8
CoDigital	Coordination of a national online Masters level certification in bioinformatics, quantitative and/or molecular genetics to counteract the lack of critical mass at most institutions and provide solid baseline training for future PhDs and postdocs.	Training Next Generation of Scientists	13
Webinar	Graduate students and training	Training Next Generation of Scientists	
Webinar	Sustainability of maintaining genetic evaluations		

Source	Comment	Theme	CoDigital Rank
Webinar	Genetic changes outpace changes in management practices (poultry). Require more study of males, currently mostly done on females.		
Webinar	Storage and preservation of genetics lines (Ft Collins stores only frozen stock) Cryopreservation difficult and 70% success with ovary transplantation.		
Webinar	Epigenetics		

Applications of Biotechnology to Animal Production Stakeholder Comments

Source	Comment	Theme	CoDigital Rank
CoDigital	As more and more bacteria become resistant to antibiotics, especially the long acting macrolides in cattle, more research needs to be done with antibiotic alternatives, especially in the area of animal derived antimicrobial polypeptides.	Animal Health	2
CoDigital	More research need to be done with DNA vaccines for parasites in ruminants, especially small ruminants. Identifying simple proteins within notable parasites for DNA vaccine production.	Animal Health	11
CoDigital	The development of strip style tests for viruses for the identification of viral infections in horses.	Animal Health	16
CoDigital	There is a need for more data and analysis related to the consumer understanding and acceptance of biotechnology in animal production.	Commercialization/Consumer Acceptance	1
CoDigital	Translation of biotechnology has great potential. Investment in how –omics results lead to biomarkers is note-worthy; however, consumer acceptance is an important component of the process.	Commercialization/Consumer Acceptance	6
CoDigital	USDA needs to better quantify the benefits of biotechnology in animal production and continue studying potential risks, to the environment and human health while developing a system to approve the use of biotechnology in animals consumed by humans.	Commercialization/Consumer Acceptance	10
Webinar	One of the challenges facing biotechnology in general is getting the acceptance of the general public. Does that fit into the research mix? If we've got the tools, but the consumers won't accept them, it'll be extremely difficult.	Commercialization/Consumer Acceptance	

Source	Comment	Theme	CoDigital Rank
Webinar	The big thing that has changed is social media. When we introduced embryo transfer, artificial insemination, pasteurization, there was pushback, but we didn't have the social media that amplified it. Now we need to be able to utilize social media tools to be able to really share what the true situation is.	Commercialization/Consumer Acceptance	
Webinar	Research on commercialization of these edited animals can be a bottleneck for funding	Commercialization/Consumer Acceptance	
Webinar	There needs to be an increased understanding of the epigenetic effects of cloning.	Epigenetics	
CoDigital	System based approaches where productivity measures are integral and can be correlated to gene changes	Functional Genomics	5
CoDigital	With the impending identification of putative causal variants for traits of interest, there is a real need to develop high-throughput systems to test causality of these variant, a biotechnology based approach may be the best way to accomplish this.	Functional Genomics	7
CoDigital	Develop projects to use technologies to improve the efficiency by which animals are used to produce foods derived from animals.	Functional Genomics	9
CoDigital	CRISPER-CAS gene editing of host genome and metagenomes.	Functional Genomics	14
Webinar	We're coming up with plenty of possible candidates or given traits of interest. How do you move that past just a simple candidate and actually prove causality, whether that is directly within the animal itself or potentially even within some cell culture in vitro process. Prove causality and therefore improve the accuracy of genetic prediction. Prove a particle or SNP that has been identified is functional relevant.	Functional Genomics	

Source	Comment	Theme	CoDigital Rank
Webinar	We need increased resource allocation to understanding or developing the tools and resources for editing in large animal species.	Functional Genomics	
Webinar	Investment in the use of genome editing for functional genomics and validation.	Functional Genomics	
Webinar	Infrastructure for large animal genome editing trials	Functional Genomics	
Webinar	Causality – we need ways that you could essentially develop faster, higher-throughput in vitro tools, perhaps in inducible pluripotent stem cells, to give a good indication which is the right mutation to take, or variant to take forward to the actual animal. There could be 20, 30 different variants for any given location or genome. We need the ability to figure out function or potential function before going to the expense of actually producing an animal.	Functional Genomics	
Webinar	Funding for infrastructure, equipment, development of extension, computing programs, especially for bioinformatics.	Functional Genomics	
Webinar	Tools for validation of important traits - functional clarifications or validations.	Functional Genomics	
CoDigital	There needs to be a better balance of funding between development of omics tools and actual application in the production arena.	Outreach	4
Webinar	We have to have the funding to do the research but also have to have a way to communicate it.	Outreach	

Source	Comment	Theme	CoDigital Rank
Webinar	We need to work with industry partners using social media to communicate the science of biotechnology. I think that the research is vital to producers who also need funding for extension outreach activities to communicate how it is applied in the field. It requires a multi-phase approach addressing the need to have consumer acceptance and providing producers the tools to use it.	Outreach	
Webinar	Genome editing is an essential part of the future of genetic improvement and for advanced reproduction and precision breeding.	Precision Breeding	
Webinar	For large animal trials and precision breeding it is going to be absolutely essential to have genome editing.	Precision Breeding	
CoDigital	NIFA needs to provide a consistent, predictable, timeframe to the RFA release and proposal due dates. You'll get more impactful proposals if given more than 4 weeks to plan and organize.	Proposal Process	8
CoDigital	Learn from other fields. Individualized medicine. We have biotechnology/activity monitors, rumen monitors. For better or worse mostly private enterprise and very expensive to test and compare. Can we change our philosophy and funding on this?	Proposal Process	13
CoDigital	Many of the tools exist. Encourage and pay for their use? Move past 'competitive' funding to larger grants with more focus. Reduce overhead. Group efforts. Develop oversight regulations that include new techniques like genome editing and gene drives.	Regulatory Issues	12
CoDigital	Develop research to support regulation of new GE techniques like CRISPR, talens, zinc fingers and gene drives.	Regulatory Issues	15

Source	Comment	Theme	CoDigital Rank
Webinar	When doing editing in animals, we need to talk to the FDA about the requirement to incinerate surrogate dams. That dramatically increases the cost of doing this research, and it really needs to be addressed if we're going to be doing this with large animals for agriculture purposes.	Regulatory Issues	
Webinar	The University of Illinois did quite a large experiment looking to whether or not there was any transfer of transgenes between litter mates and actually pen mates and from offspring to dam. The data showed that that wasn't the case.	Regulatory Issues	
Webinar	Regulatory hurdles, even experimental regulatory hurdles should be proportional to the novelty of the proposed end product rather than what technique was used to achieve it.	Regulatory Issues	
Webinar	Regulatory is probably the biggest hurdle for public sector scientists trying to use this technology to make improvements in animals for the public breeding programs. We don't have \$85 million to run an animal through regulatory. That's what it cost the salmon to get through regulatory.	Regulatory Issues	
Webinar	We need to have real clarity as to whether or not we do need to incinerate all of our surrogates. That will price out any research in cattle in this area. And that needs to be decided before the grant application even goes in, because it dramatically changes the budget.	Regulatory Issues	

Source	Comment	Theme	CoDigital Rank
Webinar	With gene editing it's important to try to have access to this technology for agricultural innovation and that is the most fundamental problem that needs to be solved. Because if we can't use it then - or we can't get it to market then it doesn't make a lot of sense to invest money in it for agricultural purposes. The PRRS pig may be our test case for whether it's possible to bring one of these gene edited products to market.	Regulatory Issues	
CoDigital	USDA/NIFA need to increase funding & programs supporting development of the animal Ag workforce. Current efforts increased 5-fold & new programs allowing for innovative PD initiated K-12, undergrad, grad, post-doc and career transition programs.	Workforce Development	3

Animal Well-Being, Stress and Production Stakeholder Comments

Source	Comment	Theme	CoDigital Rank
CoDigital	Potential development/refinement of a herpesvirus vaccine for horses to limit the exposure risk and potential unnecessary isolation of exposed horses in an outbreak situation.	Animal Health	22
CoDigital	American Feed Industry Association requests that this program support a nationwide study to sample feed facilities to determine the prevalence and serotype of salmonellae is needed.	Animal Health	27
CoDigital	Modern day management techniques are needed for animals susceptible to laminitis, colic, etc. These conditions, which previously were considered fatal, are no longer treated as such and affected animals are handled using outdated techniques.	Animal Health	28
CoDigital	The concept of "One Health" should be coordinated between veterinary and human medical practices, including a strong component of animal health and welfare for companion and agricultural animals.	Animal Health	29
Webinar	Sow shoulder lesions - identifying the critical time point for risk assessment and intervention.	Animal Health	
Webinar	Lameness in dairy cows - the impact of genetics as well as housing and other things related to lameness in animals.	Animal Health	
CoDigital	Climate change has increased temperature and increased the severity of storm events both of which impact animal welfare: What can be done proactively to better protect animals from these changes in the weather?	Climate	30
Webinar	With the international markets we have, we have to be cognizant of the international consumer perception to protect this trade. We need to listen to what their concerns are too make sure that we can adequately communicate how we're addressing those.	Consumer Issues	
Webinar	Consumers – we need to listen to their concerns and to be able to respond to them and determine how we are addressing their concerns.	Consumer Issues	
Webinar	Consider international consumers so that we can remain competitive within an international environment.	Consumer Issues	

Source	Comment	Theme	CoDigital Rank
CoDigital	If producers are to adopt new practices to improve animal welfare, it is critical that we can demonstrate what benefit, or cost, there is in adopting these practices. A cost-benefit analysis should be a key component of all animal welfare research.	Economic analysis	2
CoDigital	Environmental stress is an animal production and welfare concern with differing impacts depending on region; more resources should be dedicated to promote long-term research including, genomics, breeding, and management to deal with this issue.	Environment	9
Webinar	Ventilation efficiency, energy efficiency and water efficiency in poultry houses. The two biggest expenses right now are energy and water. They both actually tie back into production and wellbeing. Performance reflects well-being.	Facilities	
CoDigital	Greater exploration of the link between high-stress living and transportation conditions and food safety issues.	Food Safety	24
CoDigital	Animal welfare is a key driver of sustainability of animal production. We need to provide leadership by supporting research that addresses the welfare challenges animal agriculture will face in 5-20 years. A proactive approach, not a reactive one.	General	26
CoDigital	I designed a project to produce Omega-3 chicken and egg. It is novel. After finishing our project I really surprised about the result. If USDA is willing to cooperate in this project we can negotiate it	General	32
Webinar	More real, applied, on the farm research.	General	
CoDigital	Animal adaptability is vital to food sustainability in diverse production environs/systems. Genome association with adaptability needs evaluation. Study re the environment influences the animal and decision making within a production system is vital.	Genetics/ Genomics	5
Webinar	Management of aggressive and damaging behavior such as ear, flank, and tail biting. Specifically looking at the genetic influence of those aggressive and damaging behaviors and then searching for genomic factors for each of those.	Genetics/ Genomics	

Source	Comment	Theme	CoDigital Rank
Webinar	It is important from a U.S. perspective to try and get involved in international research, so that we get an idea of what's going to potentially become important in animal welfare terms within the U.S. in the future.	International	
CoDigital	We need software and tools to collect and measure on farm well-being on real time, so to help the farmer to identify problem areas immediately and aid with resolutions. This type of tools can help the farmers to self-evaluate the farm welfare state.	Models/tools	3
CoDigital	Support basic research to discover minimally invasive, more accurate and sensitive markers, of acute stress and chronic stress in animals.	Models/tools	4
CoDigital	Substantial research has been conducted to measure animal welfare. However, little has been conducted to quantify when producers are doing a good job. How do we quantify the absence of bad?	Models/tools	17
CoDigital	American Feed Industry Association recommends supporting research to create a standard approach to measure animal well-being and education programs for consumers.	Models/tools	21
Webinar	An overall challenge for us is to have measures of animal wellbeing and animal welfare on the farm as opposed to research studies.	Models/tools	
Webinar	We need to develop objective standards to evaluate the wellbeing. We need these to be more automated techniques.	Models/tools	
Webinar	Tracking individual animal care on our farms. Being able to track animals to note response to treatment, timely euthanasia. It needs to be part of audits and assessments.	Models/tools	
Webinar	We need to provide our producers with the tools to be able to show that we can indeed provide individualized animal care even in a population medicine setting, especially on larger animal production farms. We need to create programs - extension tools. We also need research in order to be able to develop and apply those tools.	Models/tools	
Webinar	Objective measures of animal welfare and perhaps moving towards automated animal welfare.	Models/tools	

Source	Comment	Theme	CoDigital Rank
Webinar	Address animals at the individual level and to be able to assess or track animals at an individual level even on a large scale operation. Need teaching, research and extension activity within this area.	Models/tools	
CoDigital	One of the easiest things NIFA can do for the Animal Ag research is provide a consistent, predictable, timeframe to the RFA release and proposal due dates. You'll get more impactful proposals if given more than 4 weeks to plan and organize.	NIFA Procedures	7
CoDigital	To improve animal well-being research, consistent, predictable RFPs should be released. Longer deadlines and shorter delays prior to review (as NSF does) would allow for more thoughtful proposals and less lag time between submission and review.	NIFA Procedures	11
CoDigital	Significant advances across disciplines could be achieved by providing for larger, integrated "CAP" type proposals. For example, multidisciplinary studies examining the impact of reducing antimicrobial use on animal welfare are urgently needed.	NIFA Procedures	18
CoDigital	We invest a lot into NIFA proposals, with low success rate. Our field is small and our resources would be better spent if the process had 1) a letter of intent evaluated by the deciding panel and 2) clearer instructions about the priority areas.	NIFA Procedures	25
CoDigital	Better opportunities to support more inclusive research. For example Salmonella resistance falls between the cracks because it is "food safety" or "not animal health." But is not accepted by those programs either.	NIFA Procedures	31
Webinar	Issues surrounding pain management and societal concerns in that regard – a challenge for our producers across species - dehorning, castrating, tail docking - requires some more research but also some communication to address societal concerns.	Pain Management	
Webinar	Pain management education for producers is needed: What tools that are available? How do producers work with the veterinarian to institute pain management strategies for providing local anesthesia, and understanding the regulatory constraints around extra label drug use for pain relief?	Pain Management	

Source	Comment	Theme	CoDigital Rank
Webinar	Pain mitigation and group housing are areas of significant importance - changes in requirements in Europe have gotten ahead of those in the U.S.	Pain Management	
Webinar	Pain management. It creates challenges across species.	Pain Management	
Webinar	Tail docking of dairy cows, from both the production and consumer perspective.	Practices	
Webinar	Veal production	Practices	
Webinar	Overcrowding of dairy facilities	Practices	
Webinar	Management of compromised animals and timely euthanasia.	Practices	
Webinar	Painful procedures and pain management, like tail docking and castration.	Practices	
Webinar	Proper procedures for weaned or feeder pig transport.	Practices	
Webinar	We need to increase our understanding of the issues associated with cattle transportation as well as pigs.	Practices	
CoDigital	Consumer preferences for production methods now drive production systems. Little is known about the impact of these on stress, aggression, mortality, disease exposure, environmental impact and production costs. These areas need to be explored.	Systems	10
CoDigital	Technology and management systems in animal agriculture are rapidly changing to improve efficiency. Consideration of animal preference/motivation tests may facilitate adaption to new systems and should be used during barn design or modification.	Systems	13
CoDigital	Growing "foods" locally has gained general public support recently. Animal production to supply local markets has grown along with this concept. What can be done to service animal welfare better for local producers while still assuring food safety?	Systems	14
CoDigital	Identification of animal biospheres with selection for the most efficient animals in that system. Environment, management and genetic variability has homogenized our animal forage converters with little selection for regional efficiency's.	Systems	15
CoDigital	Discern how animal welfare interacts with elements of a production system including natural resource sufficiency. New research approaches incorporating multidisciplinary expertise and data integration to arrive at sustainability metrics is needed.	Systems	19

Source	Comment	Theme	CoDigital Rank
CoDigital	Animal agriculture needs sound behavioral research that tackles animal welfare issues the public cares about. These are the key drivers for animal agriculture right now.	Systems	23
Webinar	Grazing livestock - care and shelter requirements, including winter care and management as well as grazing factors.	Systems	
Webinar	Optimizing the environment of housing system for the sow and the piglets to prevent pre-weaning mortality.	Systems	
CoDigital	With the urbanization of the US population, fewer people are trained in animal husbandry and handling. There is a need to develop training programs that highlight the importance of animal behavior and animal husbandry to food production systems.	Technology Transfer	1
CoDigital	A substantial body of research has been conducted in animal welfare science, however, there is still a problem disseminating this knowledge to producers. One limiting factor may be that there are few extension agents or faculty with welfare training.	Technology Transfer	6
CoDigital	Greater emphasis needs to be given to technology transfer. Grants should be more readily available to fund stakeholder conferences and dissemination of science. There's a great deal of useful information not hitting the target audience.	Technology Transfer	16
CoDigital	Canada has worked with key stakeholders (academia, industry, consumers, etc) to develop the "Codes of Practice" that gives guidance for best practice standards by species. USDA should create a similar document tailored to US food animal production.	Technology Transfer	20
Webinar	In the dairy calf arena, for many years, communications to the public, educating the public, often times appears to not do any good. What are some new methods to get our message out and get our message implemented?	Technology Transfer	
Webinar	Communicating what producers really do to consumers	Technology Transfer	

Source	Comment	Theme	CoDigital Rank
Webinar	Communication with the public – pain relief is an expectation, but understanding some of the associated challenges, particularly regarding pain assessment and determining whether these drugs are working is needed. For instance, public understanding of the fact that we currently have no drugs approved for this purpose in the U.S.	Technology Transfer	
Webinar	Educating the public that has no understanding of what is improved care and proper care of livestock.	Technology Transfer	
Webinar	With the internet and news media, the public is aware of practices that are used in other countries and they assume that the same is common in the U.S. This is often not the case. We need to find ways to address these issues and make our practices better known and understood by the general public.	Technology Transfer	
Webinar	Need to educate producers as well as the public where possible	Technology Transfer	
CoDigital	USDA should be investing more in training the next generation of animal welfare scientists. It is a key area, and there should be a fellowship scheme that fully funds a PhD, including stipend and research costs.	Training Next Generation of Scientists	8
CoDigital	USDA/NIFA need to increase funding & programs supporting development of the animal Ag workforce. Current efforts increased 5-fold & new programs allowing for innovative PD initiated K-12, undergrad, grad, post-doc and career transition programs.	Training Next Generation of Scientists	12
Webinar	One of the primary challenges that we've got in poultry production is water quantity and quality. We've got a lot of farmers in the state that are now paying more for water than they are for fuel.	Water	
Webinar	Poultry industry - water quality and quantity	Water	

Animal Reproductive Biology Stakeholder Comments

Source	Comment	Theme	CoDigital Rank
Webinar	Reduction in reproductive efficiency and sustainability with changes in the feed directive related to antimicrobials. We need alternatives to existing products for management of reproductive disease and the impact of that in both the sheep and goat industry.	Antimicrobials	
Webinar	Embryonic mortality in both the dairy and beef or really all facets of pregnancy failure. Fertilization occurs, but the pregnancies aren't maintained.	Embryonic mortality	
Webinar	Embryonic mortality and stress.	Embryonic mortality	
Webinar	Embryonic mortality needs to be more broad. It is really about getting animals pregnant with everything that is involved with that.	Embryonic mortality	
Webinar	Research in dairy cows that leads to improvements in estrus detection or estrus synchronization, prevention of early embryonic death.	Estrus detection and synchronization	
Webinar	Move away from general genomic approaches and get down to understanding specifically how these genes and how they're products - in context of how the proteome and metabolome really function to help sustain pregnancy or regulate reproduction in farm animals Invest in the functional side of the genomics and how it impacts reproduction.	Functional genomics	
CoDigital	Continue to develop the technology of gene editing to improve the use of animals to feed people.	Gene Editing	2
CoDigital	The current RFA does a nice job at including important areas of study in reproductive biology. Taking an approach to be inclusive of all things reproduction in food animals is important to facilitate novel discoveries relevant to feeding the world.	General	Unranked
CoDigital	Viable and affordable poultry germplasm preservation methodologies for both ova and semen are needed both for commercial applications as well as for conservation efforts.	Germplasm preservation	6
CoDigital	Better understanding of functionality of sperm storage tubules in avian species. There are considerable differences between avian species. This impacts reproduction rates.	Germplasm preservation	7

Source	Comment	Theme	CoDigital Rank
CoDigital	Individual customized and optimized cooling profile for sperm cryopreservation can be achieved by multilayer insulation of sperm samples in different insulation unit and cooling by immersing in liquid nitrogen at different controlled cooling rates.	Germplasm preservation	8
CoDigital	Basic research addressing neuroendocrine and endocrine regulation of reproduction involving the hypothalamo-pituitary-gonadal (HPG) axis	Hormonal Regulation	5
CoDigital	Infertility poses unique issues for business continuity within the sport/entertainment sector of the equine industry, and identifying the correlation between athletic animals and infertility may have broader implications in the human health realm.	Infertility in equine athletes	9
Webinar	Expression of breeding behavior, especially in small ruminants. With 25% of rams showing less than optimal male behavior you're losing 25% of your males or your potential genetic progress. Artificial insemination is not really feasible.	Male fertility	
Webinar	Fertility in bulls, boars, and rams. If we can improve our exams for fertility and actually select for improved fertility among males, it should have a huge trickledown effect on overall herd fertility.	Male fertility	
Webinar	Neonatal survivability.	Neonatal survival	
CoDigital	Reproductive losses occur in many categories. Investment in how the environment (both climate and chemical exposures) influences physiological mechanisms and the production system response is vital.	Reproductive losses	1
Webinar	Seasonality of small ruminants, particularly sheep and goats. In the majority of the breeds that really affect our ability to market animals in a uniform pattern throughout the year. This is Tom Boyer thank you.	Seasonality	
Webinar	Seasonality in pigs is an issue, both on the female side as well as the male side. This includes addressing seasonality in boar fertility to help reduce discard rates during the hot summer months with the semen that gets collected. On the female side it shows up as increase culling rate during the months of October, November, December because those are the females that were bred during the hot summer months and came back open.	Seasonality	

Source	Comment	Theme	CoDigital Rank
Webinar	Seasonal effects on reproduction is a big problem due to dairy and beef industry. In the summertime you'll see a depression in breeding efficiency that causes a problem with reproductive longevity in the herds.	Seasonality	
Webinar	Heat stress in dairy cows associated with poor reproduction and also transition cow health, leading to involuntary culling that occurs due to reproductive failure.	Seasonality	
Webinar	In the small ruminant area, especially goats - the issue is seasonality. The need to improve reproductive efficiency is critical to commercial success of the industry.	Seasonality	
Webinar	Improving sow lifetime productivity. We define that as the total number of quality pigs weaned from the time a female becomes breeding eligible until she leaves the herd.	Sow productivity	
Webinar	Piglet viability - characteristics of the litter that will be predictive of the success that the female would have in the herd over time.	Sow productivity	
Webinar	Getting cows pregnant during the summer as well as those with high production.	Successful rebreeding	
Webinar	Grazers - getting cows bred in the timely manner so that they fit in with intensive grazing programs - getting cows bred in a timely manner and maintaining those pregnancies.	Successful rebreeding	
Webinar	Retention of breeding animals – they go up through development, but then fall out of the herd after they have their first or second litters. High fallout rate. Culling decisions are based on either poor reproduction or small litter size.	Successful rebreeding and litter size	
CoDigital	More group efforts Better full data set sharing Use NANP and other websites Encourage promote and tenure for group work Encourage 'cross discipline' stop with the 'repro person', 'genetics Person nutrition Person more integration Use of models	Systems	3

Source	Comment	Theme	CoDigital Rank
CoDigital	Reproductive fertility (live calf/pig) is a function of many processes we should study that way how do we maintain proper 'synch' programs but encourage genetic improvement? we feed for reproduction...can we expand these efforts	Systems	4
Webinar	We need to emphasize two things - how epigenetics effects the phenotypic outcomes of gene expression. We need workshops to help physiologist better utilize pathway analyses that we generate. We need more crosstalk between bioinformatics people and physiologists.	Systems	
Webinar	Extension is very important is very important to the sheep industry. The sheep trade association makes a pretty sizeable investment in getting technical information out to producers.	Technology Transfer/Outreach	
Webinar	For small ruminants, university extension is in some areas excellent, in other areas it's not. e-Extension is valuable and helpful, but in some states Extension does not provide near the quality of information as other sources.	Technology Transfer/Outreach	
Webinar	Small ruminant groups have contacts with individuals in other countries, both the professional and organizational contacts who have been very helpful for us, particularly as it comes to drugs, disease information, some types of data. They've played a key part in the genomics research, the microscopic amount that's been done on sheep. International resources to help us where we have significantly more limited access to research and information within the U.S.	Technology Transfer/Outreach	
Webinar	Scientific journal articles rarely provide technical information to industry stake holders directly. Content from scientific journal articles need to be interpreted for business purposes by in house employees or others, such as extension agents, consultants, etc.	Technology Transfer/Outreach	
Webinar	Each university should have state species, specific reports on research and application of that research. We also need to have a producer friendly summary statement with our more fundamental research that we publish.	Technology Transfer/Outreach	

Source	Comment	Theme	CoDigital Rank
Webinar	One of the big ways that dairy producers get information is through a number of major dairy conferences.	Technology Transfer/Outreach	
Webinar	The American Dairy Science posts proceedings of conferences and we have proceedings from close to 60 of the conferences available online. It's a subscription service, but a way that producers can get access to technical information that is presented at these both national and international meetings.	Technology Transfer/Outreach	
Webinar	The Journal of Dairy Science includes interpretive summaries. It's intended to provide information in less technical language. They are also putting out a number of press releases that are being utilized by trade media to put some of the technical information in more producer friendly format.	Technology Transfer/Outreach	
Webinar	Extension is critical, but with the funding cuts we need to find additional ways to work with it to make it work.	Technology Transfer/Outreach	
Webinar	The people that are working in swine field and reproduction is pretty small and I think it's pretty critical that we continue to do research in this area. We need to foster our next generation of researchers.	Training Next Generation of Scientists	
Webinar	Train our next generation of researchers to be able to communicate their research findings in a way that's easily understandable and that it can be converted on farm tools or educational materials or management practices that will have application on the farm.	Training Next Generation of Scientists	
Webinar	In the small ruminant area, we are in desperate straits for personnel. Those who are retiring from the research sector of the small ruminant area are not being replaced. There a need for the trained personnel, but there's desperate need for funding for these positions.	Training Next Generation of Scientists	
Webinar	Funding for graduate students is shrinking.	Training Next Generation of Scientists	
Webinar	Educating and training future scientists and reproductive workers is essential. There is already a shortage. Finding people that would like to have a career in true animal agricultural research in a land-grant university system is quite difficult	Training Next Generation of Scientists	

Source	Comment	Theme	CoDigital Rank
Webinar	Grad students see us struggle for money to conduct research and don't want to do it. I advertised for a post-doc position and every applicant was international.	Training Next Generation of Scientists	
Webinar	The issues posed by the developing heifer. There's a wide degree of variability depending on breed type and mature weight. Producers want to intensively manage the heifer. Approaches that work in a mature cow don't necessarily work in the heifer. It comes down to puberty and misinformation about age at puberty, controlling puberty, factors that affect age at puberty and how to avoid disasters associating with controlled breeding as a result of not understanding how much variability there is in age at puberty.	Youngstock development	
Webinar	Gilt development - how we develop that female and bring her along so that she becomes a successful member of the herd and produces well over her lifetime.	Youngstock development	

Quality, Nutritional Value and Healthfulness of Animal Products Stakeholder Comments

Source	Comment	Theme	Rank
Codigital	As more and more bacteria become resistant to antibiotics, especially the long acting macrolides in cattle, more research needs to be done with antibiotic alternatives, especially in the area of animal derived antimicrobial polypeptides.	Alternatives to Antibiotics	2
Codigital	More research need to be done with DNA vaccines for parasites in ruminants, especially small ruminants. Identifying simple proteins within notable parasites for DNA vaccine production.	Alternatives to Antibiotics	11
Codigital	The development of strip style tests for viruses for the identification of viral infections in horses.	Alternatives to Antibiotics	16
Codigital	There is a need for more data and analysis related to the consumer understanding and acceptance of biotechnology in animal production.	Consumer Acceptance	1
Codigital	Translation of biotechnology has great potential. Investment in how must-omics results lead to biomarkers is note-worthy; however, consumer acceptance is an important component of the process.	Consumer Acceptance	6
Codigital	USDA needs to better quantify the benefits of biotechnology in animal production and continue studying potential risks, to the environment and human health while developing a system to approve the use of biotechnology in animals consumed by humans.	Consumer Acceptance	10
Webinar	Consumer acceptance of biotechnology - education and extension	Consumer Acceptance	
Webinar	Investigate epigenetic effects of cloning	Epigenetics	
Codigital	System based approaches where productivity measures are integral and can be correlated to gene changes	Functional Genomics	5
Codigital	With the impending identification of putative causal variants for traits of interest, there is a real need to develop high-throughput systems to test causality of these variant, a biotechnology based approach may be the best way to accomplish this	Functional Genomics	7
Codigital	CRISPER-CAS gene editing of host genome and metagenomes.	Functional Genomics	14
Webinar	Gene editing approaches to determine gene function, identify if genes/alleles are causative for a given phenotype	Functional Genomics	
Webinar	Need for approaches that combine contemporary breeding with gene editing to get precision breeding	Precision Breeding	

Codigital	NIFA needs to provide a consistent, predictable, timeframe to the RFA release and proposal due dates. You'll get more impactful proposals if given more than 4 weeks to plan and organize.	Proposal Process	8
Codigital	Learn from other fields individualized medicine we have biotechnology/activity monitors rumen monitors for better or worse mostly private enterprise and very expensive to test and compare can we change our philosophy and funding on this?	Proposal Process	13
Codigital	Many of the tools exist. Encourage and pay for their use? Move past 'competitive' funding to larger grants with more focus Reduce overhead Group efforts Develop oversight regulations that include new techniques like Genome editing and gene drives.	Regulatory Issues	12
Codigital	Develop research to support regulation of new GE techniques like CRISPR, talens, zinc fingers and gene drives.	Regulatory Issues	15
Webinar	Reduce costs of this kind of research - requirement to incinerate large animals is prohibitive.	Regulatory Issues	
Webinar	Risk assessments for biotech animals	Risk Assessment	
Codigital	There needs to be a better balance of funding between development of omics tools and actual application in the production arena.	Technology Application	4
Codigital	Develop projects to use technologies to improve the efficiency by which animals are used to produce foods derived from animals.	Technology Application	9
Webinar	Improve IVF to allow more efficient (practical) use of gene editing	Technology Application	
Codigital	USDA/NIFA need to increase funding & programs supporting development of the animal Ag workforce. Current efforts increased 5-fold & new programs allowing for innovative PD initiated K-12, undergrad, grad, post-doc and career transition programs.	Workforce Development	3

Lactation Biology and Nutritional Efficiency of Animals Stakeholder Comments

Source	Comment	Theme	CoDigital Rank
Webinar	Capacity investment – invest in facilities capability of looking at nutritional needs of the sow and litter - facilities really to do metabolic research on sows and their litter and the amino acid requirements of lactating sows	Capacity	
Webinar	We know very little about growth characteristics, lean and fat deposition in pigs beyond 275 lbs, and what the nutritional requirements are. Having larger and larger pigs is going to be the standard.	Composition of Growth	
Webinar	Body and frame development in pullets (layers) - if you don't get a good bird grown in those 18-20 weeks you're going to have just an under-performing flock for the next two years – Growth and uniformity.	Composition of Growth	
Webinar	Healthy body weight in layers - good muscle accretion and skeletal development for life of production - focusing early on first 18-20 weeks	Composition of Growth	
CoDigital	The role of milk components including miRNA and other small molecules on health/ metabolic diseases of the dam and offspring is critical for the future.	Disease prevention	11
Webinar	Protection of our neonatal animals and pre-weaning animals through passing of antibodies in the milk against enteric diseases, e.g. antibodies that the sow passes on in her milk after colostrum is protective against PED.	Disease resistance	
Webinar	Research the interface between animal health and nutrition – e.g. amino acids requirements of pigs that are health challenged, e.g., if we knew animals challenged by a particular disease, could benefit from preemptive help like pre-loading them nutritionally so that they would either be resistant or resilient to that disease or recover more quickly	Disease resistance	
Webinar	Major concern for poultry – loss of treatment options with antibiotics and other items.	Disease resistance	
Webinar	The genetic interaction of disease resistance is absolutely a high priority	Disease resistance	
Webinar	The linkages of nutrition with animal well-being, animal health are going to be critical, from both the producers stand point and meeting consumer needs.	Disease resistance	

Source	Comment	Theme	CoDigital Rank
CoDigital	Undergirding nutritional efficiency is nutrient digestion, absorption and metabolism as well as animal health. We need to support basic biochemical (i.e., molecular, cellular) as well as applied nutritional studies to improve efficiency.	Efficiency	2
CoDigital	Nutritional efficiency is dependent on intake, digestion and absorption, incorporation (tissue/product), and energy expenditure. Genetic, feed processing, nutrition and physiology studies should aim to improve efficiency through these variables.	Efficiency	3
Webinar	It might be possible that the nutritional efficiency would be different for a larger pig.	Efficiency	
Webinar	Cow size and the impact that has on relative efficiency - the efficiency of a smaller framed cow versus large cows	Efficiency	
Webinar	Invest in mechanisms whereby our producers, pork producers can really begin to implement some of the things that we are publishing in our scientific journals.	Extension	
Webinar	Publishing lay abstract of research, how is this related to extension? ARS - when we publish an article, we also write an interpretive summary which is really designed for a lay person to be able to understand it. The same is done for journal articles in the Journal of Dairy Science. There's an interpretive summary that goes with each. Major dairy producer conferences is another way that a lot of that gets disseminated.	Extension	
Webinar	The public are interested in different things, so how do we select? We need to get as much information as possible to the public with no pre-selection.	Extension	
Webinar	Extension capabilities are getting very limited.	Extension	
Webinar	Feed additives for poultry - whether from an immunity stand point or overall gut health	Feed Additives	
Webinar	Use of alternative ingredients in Dairy rations	Feedstuffs	
Webinar	USDA should avoid funding human nutrition related research.	Funding for Animal Science	
Webinar	NIH should be supporting human nutrition because they have more than \$30 billion but the USDA has a few hundred million dollars. If USDA funds nutrition research it should be animal research.	Funding for Animal Science	
Webinar	Research on food choice etc. should be NIH. USDA needs to put our limited funding on agriculture.	Funding for Animal Science	

Source	Comment	Theme	CoDigital Rank
Webinar	USDA has limited funds to invest, so we should focus on the animal side and not the human side.	Funding for Animal Science	
Webinar	Work as collaboratively as possible with NIH. If we're not involved in the process there we're not going to get looking at their projects.	Funding for Animal Science	
CoDigital	We need more research on nutrient-gene interaction (i.e., nutrigenomics) to exploit the capability of nutrients to improve the physiological conditions of the lactating animal	Genetics/genomics	4
CoDigital	Determine underlying mechanisms and causative genes for SNP and QTL discovered by geneticists that alter growth and efficiency. Exploit the wealth of information produced by whole genome work. Translate that into strategies to increase efficiency.	Genetics/genomics	5
CoDigital	Nutritional efficiency can be sorted based on specific herd pedigrees and pinpointed to genetic influence as well. More data analysis is required to see which genetic markers are resulting higher milk production over DMI.	Genetics/genomics	8
CoDigital	There is still the need to understand better mammary development in ruminants and the role of mammary stem cells. For instance we have no idea how fetal reprogramming and/or diet in early age affect the biology of mammary stem cells	Lactation biology	10
CoDigital	American Feed Industry Association recommends that the USDA considers the biology of the lactating sow in this topic area.	Lactation biology	18
CoDigital	In beef cattle, aggressive selection for milk yield continues while commercial operation weaning weights have not changed for 24 years. Determine/explore optimal milk yield under common commercial cow/calf production systems and environments.	Management	13
Webinar	Lactation, pregnancy and dry period issues with the reproductive female goat - we still have a lot of unknown areas and areas that haven't been tested well.	Management	
CoDigital	Removal of antibiotics from the feed is precipitating the need for a better understanding of the impacts of intestinal health, microbiome, etc on efficiency of nutrient utilization.	Microbiome	6

Source	Comment	Theme	CoDigital Rank
Webinar	Basic research to understand microbiome - basic knowledge of the microbiome and how it changes in response to dietary factors	Microbiome	
CoDigital	Support and publish integrative, mathematical genetic, physiological, nutrient use, reproductive models as RESEARCH programs as in other fields...join this century. reduce narrow disciplinary funding and train true integrative biology	Models/decision support	14
Webinar	Lactation model for sows	Models/decision support	
CoDigital	Promote both basic and applied research to improve our understanding of nutrition, lactation, growth. Many key applied and basic questions may be best addressed with an integrative whole animal approach.	Multidisciplinary work	1
CoDigital	Multidisciplinary work in nutrition, genetics and nutrition - large studies to describe the real interaction of genetic selection, nutrient availability and productive and reproductive efficiency stop the categories and fund integrative work	Multidisciplinary work	7
CoDigital	Support and encourage multistate work, support and encourage field work with large numbers of animals; tenure and promote based on true integrative work more training in quantitative and integrative biology; Mathematical models as a research approach	Multidisciplinary work	15
CoDigital	Information is needed on nutrient metabolism in high producing beef and dairy cattle. Diets have changed dramatically in recent years without knowledge of the true end products of fermentation and digestion.	Nutrient requirements	12
CoDigital	Focusing on blood protein, minerals and nutritional parameters in animals at different stage of production and creating relationship with diets used. We need to study and focus on feeds that create a matrix with balanced & high lactation curves.	Nutrient requirements	16
Webinar	We have significant need for research in the area of big pig nutritional requirements. We have very little understanding or information regarding pigs that are greater than about 275 lbs. which is where I think the current NRC requirements tops out.	Nutrient requirements	

Source	Comment	Theme	CoDigital Rank
Webinar	Nutritional requirements for in goats - particularly we still have some issues with the mineral requirements of goats for production. It seems to be very limited on what we have with that and how this applies to growth.	Nutrient requirements	
Webinar	Updated nutrient requirements for sheep (NRC)	Nutrient requirements	
Webinar	Energy/metabolizable energy in dairy cattle	Nutrient requirements	
Webinar	The digestibility of fiber in dairy cattle – it is important for forage use.	Nutrient requirements	
CoDigital	Promote integrative work that links nutritional efficiency and growth to product quality. What is the point of producing more meat more efficiently if no one wants to eat it? Is growth and efficiency always negative for meat quality?	Nutritional/Product quality	9
CoDigital	What high value products are in milk that need to be exploited for use in human medicine and human health maintenance and improvement?	Nutritional/Product quality	17
Webinar	The current practice of fattening beef causes a lot of health problems. With the upcoming ban on antibiotic use, basic research should be funded on improving health of beef animals during the fattening process.	Nutritional/Product quality	
Webinar	We need to look at how our animal products tie in with human research needs. I think we certainly need to collaborate.	Nutritional/Product quality	
Webinar	Animal products and human health. There is a great deal of misinformation. Is NIH going to come forward and objectively evaluate how animal products should be incorporated into a healthy diet or is that going to be USDA who is going to do that?	Nutritional/Product quality	
Webinar	The World Health Organization is saying that children shouldn't be drinking milk. How do we combat those kind of things that are put out in the press that are harmful?	Nutritional/Product quality	
Webinar	Parasite issues in goats and the connections between parasitism and protein levels. Is this impacted by heat stress in those animals?	Parasites	

Source	Comment	Theme	CoDigital Rank
Webinar	Consumer preferences – consumers who buy food purely on how it was raised, organic, etc. welfare or whatever versus consumers who buy on price and taste. The question becomes as the population doubles in the next 50 years if we don't have biotechnology or technology, how are we going to feed the world? Help develop technology but also educate the public on technology and why it's needed.	Social	
Webinar	The difficult problem of public perception	Social	
Webinar	USDA needs to put emphasis on educating the public about genetic engineering.	Social	
Webinar	Educate human nutritionists themselves - protein quality and amino acid balance	Social	
Webinar	Millennials' perception and purchasing decisions on food versus older generations. They are a much larger portion of the upcoming consumers and are looking at things differently than what we have in the past. If we ignore them, we do so at our own risk. We need education, but we also need to address their concern.	Social	
Webinar	Research to develop understanding the underlying biological mechanisms of heat stress. We really need to work in the area of heat stress, especially in our livestock species and poultry.	Stress	
Webinar	Both information on heat stress as well as some information on cold stress in goats – regional climate variation and its effect on goat performance	Stress	
Webinar	Heat and cold stress and their interactions with disease potential	Stress	
Webinar	Heat stress and cold stress and their effect on growth and lactation	Stress	
Webinar	Oxidative stress and mortality in sows - measures of oxidative stress - definitive test to understand animals under oxidative stress.	Stress	
Webinar	Can load an animal or actually amend the diet to offset potential oxidative stress	Stress	
Webinar	The heat stress model for sows	Stress	
Webinar	Basic and applied research into the mechanisms that are causing oxidative stress as well as measures to detect that and how oxidative stress affects animals in the field.	Stress	

Animal Growth Biology and Alternatives to Antimicrobials for Growth Promotion Stakeholder Comments

Source	Comment	Theme	CoDigital Rank
CoDigital	What is the impact of high welfare practices, e.g., regular access to the outdoors/sunlight, freedom of movement, nutritious diets suitable to the species, etc., on animal growth?	Animal welfare	16
Webinar	More genomes and better annotation of genomes and more understanding of genome-environment-microbiome and their actions	Breeding/Genetics	
CoDigital	General breeding....is it still worthwhile to breed for faster growth or have we hit practical limits?	Breeding/genetics	10
Webinar	Antimicrobials can contribute to public and animal health directly by controlling pathogens and contributing to the overall health of the animal.	Disease resistance	
Webinar	Problem - some of the shared use or even some of the only human use are really the only antibiotics that will treat an animal disease, so how do deal with not being able to treat an animal disease? How do you treat when the antibiotic that you might want to use falls into a human only?	Disease resistance	
Webinar	Genetically modified animals for disease resistance should be promoted again. Support is not sufficient. Making it a priority as needed	Disease resistance	
Webinar	Genetic modification is a potential disease prevention mechanism.	Disease resistance	
CoDigital	Nutrient-gene interaction (i.e., nutrigenomics) to improve the immune resistance of animals. This requires a lot of fundamental research using molecular biology tools before being able to translate the finding into efficacious practical applications.	Disease resistance	1
CoDigital	Has the use of both the usual and novel (but readily available) plant materials (feed/fodder) been sufficiently surveyed to know whether or not any can strengthen resistance to disease and pathogenic bacteria?	Disease resistance	5
CoDigital	Breed for resistance to the diseases antimicrobials are holding down? General breeding....is it still worthwhile to breed for faster growth or have we hit practical limits?	Disease resistance	9

Source	Comment	Theme	CoDigital Rank
CoDigital	American Feed Industry Association recommends funding research to enhance understanding of gut physiology in relation to developing strategies for gut health alternatives.	Disease resistance	12
Webinar	If we're going to overcome the loss of antibiotics in a number of species, we have to use other therapies or other treatments in order to overcome the decrease in production which we're going to see.	Feed Additives	
CoDigital	American Feed Industry Association recommends funding extension education to consumers on the benefit of feed additives to animal wellbeing and food safety.	Feed Additives	18
CoDigital	Supplementation of antimicrobial peptides (AMP) have been found to improve performance while reducing gut inflammation and disease incidence. Can recombinant AMP and AMP-expressing probiotics be delivered to promote growth and disease resistance?	Feed Additives	3
CoDigital	Bacteria such as those producing butyrate can be isolated from healthy animal gut and used as direct fed microbials to prevent pathogen colonization. By reducing pathogen load, these beneficial bacteria will act as alternative to antibiotics	Feed Additives	4
CoDigital	What are the relative costs (compared to antimicrobial growth promotants) of the non-antimicrobial growth promotants? What is the relative efficacy of these alternatives?	Feed Additives	8
CoDigital	More research needs to be performed on non-antibiotic antimicrobials that increasingly being used to replace antibiotics to determine their animal and human health implications and their impact on the environment.	Feed Additives	13
CoDigital	More research is needed into the environmental and public health impacts of nonantimicrobial growth promoters, both from the presence of residues on food and their proliferation in the environment.	Feed Additives	15
Webinar	Funding for epigenetics of prenatal programming. Can you pre-program the animal in utero?	Fetal programming	
Webinar	Environmental effects on prenatal programming and fetal growth.	Fetal programming	

Source	Comment	Theme	CoDigital Rank
CoDigital	How important are environmental conditions related to antibiotics? Can clean water and living conditions be used to reduce or eliminate the need for prophylactic antibiotics?	Growing environment	6
CoDigital	More research needs to be conducted to determine if better animal husbandry, housing, welfare, and manure handling techniques can be used to reduce or eliminate the need for sub-therapeutic anti-microbial use.	Growing environment	14
Webinar	Studying the microbiome is one of the key features to be able to replace the growth promoting activity of antibiotics with some other alternative.	Microbiome	
Webinar	Enhanced funding of microbiome research across all species	Microbiome	
Webinar	Microbiome research has huge implications for animal growth and development as well as utilization of nutrients. It is an untapped area where we need more information. There needs to be a large investment in that in order to help us utilize this “other genome” that is part of every animal in the most effective way possible.	Microbiome	
Webinar	Investment by the USDA in the area of microbiome.	Microbiome	
Webinar	Basic research on the microbiome - the mechanism of growth promotion, changes that result because of antibiotic use, following anti-microbial resistance genes through the production pipeline.	Microbiome	
Webinar	Matching animal genetics to microbiomes	Microbiome	
Webinar	Reducing methane emission through genetics and selection of a microbiome. Reduce greenhouse gasses, and increase growth efficiency	Microbiome	
Webinar	Can you make custom cocktails of microbiomes for the right genetics of any particular species?	Microbiome	
CoDigital	What role does the metagenome of the respiratory tract, GI track, etc. have on growth? Disease incidence? etc. Can manipulation of the metagenome be used to stimulate growth and production of livestock?	Microbiome	2
CoDigital	For growth we need to focus on role of hormones and factors in embryonic stage of animal and then find turn on gene signals which help in creating microflora balance in our desired bacteria. Animals’ microflora needed to be studied more for this data.	Microbiome	7

Source	Comment	Theme	CoDigital Rank
Webinar	Growth promoting activity can be a result of their antibacterial activities, but there's also a lot of unknowns in how growth promoting antibiotics actually work.	Mode of Action	
Webinar	Antimicrobials alter the intestinal microflora and microbiome.	Mode of Action	
Webinar	Understanding what changes occur, we may be able to replace growth promoting antibiotics with other alternatives which are more acceptable to the public and to the public health community. For instance, probiotics, nutritional supplements, other management practices that will allow us to achieve enhanced growth rates in animals without the use of sub-therapeutic antibiotics.	Mode of Action	
Webinar	Antibiotic research to figure out how these things work mechanistically and then be to replace them with some other non-antibiotic or non-antimicrobial intervention	Mode of Action	
Webinar	Mechanisms over outcomes because if you have mechanisms then you can design, potentially, very, very effective targeted promoters of growth or health.	Mode of Action	
Webinar	Research to develop understanding of the basic mechanisms of muscle, bone, adipose, early embryo development.	Physiological mechanisms	
Webinar	Improve our understanding of the actual function of the genes themselves and what physically drives their expression and the variation that exists in them.	Physiological mechanisms	
Webinar	Knowledge of mechanisms controlling different aspects of animal growth and development.	Physiological mechanisms	
Webinar	Investment in prevention - research that surrounds the importance of prevention antibiotics and understanding the mechanisms behind it.	Physiological mechanisms	
Webinar	Plant derived antimicrobials such as spices should be tested as food additives - spices are safe and cheap	Probiotics	
Webinar	Other preventatives outside of antibiotics, what are those other preventative measures?	Probiotics	
Webinar	Understanding the classes of antibiotics the FDA has put together; human use only, shared class that will go to VFD, and then animal use only products. Education is needed to allow producers to know which ones of these classes of antibiotics can be used.	Producer education	

Source	Comment	Theme	CoDigital Rank
Webinar	Translational research – get information to the farmer and to the producer.	Producer education	
Webinar	A primary concern - the push from public activist groups as well as food service regarding why we use antibiotics and why they're important for prevention and control and treatment. They need to understand that these are important tools and that we really can't lose them. The industry needs help with this message, coming from scientists	Social	
Webinar	Need holistic approach to research - when we implement alternatives or alter the microbiome, how does that impact not only animal health and public health but also meat quality, animal welfare, worker health and safety, and economics?	Systems	
Webinar	Mechanistic approaches and non-antimicrobial approaches to improving growth promotion and improving food safety, reducing pathogen load, both pre- and post-harvest.	Systems	
Webinar	“Precision agriculture” at the animal level	Systems	
Webinar	Holistic research that determines how antimicrobials, or their removal, impacts everything including quality and welfare and human health and animal health and resistance.	Systems	
CoDigital	Growing bigger animals at faster and faster rates/efficiencies has been the mantra for decades. Given the social desire for smaller scale local food production should we consider how better to grow smaller animals on a smaller scale by more people?	Systems	11
Webinar	Research to transform animal production and health into a very predictive science, so we can determine an animal’s potential and can change the management of that animal utilize it most effectively, enhancing the economics of livestock production throughout the system. Change the biology of animal production from a descriptive science to predictive science.	Tools/models	
Webinar	Animal models for growth and development and disease resistance.	Tools/models	
CoDigital	American Feed Industry Association recommends funding research on rapid effective methods for testing to prevent mycotoxin transmission from feed to animal to the end products.	Tools/Models	17

Forages and Forage Utilization for Animal Production Stakeholders Comments

Source	Comment	Theme	CoDigital Rank
Webinar	Internal parasites	Animal health	
Webinar	Goats – internal parasites	Animal health	
Webinar	Climate change - inadequate precipitation and excess precipitation which has really made hay harvest in the Midwest challenging in the recent years.	Climate	
Webinar	Heat stress, particularly our grazing livestock	Climate	
Webinar	Another challenge for forage production is drought.	Climate	
Webinar	Drought tolerance	Climate	
Webinar	Systems to adapt forage based production systems to climate change -- forage production and irrigation, harvesting, e.g., trying to bale hay when it's wet	Climate	
Webinar	Climate change, whether drought, irrigation, the extreme weather, water issues	Climate	
Webinar	Integrate alternative forage species into row crop	Cover crop	
Webinar	Cover crops and cover crop mixtures	Cover crops	
Webinar	Cover crops have become a big player up here in the Midwest - the quality and their ability to supporting needs of lactating cows.	Cover crops	
CoDigital	Development of methods to improve persistence and nutritional characteristics of legume forage species to improve animal production while reducing methane and nutrient loading of the environment	Cultivars	2
CoDigital	Lengthen the grazing season to the fullest extent possible in northern and high altitude farms by formulating mixes of annual and perennial forages adapted to those areas.	Cultivars	3
CoDigital	Develop forage varieties and appropriate management to allow pasture production to transition from high input-based systems to sustainable, ecologically based systems utilizing increased plant diversity including adapted legumes.	Cultivars	8

Source	Comment	Theme	CoDigital Rank
CoDigital	With the popularity of mob grazing and "stockpiling" forage rather than haying, forages need to be developed that are easily digestible even as they age. This will not only benefit the animal but it will decrease enteric methane production	Cultivars	12
CoDigital	Develop management systems and perennial forages that minimize the number of harvests required while maintaining land in perennials, and providing the quality of forage to support high, efficient productivity in livestock.	Cultivars	16
CoDigital	Plant-animal interface research in support of new cultivar development.	Cultivars	18
CoDigital	Annual forages play a significant role in our beef production system and this component could benefit greatly from improved management and cultivar selection.	Cultivars	25
CoDigital	Increase condensed tannins in birdsfoot trefoil to provide more bypass protein to the lower GI tract while maintaining its palatability.	Cultivars	26
CoDigital	American Feed Industry Association recommends funding research and extension education to investigate novel forage varieties to increase the efficiency of nutrients and to minimize production impact of horses on the environment.	Cultivars	28
Webinar	Forage nutritional quality, anti-quality factors in terms of animal production.	Cultivars	
Webinar	Alternative forage species, alternative management.	Cultivars	
Webinar	Maximize production from perennial forages - can we continue to have higher stocking rates and get more out from the same amount of land in perennial forages?	Cultivars	
Webinar	Extending the grazing season	Cultivars	
Webinar	Summer slump	Cultivars	
Webinar	Annuals that can fill in gaps - on crop land or renovated perennial pastures	Cultivars	
Webinar	Finishing animals on pastures - what types of forages will do that	Cultivars	
Webinar	Insect resistance	Cultivars	
Webinar	Water use efficiency relative to production of the crops	Cultivars	

Source	Comment	Theme	CoDigital Rank
Webinar	Legume persistence, clovers, also some legumes that contain condensed tannins.	Cultivars	
Webinar	Tremendous potential of perennial legumes - lower NDF, high non-fiber carbohydrate levels and so they have such potential for gain.	Cultivars	
Webinar	Legumes other than clover in the south	Cultivars	
Webinar	Alternative forages to fill in gaps	Cultivars	
Webinar	Persistence and nutritional value of legumes	Cultivars	
Webinar	A perennial legume that fits into southern production systems.	Cultivars	
Webinar	Legume persistence and nutritional properties to improve their use and any adverse effect they have on environmental quality.	Cultivars	
CoDigital	With the USDA focus on methane as a GHG at about 20-25 times CO ₂ , breaking down forage without producing methane is very important. We need to make forage nutrients more available to the animal and at the same time make the animal make less CH ₄ .	Environment	22
Webinar	Effects of forage systems on environment relationships and quality	Environment	
Webinar	Negative and positive impacts of forage based livestock and production on environmental quality - methane per animal compared to confinement, soil organic matter, water quality, nutrient management, utilizing forages in a way that doesn't affect water quality.	Environment	
Webinar	Improved nutrient management - nitrogen and phosphorus- in relationship to water quality and also greenhouse gas emissions.	Environment	
Webinar	Soil health and forage productivity, environmental concerns, methane concerns, carbon sequestration, etc.	Environment	
Webinar	GHG and the beef cow - the beef cow produces 80 percent of the methane involved in the beef production system – increase feed efficiency to reduce feed intake by cows to reduce methane production	Environment	
Webinar	Breeding beef cattle for tolerance or resistance to fescue toxins/endophytes.	Fescue toxicosis	

Source	Comment	Theme	CoDigital Rank
Webinar	Fescue toxicosis and other anti-quality factors found in various forages.	Fescue toxicosis	
Webinar	Handling fescue toxicosis	Fescue toxicosis	
CoDigital	Management of the negative impacts of tall fescue toxicity in grazing cattle and small ruminants particularly under conditions associated with climate change	Fescue toxicosis	14
Webinar	Commercialization of non-toxic endophytes that also impart protection to the plant.	Fescue toxicosis	
Webinar	Lost infrastructure and facilities for grazing trials on a large enough scale to be useful to producers – getting larger amounts of funds to either reinvigorate or reinstate some of the facilities and infrastructure that used to be available	Infrastructure	
Webinar	Infrastructure – the ability to do the work that's really needed. We need these enhanced facilities	Infrastructure	
Webinar	Increase number of graduate students trained in forage production and utilization.	Infrastructure	
Webinar	Limited land for perennial forage production. We've lost, in the Midwest over 20 percent of our grasslands, in the last decade, to agriculture uses, again primarily row crop production or also non-agricultural uses,	Land use	
Webinar	Is there flexibility in crop land, so if it's not profitable to produce corn is there an annual forage species that could integrate grazing into that production system.	Land use	
Webinar	Range land - very low carrying capacity, land degradation and ingress of brush and loss of good graze-able acreage..	Land use	
Webinar	High plains of Texas - irrigation - the aquifer is declining and a lot of acres are going out of irrigation. We are getting that land back into animal production - grassland is a major thrust	Land use	
Webinar	Land limitation	Land use	
Webinar	Limited knowledge of the nutritional physiology of grazing livestock – use new technologies such as motion and other types of physiological sensors, GPS tracking to more accurately determine the nutrient requirements of grazing animals.	Livestock physiology	
Webinar	Dealing with livestock stresses.	Livestock physiology	

Source	Comment	Theme	CoDigital Rank
Webinar	Beef cow efficiency	Livestock physiology	
Webinar	The increasing need from emerging economies on US produced forage. China buys a lot of US produced alfalfa. How will this effect US ability to feed our animals?	Markets	
Webinar	Marketing - forage based, grass-based, grass milk	Markets	
CoDigital	Forages are 30 - 70% of animal intake. We need to focus on individual nutrient balance of rumen from forages only and develop interactive forage digestion interface (Software) which give farmer access to amount, type and quality of forage needed.	Models/Decision support	4
CoDigital	Grazing management lacks real time management tools that target specific animal production goals. Tools that allow farmers to make daily management, supplementation decisions to achieve desired levels of production.	Models/Decision support	15
Webinar	Work on how we can better measure and estimate and model intake on grazing. Needed for models of nutrient cycling, water use efficiency, sustainability indexes, decision support systems	Models/Decision support	
Webinar	Develop the decision support systems, so this bridges between research and extension, so that land owners can make wise choices among the limited resources	Models/Decision support	
Webinar	Decision support for forages - legume crops in terms of yield and economics - could also spin into nutrient management issues.	Models/Decision support	
Webinar	Better, longer term weather forecasting – months - for decision support systems for planning water use	Models/Decision support	
Webinar	Nitrogen intake and utilization	Nutritional value	
CoDigital	Research what types of supplementation give the best animal performance from different forage bases, and what minimizes conflict with humans for crops that could be used for food.	Nutritional value	9
CoDigital	Support integrated research to better match forage composition and yield with animal requirements AND overall water/fertilizer/equipment use (is an extra T/acre at 2 % points less protein more efficient overall than 24 % CP and low NDF)	Nutritional value	10

Source	Comment	Theme	CoDigital Rank
CoDigital	Strategic supplementation plans aligned with pasture composition to prevent nutrient loading while maintaining animal performance	Nutritional value	11
CoDigital	Develop supplement strategies for pastured dairy cows that improve energy and protein balance in their diets to produce more milk and less uric acid.	Nutritional value	23
CoDigital	Forages, byproducts, and other feeds support ruminant livestock. Investigate how rumen and animal performance are affected by interactions among feed components so we can optimize animal performance/efficiency under different conditions.	Nutritional value	27
Webinar	Maximizing forage yield and quality - nutritional values for cattle	Nutritional value	
Webinar	Frost stressed crops and how we deal with that	Nutritional value	
Webinar	Understanding microbial protein flow - protein and protein degradability and getting RUP into the animal is critically important	Nutritional value	
Webinar	Legumes and forage degradability	Nutritional value	
CoDigital	Determine ways to control clover root curculio in clover, alfalfa, trefoil, and other legumes so they are less susceptible to root rot due to infections brought on by root feeding by the curculio.	Plant disease	21
CoDigital	Improve disease resistance in birdsfoot trefoil so that it remains in hay and pasture mixtures for several years without reseeding or allowing it to reseed naturally.	Plant disease	24
CoDigital	Develop alternative processing methods for / products made from perennial forages so that they have alternative commercial uses, enhance farm income, allow more land to be profitably maintained in perennials to reduce erosion	Processing	19
CoDigital	Develop forage varieties and appropriate management to allow pasture production to transition from high input-based systems to sustainable, ecologically based systems utilizing increased plant diversity including adapted legumes.	Systems	13

Source	Comment	Theme	CoDigital Rank
CoDigital	Development and evaluation of systems integrating forage-based livestock production with crop production and other land uses to maintain farm/ranch productivity and reduce environmental impact (erosion, GHG, water).	Systems	1
CoDigital	Plan and implement site specific grazing systems, focusing on grazing management rather than introducing "miracle plants", to extend the grazing season and minimize purchased or farm-produced stored feed.	Systems	6
CoDigital	Year round forage systems for beef cattle are needed to be developed in different regions of the country. These systems need appropriate cultural practices and forage management that would maintain soil health.	Systems	7
CoDigital	The plant and animal interface on native rangelands is a different than a cultivated system. Investment to better understand grazing distribution and diet selection are vital to helping sustain grazing on western rangelands.	Systems	20
Webinar	Effects of forage systems on animal production and health	Systems	
Webinar	Cow-calf production systems work that complements the forage work	Systems	
Webinar	Traditional production systems have been based on primarily spring calving, summer perennial forage grazing. What optimizes the production system when that changes?	Systems	
Webinar	The New Zealand style seasonal dairy production, addressing various questions such as waste management and integrated crop livestock	Systems	
Webinar	Grass fed dairies	Systems	
Webinar	Finishing animals on pastures	Systems	
Webinar	Livestock production on perennials	Systems	
Webinar	Using crop residues and crop byproducts so dairies can supplement grazing cattle - requires systems analysis and sustainability analysis.	Systems	
Webinar	Integrated livestock with byproducts and supplementation.	Systems	
Webinar	Funding for cow-calf work. It's difficult to do cow-calf as opposed to stocker	Systems	

Source	Comment	Theme	CoDigital Rank
Webinar	Diversifying farms - dairy, beef, or small ruminant farm and putting small ruminants on cattle farms. Better forage utilization, diversify income, control weeds, to control internal parasites - how to do it from the economics to managing the forages to managing the animals themselves.	Systems	
Webinar	Invest money in production systems. Consider investing somewhat smaller amounts of money into a more diverse production system to help our clientele more completely.	Systems	
Webinar	Evaluation of integrated systems of forage production with other crop production systems and other land uses, including cover crops, summer annuals, live mulches or even short term crop rotations, and grazing.	Systems	
Webinar	Ecological and economic assessments of forage based livestock production systems - long term assessments	Systems	
Webinar	Developing systems to integrate forages with cow/calf operations	Systems	
CoDigital	Improved measurement of feed intake, nutritional requirements, nutrient use, and gaseous emissions from grazing cattle and small ruminants utilizing a new generation of technologies	Tools	5
CoDigital	Forage energy values are derived from equations based on past history. We need more accurate energy value equations for the newer sorghum forages, especially BMR varieties, so testing more accurately reflects true energy values.	Tools	17
Webinar	Water availability and quality	Water	
Webinar	Water efficiency	Water	

Reducing Environmental Impacts of Animal Production Stakeholder Comments

Source	Comment	Theme	CoDigital Rank
Webinar	Odor nuisance as an environmental impact associated with livestock facilities - prevents expansion and creates difficulty with local decision makers - solutions by siting or through mitigation of the odor	Air quality	
Webinar	Dust as an environmental issue in feedlot operations	Air quality	
CoDigital	Better bugs for waste breakdown. Develop microorganisms to produce other value added products and more methane. A great deal of the fibrous material coming through the digester could, in itself be broken down and methane produced.	Anaerobic Digestion	16
Webinar	Management of herd structure to reduce number of cow days of non-productivity and consequently reduce methane	Animal management	
Webinar	How disease and stress in animals effects the performance and environmental impact. Changes in emissions or nutrient output if the animal is compromised	Animal stress	
Webinar	Environmental impact of heat stress	Animal stress	
Webinar	A market place for carbon and traditional environmental pollutants	Cap and trade	
Webinar	Quantification protocols so that producers can take advantage of programs	Cap and trade	
CoDigital	In-depth, full chain comparison of the relative climate impacts of pasture-based production and confinement production systems.	Climate Change	23
Webinar	Education – we need people who are being trained in sustainable agriculture and particularly trained in animal production	Education	
CoDigital	Perform the genomic and feed/nutrient interaction studies on the rumen and its microbiome to determine how to enhance the efficiency of conversion in the rumen of feed to nutrients for the animal, and reduce methane.	Efficiency	1
Webinar	Improve the overall efficiency of nutrients used and reduce greenhouse gas emissions	Efficiency	
Webinar	Look at the genetics and the management of the animals to see what else we can do to improve the efficiency and reduce the potential pollution	Efficiency	

Source	Comment	Theme	CoDigital Rank
Webinar	Reduction of greenhouse emissions through improvements in efficiency	Efficiency	
Webinar	Management practices to increase individual cow productivity to reduce methane	Efficiency	
Webinar	Enhancing food quality and ingredient usage to improve feed efficiency to reduce methane	Efficiency	
Webinar	Methane emissions - rumen microbial genomics and ecology	Enteric methane	
Webinar	Refinement of methane measurement techniques	Enteric methane	
Webinar	Rumen function and modifiers to reduce methane	Enteric methane	
Webinar	Enteric methane emission	Enteric methane	
Webinar	As we compare different production facilities are there things we can do to mitigate what's there?	Facilities	
Webinar	Layers in a cage free system - air quality and the environmental impact inside that house	Facilities	
Webinar	New ventilation system design for cage-free layers	Facilities	
Webinar	Dairy feed production as a source of methane	Feed production	
Webinar	Dairy feed production - how the animal industry and the crop and the feed sectors work together	Feed production	
Webinar	Silage shrinkage and its contribution to environmental pollution	Feed production	
Webinar	Give more priority to extension efforts - educate people how to preserve animal and crop products to reduce waste	Food waste	
Webinar	Food waste and its impact on the environment	Food waste	
CoDigital	In extensive pasture systems in the western U.S., distribution of animals is important. Therefore, investment in the management and genetic programs to better fit animals to the environment and production systems is vital.	Genetics	12
CoDigital	Given the SW has been getting hotter and drier for decades perhaps the production of new animal species that are already more adapted to arid conditions should be considered. Eland, kudu, Barbary sheep, oryx, camels are a few or many possibilities.	Genetics	22
Webinar	Genetic influences in different species in terms on nutrient utilization	Genetics	
Webinar	Reducing environmental impact through genetic improvements	Genetics	

Source	Comment	Theme	CoDigital Rank
Webinar	Effect of genotype on reducing environmental impact	Genetics	
Webinar	Genetic improvement - select for improvement of efficiency or select for low emitting animals	Genetics	
Webinar	Genetic approaches to increase individual cow productivity to reduce methane	Genetics	
Webinar	Genetic selection of hens adapted to cage-free systems – hens adapted to a conventional cage system do not cope well in a cage free system – piling and high mortality	Genetics	
Webinar	How to estimate and reduce greenhouse gas production	Greenhouse gasses	
Webinar	Life cycle analysis – a lot of greenhouse gas production and water use, are associated with feed production – engage entire agricultural system	Life cycle analysis	
CoDigital	Effective and affordable manure storage, so that farmers of all sizes can manage manure applications to cropland with sound consideration of impacting weather events.	Manure management	8
CoDigital	Manure solid and nutrient separation technologies that capture more solids and nutrients from liquid manure, leading to better manure nutrient utilization, less odor and gas emissions, and lower water pollution potential.	Manure management	9
CoDigital	Elucidate proper management of riparian pastures in eastern humid US that limits access to streams, ponds, and lakes using rotational grazing schemes and watering systems to minimize direct contamination of surface waters by animal waste.	Manure management	11
CoDigital	Land applying manure has ruined soils in many areas primarily due to salt imbalances. Local application in some regions is no longer an option requires manure be transported long distances. Specific solutions to these problems are needed.	Manure management	17
CoDigital	Algae production from animal waste can be a highly effective way to utilize CO2 and sunlight while producing desirable nutrients/feedstuffs at the same time. Since harvest and processing of waste is an ongoing subject extension of idea has merit.	Manure management	18

Source	Comment	Theme	CoDigital Rank
CoDigital	Bacteria, particularly in storm water runoff, is a water quality standard problem. Identifying better fecal indicator bacteria (FIB) or surrogates is needed to enable water reclamation or reuse, thus reduce environmental impacts.	Manure management	19
Webinar	Climate change and how we can inform farmers regarding manure handling	Manure management	
Webinar	Manure management to reduce methane	Manure management	
Webinar	Manure management - alternative practices for manure handling and land application technologies	Manure management	
Webinar	Manure handling - land application	Manure management	
Webinar	Manure handling and land application	Manure management	
Webinar	Methane produced by agriculture – collect to be used for energy may offset need to modify the animals	Methane for energy	
Webinar	Biodigesters - have been shown to be effective, but in the US is the economics don't always work out. What can we do to encourage producers to be able to take advantage of the technology?	Methane for energy	
CoDigital	Better bugs for the rumen / evaluation of current efficient bug profiles. Microorganisms that will more completely break down feedstuffs, making more nutrients available to the animal without methane production.	Microbiome	13
Webinar	Modeling of efforts to quantitatively integrate knowledge	Modeling/Decision Support	
Webinar	Process-based modeling that can adapt to different climates	Modeling/Decision Support	
CoDigital	Develop research information to support ration formulation systems for livestock that predict both nutrient excretion and animal performance with more complete feed and animal measurements than have been available.	Modeling/Decision Support	4

Source	Comment	Theme	CoDigital Rank
CoDigital	The animal industry and food supply chain are leading efforts to define and measure "sustainability". USDA should support development and evaluation of livestock environmental performance indicators/metrics for informing sustainability discussions.	Modeling/Decision Support	5
CoDigital	Better environmental stress assessment models and mitigation for livestock that yield sustainable intensification +food, -impact	Modeling/Decision Support	7
CoDigital	Creating Simulation system with Stress response calculation and having ability to merge different stresses and finding losses. There could be Cost relation developed with mitigation process adopted. This should be software based and linked to experts	Modeling/Decision Support	15
Webinar	The relationship between manure and ammonia - technology that reduces ammonia emissions	Nitrogen emissions	
Webinar	Ammonia and reactive nitrogen	Nitrogen emissions	
CoDigital	More research is needed into the environmental and public health impacts of non-antimicrobial growth promoters, both from the presence of residues on food and their proliferation in the environment.	Non-antimicrobial growth promoters	24
CoDigital	Next generation of animal systems nutrient management strategies. Improved manure management is only partial solution. Strategies targeting nutrient recovery, feed management, and manure export should be options for public policy.	Nutrient Management	10
Webinar	Precision agriculture	Nutrient management	
Webinar	Technologies to help nutrient management	Nutrient management	
Webinar	Manure as a resource – not just waste - fractionate nutrients - new revenue streams from manure and greater ability to manage nutrients	Nutrient management	
Webinar	Put nutrients where the soil needs and not into the water body	Nutrient management	
Webinar	Nutrient management and nutrient recovery from manure	Nutrient management	
Webinar	Promote the use of manure as fertilizers in place of chemical fertilizers	Nutrient management	

Source	Comment	Theme	CoDigital Rank
Webinar	Crop growth concentrates nutrients from soil and subsequently moves those nutrients to animals. Since animals are concentrated, nutrients are also greatly concentrated. Not only do we need to increase use efficiency but we need to find ways to recover in more transportable forms than currently employed.	Nutrient management	
CoDigital	Supplement pastured livestock with concentrates or partial total mixed rations to better balance energy and protein in their diets to keep excretion of excess nitrogen to lowest level possible.	Nutrition	21
Webinar	Solutions that reduces environmental impact without actually compromising productivity or even improving productivity	Productivity	
CoDigital	Develop and evaluate integration of feeding systems with genetic feed efficiency of ruminant animals and their microbiome to minimize methane and nutrient loading of the environment.	Systems	2
CoDigital	Encourage optimization of the food, energy and water systems (FEWS) nexus beyond processing towards the broader continuum of plant and livestock-based agriculture - increase existing farmland food production while minimizing environmental impacts.	Systems	3
CoDigital	Intensification of pastures systems in cow-calf systems are needed. Reduction of GHG emissions is needed and mitigation through management is needed.	Systems	14
CoDigital	Growing large numbers of animals in small areas is a key source of pollution. Growing fewer animals in less confined conditions would help. Encouraging small scale production/processing would localize and limit impact of large production facilities.	Systems	20
Webinar	The flow of nutrients and other potential pollutants from production systems - from the animal, from the facilities - how do we minimize that flow of potential pollutants from the system.	Systems	
Webinar	Air, water and soil quality are all related to the manure management discussion we make and needs to be addressed from a systems perspective	Systems	

Source	Comment	Theme	CoDigital Rank
Webinar	Systems and a systems approach to increase efficiency of use of resources and reduce environmental impact	Systems	
Webinar	Nutrient use efficiency and environmental impact - need to integrate research that addresses all phases of production	Systems	
CoDigital	We need to be able to reliably measure the impact of an animal on the environment, e.g. how much methane is produce by a cow on pasture in different environmental conditions (lush grass vs. New Mexico).	Tools	6
Webinar	Water - the largest part of the water use in animal production is in growth of crops	Water	
Webinar	The most efficient utilization of water and water reuse in the dairy enterprise	Water	
Webinar	Funding priority should be given to water reuse. It is going to be the biggest problem facing us	Water	

