2021 IMPACT REPORT

International Consortium for Antimicrobial Stewardship in Agriculture

ICASA

A FFAR COLLABORATIVE

ICASA Vision Statement

The appropriate and judicious use of antibiotics in animal agriculture to advance both animal and human health and wellness, enhance pre-harvest food safety, preserve available treatment options for the future and promote trust and transparency in food production practices.

Letter from Tim Kurt, Scientific Program Director

Dear ICASA Participants,

The International Consortium for Antimicrobial Stewardship in Agriculture continues to grow! In 2021, we welcomed three new organizations as Associate Participants, created a new Beef Stewardship Working Group and completed three competitive calls for proposals that produced nine new projects approved for funding.

With the addition of Cargill, Yum! Brands and Zoetis as Associate Participants, the ICASA program continues to gain subject-matter expertise from across the animal protein value chain. The knowledge and expertise shared amongst all Participants is at the core of ICASA's success and is critical to accelerating outcomes in antimicrobial stewardship and animal health. Since the program's launch in 2019, ICASA has become a forum for discussing animal health and welfare, and a catalyst for research and development of potential solutions to animal health challenges.

By adding the Beef Stewardship Working Group, ICASA expanded to become more inclusive of restaurant and food company perspectives. The objectives of this Working Group are to support high-level research on antimicrobial use and explore opportunities for improvement. One of the first projects approved by the Working Group focuses on antibiotic-use data interoperability in the beef industry. The collection, reporting and interpretation of antibiotic-use data is a significant issue that affects the way that external stakeholders view treatment decisions and antimicrobial stewardship more broadly. It is important that research on antibiotic-use reporting is well-designed, accurate and transparent, and the thought-leadership provided by researchers and industry representatives in the ICASA program continues to steer our collective movement in the right direction.

In addition, we held an open call for research that will contribute to our understanding of basic liver abscess etiology and the development of new models for liver abscesses in beef cattle. Liver abscesses are a major driver of antimicrobial use, yet the development of effective interventions depends on support for basic science and the availability of reproducible models.

Separately, we completed a call for research projects on *Mycoplasma hyosynoviae*, a pathogen associated with lameness in finishing pigs that often necessitates mass treatment of animals. Understanding the factors contributing to lameness in pigs and improving protocols for vaccination against this pathogen hold promise for addressing the underlying issue driving antimicrobial use while improving pig health and welfare.

In total, the ICASA program has now approved over 20 projects with a total value of over $10 million in research. Each project has an average of three or more contributing organizations, not including FFAR, so that each ICASA Participant's contributions are leveraged approximately **6-to-8 fold per project**. This model speaks to the impressive value of the collaborative framework.

I am extremely pleased with the milestones ICASA has achieved in 2021. These achievements were only possible through the support of all Participants and I am deeply thankful for your continued collaboration. As we look forward to 2022, we continue to learn from the projects underway, strengthen the collaborative framework and form lasting partnerships that will help create solutions to tomorrow's challenges.

Sincerely,

Timothy Kurt, D.V.M., Ph.D.
Scientific Program Director
Foundation for Food & Agriculture Research

CONTENTS

EXECUTIVE COMMITTEE REPRESENTATIVES

Hugh Aljoe
Noble Research Institute

Ben Holland
Cactus Feeders

Miles Theurer
Veterinary Research and Consulting Services (VRCS)

Banks Baker
McDonalds Corporation

Tom Jones
Hy-Plains Feedyard

Ryon Walker
Noble Research Institute

Jessica Clowser Burkham
Beef Alliance

Joel Nerem
Pipestone Veterinary Services

Jennifer Williams
Tyson Foods

Matthew Cleveland
Genus ABS

Kathy Simmons
National Cattlemen's Beef Association

Alyssa Word
Cactus Feeders

Joy Parr Drach
Advanced Animal Diagnostics

Mary Soukup
Beef Alliance

Ashley McDonald
U.C. Roundtable for Sustainable Beef
(rotating ex-officio Participant)

Heather Fowler
National Pork Board

Derek Vote
JBS USA

Tim Kurt
Foundation for Food & Agriculture Research

Not pictured: Samantha Conrad, Tyson Foods

ICASA has provided a valuable platform for Zoetis to share our animal health expertise and research to support responsible antibiotic use. Through the working groups, we are privileged to contribute to key discussions, identify research needs and support the actions and outcomes. We are proud to collaborate with organizations that are committed—as Zoetis is—to advancing antibiotic stewardship while prioritizing the health and welfare of livestock.

Dr. Christi Calhoun, Food Chain Relations, Zoetis

Yum! Brands appreciates the work of ICASA in bringing together all stages of the US livestock supply chain to improve animal health and the responsible use of antibiotics. Collaborative partnerships, like ICASA, are critical to promoting research, dialogue and progress in antimicrobial stewardship.

Jon Hixson, Chief Sustainability Officer, VP Global Gov Affairs, Yum! Brands

Executive Summary

Prioritizing collaboration and stakeholder engagement, the International Consortium for Antimicrobial Stewardship in Agriculture (ICASA) welcomed three Associate Participants in 2021: **Cargill, Yum! Brands and Zoetis**. The addition of these key players adds invaluable food and animal health perspectives to ICASA research, ultimately benefiting both industry and academic partners. Sharing knowledge across the protein value chain and building consensus on research priorities is one of the intangible benefits of ICASA's public-private partnership model.

Another benefit of ICASA is the return on investment for both the public and private sectors. In grants made through the ICASA program, every FFAR dollar has been matched 1:1 — doubling the public investment in antimicrobial stewardship research.

As a result of the commitment exhibited by the ICASA Participants, in 2021 the Consortium approved funding for **12 research projects** across six Working Groups for a total investment of **$4,478,352** in research. The Swine Health Working Group approved three proposals that sought novel and potentially high-impact projects related to *Mycoplasma hyosynoviae* associated lameness in finishing pigs. Through a separate open call, the Liver Abscess Working Group approved five projects for funding that sought novel and potentially high-impact projects related to liver abscesses in beef cattle. In addition, ICASA funded its first major genetics research project investigating feedlot heart disease — a collaboration supported by Genus ABS and other organizations. The project abstracts can be found in Appendix C.

WORKING GROUP (WG)	PROJECTS FUNDED	FFAR FUNDING	MATCHING CONTRIBUTIONS	TOTAL 2021 PROJECT VALUE
Technologies	1	$200,000	$200,022	$400,022
Metaphylaxis	1	$63,000	$70,805	$133,805
Liver Abscesses	5	$824,000	$823,999*	$1,647,999*
Swine Health	4	$596,783	$701,344	$1,271,127
Late Morbidity	1	$433,721	$564,678	$998,399
Total	**12**	**$2,117,504**	**$2,360,848**	**$4,478, 352**

**Pending final budgets per final grant award agreements*

A summary of all projects funded by the Working Groups can be found on page 16.

In addition to the funding milestones achieved, the ICASA program held four Executive Committee meetings and approximately 70 Working Group meetings in 2021. Meeting approximately once per month, Working Group members have the opportunity to discuss research topics and potential projects that advance the goals of the Working Group and receive updates on projects in progress. We have also hosted guest presentations from several researchers and external organizations, expanding our reach and efforts across the industry.

In summary, ICASA celebrates another successful year! We are excited to support innovative research to promote the appropriate use and stewardship of antimicrobials and we look forward to advancing scientific research within animal agriculture.

Project Impacts

2020 TECHNOLOGIES WORKING GROUP OPEN CALL KEY PROJECT FINDINGS

FIELD-DEPLOYABLE BIOSENSORS FOR ANTIBIOTIC STEWARDSHIP

Institution: Purdue University

PI: Dr. Mohit Verma

Funding Partners: Cactus Feeders, Five Rivers Cattle, Tyson Foods, McDonald's, Purdue University

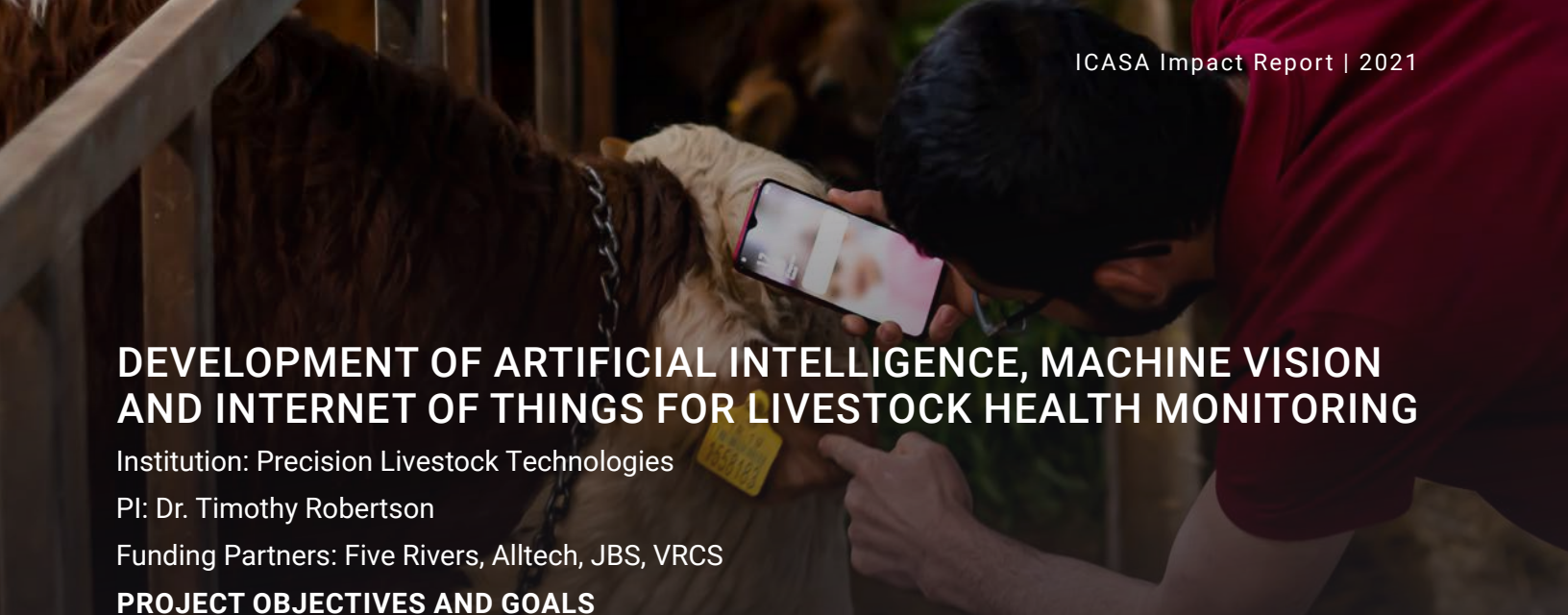
PROJECT OBJECTIVES AND GOALS

Demonstrate multiplexed detection of genes on paper-based devices. Collect 100 nasal swabs (50 healthy, 50 BRD animals) from each of Cactus Feeders and Five Rivers Cattle. Collect 100 isolates of *Pasteurella multocida* and the corresponding antibiogram data.

KEY PROJECT RESULTS

To date, the project team has demonstrated that they can detect four different targets on paper-based biosensors. They used already developed primer sets to show a color change on paper using a water bath setup. They will now use new primer sets for antibiotic resistance genes and test them in liquid and paper-based assays. They have collected almost 190 samples from ICASA participants and are in the process of analyzing them. They have collected 89 isolates of *P. multocida* and sequenced them. They are in the process of assembling the genomes and analyzing them for identifying concordant antibiotic resistant genes.

Provided by Dr. Mohit Verma



DEVELOPMENT OF ARTIFICIAL INTELLIGENCE, MACHINE VISION AND INTERNET OF THINGS FOR LIVESTOCK HEALTH MONITORING

Institution: Precision Livestock Technologies

PI: Dr. Timothy Robertson

Funding Partners: Five Rivers, Alltech, JBS, VRCS

PROJECT OBJECTIVES AND GOALS

The primary goal for 2021 was to complete Phase I of their program by training algorithms to detect visual signs of illness. This is to be accomplished by comparing images and medical records between cattle in the hospital pen at a large feedlot. Images of sick cattle from the hospital pen are identified and then labeled by experienced veterinary students. Next, these labeled/coded images are used to train algorithms to detect visual cues indicating if an animal is healthy or ill.

Another primary goal for this period is to compare feeding behavior between high and low risk cohorts of cattle to identify signs of unhealthy binge feeding and determine if differences in feeding patterns can be used as an indicator of pen health. We aim to do this by identifying key metrics such as feeding aggression, feeding time and feed level that can be used as indicative signals.

KEY PROJECT RESULTS

More than 20 cameras were installed at the Five Rivers Cattle Company feedlot in Kuner, CO. The cameras have operated well and reliably transmitted millions of images to the cloud for storage and analysis.

The project team's first cohorts of high and low risk cattle were processed and placed in late June. They are scheduled for reimplantation at the end of November, and we expect closeout on the cohorts in the first quarter of 2022.

Thousands of images of individual calves have been labeled by trained veterinary students. Labeling has entailed identifying key features related to nose, eyes, mouth, posture, head position, lying position, rumen and others commonly used to determine health status. Students also make an overall assessment of the health of the animal (i.e., healthy or not). A semi-automated pipeline has been established to: 1) identify images; 2) crop individual animals and 3) label images. The labeled images form the basis for artificial intelligence algorithms that identify features, characterize them and then combine those automated observations to derive a prediction of health status.

They have also developed an algorithm that estimates the weight of a calf based on a picture taken near the feedbunk. The algorithm works well over about 1,000 lbs and seems to be accurate to within five percent. We are continuing to refine this algorithm by adding training data from images taken when the cohorts were weighed on intake.

They have developed an extensive feeding dashboard, measuring characteristics like number of animals feeding, aggression around the bunk, bunk fill and empty times and night slick times. The information is presented in an integrated dashboard for easy evaluation by feedlot personnel.

They have also developed algorithms to characterize general levels and types of activities such as sitting, lying, drinking or eating. We can track the duration that animals remain in these "states" and will compare this data with overall pen health records to gauge its ability to predict pen health.

Provided by Dr. Timothy Robertson

Project Impacts

2020 LIVER ABSCESS KEY PROJECT FINDINGS

EVALUATION OF DIETARY TYLOSIN INTAKE ON INCIDENCE AND SEVERITY OF LIVER ABSCESSES IN FEEDLOT CATTLE (IMPACT OF 60 VS. 90 MG/HD/D TYLOSIN)

Institution: Beef Alliance

PI: Dr. Todd Milton

Funding Partners: Beef Alliance, Cactus Feeders

PROJECT OBJECTIVES AND GOALS

Goals for the fourth quarter include collecting all final liver abscess data from personnel at the Beef Carcass Research Center, West Texas A&M University, as well as all final performance data and carcass characteristics from the participating feedyards. Upon collection of all final information, analysis will begin.

KEY PROJECT RESULTS

The final cattle for this trial were harvested late in the 3rd quarter, bringing the total number of cattle in the trial to 12,520 across six cattle feedyard locations. During the 4th quarter, we are waiting to receive all final data and information from the liver collection process and performance and carcass data from each feedyard. Analysis will include information from all six locations.

Provided by Dr. Todd Milton

Research Grants Awarded in 2021

Project Title	Funding Mechanism	Institution	Principal Investigator	Project Timeline	Co-funders	FFAR Funding	Matching Contributions	Total Value
Technologies & Beef Stewardship Working Groups								
Feedyard abx use data standardization and inter-operability	Direct Solicitation	Kansas State University	Apley, M	Jan 1, 2022 - Dec 31, 2024	Cargill; Tyson; Yum! Brands; Kansas State University	$200,000	$200,022.22	$400,022.22
Swine Health Working Group								
Developing a model protocol for tracking antibiotic use and AMR surveillance for the swine industry [Renewal]	Direct Solicitation	Pipestone Veterinary Services	Dee, S	Jul 1, 2021 - Jun 30, 2022	Pipestone Veterinary Services; National Pork Board; USDA-APHIS	$179,330	$179,330	$358,660
Improving the efficacy of vaccination against *Mycoplasma hyosynoviae* by identifying optimal application times	RFA	University of Minnesota	Pieters, M	Jan 1, 2022 - Dec 30, 2023	Pipestone Veterinary Services; Tyson	$149,747.78	$209,871.11	$359,618.89
Fecal microbiota transplant for post-weaning diarrhea and antibiotic use	RFA	Purdue University	Johnson, T	Jan 3, 2022 - Dec 31, 2023	Elanco; Purdue University	$140,002.22	$171,352.89	$311,355.11
Risk Factors for Lameness in Finishing Pigs	RFA	University of Pennsylvania School	Pierdon, M	Jan 1, 2022 - Dec 31, 2023	Genus PIC; Pipestone Veterinary Services; Tyson	$127,702.84	$140,789.68	$268,492.52
Metaphylaxis Working Group								
Acoustic Monitoring to Support Mass Treatment Decisions	Direct Solicitation	Ergense, Inc	Darbonne, T	Jan 1, 2022 - Jan 1, 2023	Cactus Research; Veterinary Research and Consulting Services (VRCS); Hy-Plains Feedyard; Five Rivers; True Ranches; McDonalds	$63,000	$70,805.44	$133,805.44

Project Title	Funding Mechanism	Institution	Principal Investigator	Project Timeline	Co-funders	FFAR Funding	Matching Contributions	Total Value
Late Morbidity Working Group								
Development of metrics to identify cattle predisposed to feedlot heart disease	Direct Solicitation	Colorado State University	Speidel, S	Aug 1, 2021 - Jul 31, 2022	ABS Global; Cactus Research; Hy-Plains Feedyard; Veterinary Research and Consulting Services (VRCS)	$433,720.64	$564,677.78	$998,398.42
Liver Abscess Working Group*								
Liver abscesses in feedlot cattle: Further delineation of the etiology and pathogenesis	RFA	Kansas State University	Amachawa-di, R	Sep 1, 2021 - Aug 31, 2023	Kansas State University; Trouw Nutrition Corp.; Micronutrients Corp.	$125,000	$125,000	$250,000
Development of a non-invasive model to induce liver abscess formation in cattle	RFA	USDA-ARS	Broadway, R	Sep 1, 2021 - Aug 31, 2023	USDA-ARS; Kansas State University; West Texas A&M University	$86,000	$86,000	$172,000
Novel Strategies to Improve the Understanding of Liver Abscess Formation in Beef Cattle	RFA	Texas Tech University	Hales, K	Sep 1, 2021 - Aug 31, 2024	Texas Tech University	$125,001.11	$124,998.89	$250,000
Pathogen-host interaction during the development of liver abscesses; local and systemic immune and metabolic responses during Fusobacterium necrophorum challenges	RFA	Texas Tech University	Machado, V	Sep 1, 2021 - Aug 31, 2023	Texas Tech University	$98,000	$98,000	$196,000
Defining the contribution of acidosis to the liver abscess complex using novel challenge model to delineate impacts of diet composition and feeding management on liver abscess pathogenesis	RFA	West Texas A&M University	Samuelson, K	Jan 1, 2022 - Jan 9, 2024	Est Texas A&M University; Cactus Feeder; Tyson Foods	$390,000	$390,000	$780,000

**Pending final budgets per final grant agreements*

Previously Awarded Research Grants

Project Title	Funding Mechanism	Institution	Principal Investigator	Project Timeline	Co-funders	FFAR Funding	Matching Contributions	Total Value
Liver Abscess Working Group								
Evaluation of Dietary Tylosin Intake on Incidence and Severity of Liver Abscesses in Feedlot Cattle	Direct Solicitation	Beef Alliance	Milton, T	Jul 1, 2020 - Jun 30, 2023	Beef Alliance; Cactus Research	$342,000	$342,000	$684,000
Swine Health Working Group								
Developing a model protocol for tracking antibiotic use and AMR surveillance for the swine industry	Direct Solicitation	Pipestone Research, LLC	Dee, S	Jan 1, 2020 - Dec 31, 2020	Pipestone Veterinary Services; National Pork Board	$313,839.40	$313,840	$627,679.40
Late Morbidity Working Group								
Identifying Potential Causes of Late-Day Bovine Respiratory Disease in High-Performing Feedyard Cattle	Direct Solicitation	Noble Research Institute, LLC	Johnson, M	Dec 1, 2018 - Oct 1, 2020	Noble Research Institute; Hy-Plains Research & Education Center; Veterinary Research and Consulting Services (VRCS)	$186,643.83	$186,644	$373,287.33
Determining risk factors for mid- and late-day bovine respiratory disease morbidity and mortality	Direct Solicitation	Kansas State University	White, B	Sep 1, 2020 - Sep 1, 2023	VRCS; Five Rivers Feedyard; Hy-Plains Research & Education Center	$171,662.51	$176,444.44	$348,106.95
Technologies Working Group								
A rapid chute-side antibiotic resistance detection tool to improve antimicrobial stewardship and optimize risk management while controlling bovine respiratory disease	RFA	College of Veterinary Medicine and Biomedical Sciences, Texas A&M University	Scott, HM	Sep 1, 2020 - Aug 31, 2023	Five Rivers; Cactus Research; NG Biotech; Texas A&M University	$250,000	$272,833.33	$522,833.33
Development of Artificial Intelligence, Machine Vision and Internet of Things for Livestock Health Monitoring	RFA	Precision Livestock Technologies	Roberston, T	Jun 1, 2020 - Dec 1, 2021	Five Rivers; JBS; VRCS; Bennett Data Science; Alltech; Iowa State University	$247,470	$379,275	$626,745

Project Title	Funding Mechanism	Institution	Principal Investigator	Project Timeline	Co-funders	FFAR Funding	Matching Contributions	Total Value
Technologies Working Group cont'd								
Field-deployable biosensors for antibiotic stewardship	RFA	Purdue University	Verma, M	Jan 1, 2021 - Dec 31, 2022	Cactus Research; Five Rivers; Tyson Foods; McDonald's, Purdue University	$250,000	$250,000	$500,000
The real-time pen-side detection of Bovine respiratory disease (BRD) complex by high-speed volatiles mass spectrometry and machine learning	RFA	USDA-ARS	Rivers, A	Aug 1, 2020 - Aug 1, 2022	VRCS; McDonald's, Trace VOC	$151,082.09	$151,082	$302,164.09
Metaphylaxis Working Group								
Predictive model development to promote science-based, strategic metaphylaxis administration in beef operations	RFA	Kansas State University	White, B	Jan 1, 2021 - Dec 31, 2023	VRCS; Hy-Plains Research & Education Center; Innovative Livestock Systems; Five Rivers	$191,798.78	$191,916.67	$391.715.45
Development of a science-based management strategy to reduce the use of antimicrobials in high-risk beef cattle	RFA	Texas Tech University	Hales, K	Sep 1, 2020 - Aug 31, 2021	VRCS; Hy-Plains Research & Education Center; Texas Tech University	$200,000	$200,000	$400,000

On the Horizon

Technologies Working Group

In 2021 the Working Group had several discussions to explore collection and analysis of data not commonly utilized by the livestock industry (i.e. non-production related data). Given that other ICASA Working Groups are pursuing technology-related projects, the Technology Working Group monthly meetings have been paused, with the option to restart in the future.

Liver Abscess Working Group

The Working Group is investigating technologies that could automate the collection of liver abscess scores in packing plants and considering supporting additional research on abscess etiology, pathogenesis and models.

Metaphylaxis Working Group

The Working Group is exploring the identification and management of cattle considered "medium" risk for developing bovine respiratory disease, as these animals present the greatest opportunity for further optimization of metaphylaxis.

Late Morbidity Working Group

The Working Group is discussing acute interstitial pneumonia (AIP) with a small group of external researchers and will likely invite a full proposal on this topic in 2022.

Swine Health Working Group

The Working Group is exploring research on *Streptococcus suis* in collaboration with international researchers, in addition to continuing support for antimicrobial resistance monitoring and microbiome research.

Beef Stewardship Working Group

The Working Group is exploring opportunities to enhance the judicious use of medically-important antimicrobials in the beef sector. One potential topic for an upcoming call for proposals would be epidemiological research to better understand variations in liver abscess incidence between regions/operations/groups within an operation.

> Cargill is proud to be a member of ICASA. This work is very challenging, and the staff and members of ICASA are not shrinking from the challenge of balancing the judicious use of antibiotics with positive animal health and welfare outcomes, while continuing to understand and limit the potential of antimicrobial resistance.
>
> **Dr. Scott J. Eilert, Customer Technical Lead, Cargill Protein North Americas**

SNAPSHOT: PROJECTS FUNDED PER WORKING GROUP

YEAR	PRINCIPAL INVESTIGATOR	FFAR FUNDING	CO-FUNDING	TOTAL PROJECT FUNDING
Technologies Working Group				
2020	Scott, HM	$250,000.00	$272,833.33	$522,833.33
2020	Robertson, T	$247,470.00	$379,275.00	$626,745.00
2020	Verma, M	$250,000.00	$250,000.00	$500,000.00
2020	Rivers, A	$151,082.09	$151,082.00	$302,164.09
2021	Apley, M *co-funded via Beef Stewardship Working Group*	$200,000.00	$200,022.22	$400,022.22
Total		**$1,113,806.00**	**$1,122,880.22**	**$2,236,686.22**
Liver Abscess Working Group				
2020	Milton, T	$342,000.00	$342,000.00	$684,000.00
2021	Amachawadi, R	$125,000.00	$125,000.00	$250,000.00
2021	Broadway, R	$86,000.00	$86,000.00	$172,000.00
2021	Hales, K	$125,001.00	$124,998.89	$250,000.00
2021	Machado, V	$98,000.00	$98,000.00	$196,000.00
2021	Samuelson, K	$390,000.00	$390,000.00	$780,000.00
Total		**$1,166,000.00**	**$165,998.89**	**$2,331,998.89**
Swine Health Working Group				
2020	Dee, S	$313,839.00	$313,840.00	$627,679.40
2021	Dee, S	$179,330.00	$179,330.00	$400,022.22
2021	Pieters, M	$149,747.78	$209,871.11	$359,618.89
2021	Johnson, T	$140,002.22	$171,352.89	$311,355.11
2021	Samuelson, K	$390,000.00	$390,000.00	$780,000.00
Total		**$910,622.22**	**$1,015,183.68**	**$1,925,805.90**
Metaphylaxis Working Group				
2020	White, B	$191,798.78	$199,916.97	$391,715.45
2020	Hales, K	$200,000.00	$200,000.00	$400,000.00
2021	Darbonne, T	$63,000.00	$70,805.44	$133,805.44
Total		**$454,800.00**	**$654,405.44**	**$1,301,005.44**
Late Morbidity Working Group				
2019	Johnson, M	$186,644.83	$186,644.00	$373,287.83
2020	White, B	$171,662.51	$176,444.44	$348,106.95
2021	Speidel, S	$433,720.64	$564,677.78	$998,398.42
Total		**$792,026.98**	**$924,432.78**	**$1,716,459.76**
WORKING GROUP TOTAL		**$4,437,255.20**	**$4,882,901.01**	**$9,511,956.21**

Appendix A Funding Eligibility & Mechanism

ICASA enables participants to drive significant advances that benefit both the public and private sectors, with $7.5M funding and administrative support from FFAR. For a Project to be eligible for funding, ICASA Participants must contribute cash or in-kind contributions and the project must be approved by the Working Group and Executive Committee. The Participant-driven structure enables a wide-variety of Projects that may be broad in scope, or specific to particular species or environments. ICASA supports critical research across the following topic areas:

1. Cross-cutting Technologies
2. Metaphylaxis
3. Liver Abscesses in Beef Cattle
4. Late Morbidity in Beef Cattle
5. Swine Health
6. Beef Stewardship.

While deliverables will vary by Project, it is anticipated that all Projects will have practical outcomes that inform and help optimize the use of antimicrobials. With recent advances in precision agriculture, genomic sequencing, metagenomics and other fields, the consortium has been formed at a time when the combined efforts of multiple Participants can accelerate discoveries in ways not possible in the past.

> ICASA has been impactful to Veterinary Research and Consulting Services by allowing us to become connected to organizations and technologies. The ability to have influence on the study design and execution of these projects from the beginning phases should result in more rapid adoption in the field.
>
> **Dr. Miles Theurer, Veterinary Research and Consulting Services**

Appendix B Working Group & Objectives

TECHNOLOGIES WORKING GROUP OBJECTIVES

Technologies

1. Identify and support technologies that improve animal health and the antimicrobial stewardship of animals.

Mid-day Morbidity and Late-day Mortality in Beef Cattle

1. Qualify and quantify the mid-day morbidity and late-day mortality, characterize the topic and define it so there is common understanding of the terms.
2. Identify possible explanations or causes of mid-day morbidity and late-day mortality as well as possible associated factors.

Metaphylaxis

1. Solicit and support research focused on the use of metaphylaxis treatment practices in cattle and swine in order to enhance antimicrobial stewardship in food producing animals.

Liver Abscesses in Beef Cattle

1. Identify a method or methods that allow for the management of liver abscesses in finishing cattle reducing or omitting the use of shared-class antibiotics while resulting in no detrimental effects to live animal performance, animal welfare or carcass quality.

Swine Health

1. Surveillance and characterization of antimicrobial resistance at the farm level;
2. Investigation into epidemiology and control of bacterial pathogens of swine. Specifically:
   - *Streptococcus suis*
   - *Haemophilus parasuis*
   - *Actinobacillus suis*
3. Projects to improve swine gut health specifically focusing on the following:
   - Neonatal diarrhea
   - Post-weaning diarrhea
4. Generate a better understanding of the swine microbiome for improved pig health and performance

Beef Stewardship

1. Identify and assess antibiotic use standards and protocols, including shared approaches and differences, that would inform organizations involved in processing, retail and food services.
2. Support research on antimicrobial stewardship in the beef industry, including the terms currently used to describe use and the rationales for treatment.
3. Support research on the potential impact of alternatives to antibiotics for the treatment and prevention of different conditions, including the efficacy of various alternatives/best management practices.

Appendix C: Proposal Abstract Summaries

(PLEASE CONTACT FFAR TO REQUEST ANY FULL PROPOSALS)

Technologies & Beef Stewardship Working Groups

Michael Apley, Antimicrobial Use Monitoring and Benchmarking in U.S. Feedyards

Antimicrobial stewardship includes evaluation of use by individual stakeholders in relation to their peers as well as the more general summary reporting of antibiotic use in the interest of transparency. This reporting is only helpful if the reported metrics are standardized and based on high quality data, and data reporting and the resulting feedback is available to all stakeholders.

Currently, there are major challenges in the ability to efficiently capture and analyze antibiotic use data from multiple beef feedlots across a wide variety of record systems. This proposal seeks to use a model data capture, analysis and reporting system to support discussion of characteristics of data structures which support efficient data analysis, followed by the optimal reporting metrics to convey the results of this analysis to both beef feedlots (benchmarks) and to the customers of beef processors (transparency).

To facilitate industry-wide participation in the discussion of standards for data quality, data structure and antibiotic use reporting metrics, a symposium will be held with brings together a wide array of expertise and experience. The results of these deliberations will be reported to the industry and begin the establishment of standards so that all beef feedlots, software developers and providers, beef processors and beef product providers will have clear targets on which to base their efforts.

Swine Health Working Group

Scott Dee, Developing a model protocol for tracking antibiotic use and AMR surveillance for the swine industry [Renewal]

Antibiotic use in livestock is often incriminated to be the source of antimicrobial resistance (AMR) in humans, despite a lack of data to support the hypothesis. As of this writing, there has been no attempt to conduct AMR surveillance across a large-scale swine production system and compare it in real time with its respective on-farm antibiotic use. We are proposing to develop a model protocol for application across the US swine industry in order to address these issues. We plan to collect accurate data and draw scientifically valid conclusions in regards to the relationship between use and resistance in swine farms.

Meghann Pierdon, Risk Factors for Lameness in Finishing Pigs

Lameness in growing swine is an important cause of illness, antibiotic therapy and mortality in growing swine. However, little is known about the prevalence of lameness at different stages of growth and which factors increase or decrease risk for lameness in growing pigs. This study seeks to determine the incidence of lameness at different ages, investigate farm level risk factors for lameness in growing swine and to examine treatment records to determine the frequency with which antimicrobials are used to treat lameness.

Maria Pieters, Improving the efficacy of vaccination against *Mycoplasma hyosynoviae* by identifying optimal application times

Control of *Mycoplasma hyosynoviae* disease should also take into account the use of effective preventive strategies in order to decrease the use of antimicrobials. Nevertheless, information on the efficacy of vaccines against *M. hyosynoviae* infections is scarce in the literature. Moreover, times for vaccine application are left as a guess to swine practitioners. Therefore, the overall objective of this study is to identify the optimal time for vaccine application against *M. hyosynoviae* that will result in significant prevention of lameness development in grow-finish pigs and replacement gilts. A decrease in clinical lameness in growing-finishing pigs will be translated into reduced use of antimicrobial compounds for disease control.

Timothy Johnson, Fecal microbiota transplant for post-weaning diarrhea and antibiotic use

Post-weaning diarrhea is perhaps the most important health challenge for swine. There is a major turnover in the intestinal microbial community due to diet change, stress and change in environment. This dysbiosis in the gut microbiome leads to susceptibility to colonization by environmental bacteria; unfortunately, these bacterial invaders are often pathogens that cause diarrhea. To gain control

during this important phase in animal growth, we propose fecal microbiota transplant at the time of weaning to reduce post weaning diarrhea and to prevent colonization by intestinal pathogens. Fecal microbiota transplant is the process of taking the complex bacterial community from one animal and administering it to the digestive tract of another animal, typically by oral gavage. An important barrier to studying and implementing fecal microbiota transplants in production settings is the mode of administering the transplant, as oral gavage requires training and is labor intensive. We propose to use rectal gavage and feed amendment with freeze-dried fecal microbiota as two less labor-intensive methods to administer fecal transplants. We will also monitor various animal health and gut health endpoints to determine the efficacy of the modes of delivery of fecal transplant and the prevention of diarrhea.

Metaphylaxis Working Group

Tom Darbonne, Acoustic Monitoring to support Mass Treatment Decisions

One of the most critical decisions made for every cattle truck arriving at the feedlot is whether to mass treat the lot with antibiotics. This decision has ramifications for acquired antibiotic resistance in humans – with the obvious goal that treating the minimal number of cattle will translate to fewer people acquiring antibiotic resistance. The standard procedure is to place each lot of cattle into a receiving pen for at least 24 hours to let them settle, and then to make a decision about whether the entire pen should receive a metaphylactic course of antibiotics. This mass treat decision is made on multiple factors including transportation, shrink, body weight, visual appraisal of body condition and sounds from the receiving pen. The decision can be very subjective.

There is an opportunity for audio to help tease out more information on the condition of the incoming lot by listening to the animals, and then pulling out statistics based on machine learning which can influence the mass treatment decision. Acoustic signatures of specific animal vocalizations can be an important determinant for the automatic detection of disease or stress. Because the audio analytic process can continuously listen during night and day, it offers clues to the animal's condition when they are not guarding their physical condition. This body of evidence can be made available before the mass treat decision is made.

Late Morbidity Working Group

Scott Speidel, Development of Metrics to Identify Cattle Predisposed to Feedlot Heart Failure

Beef cattle have been selected over time for increased production levels (growth and fatness) to meet consumer demand. These changes have corresponded to increases in individual animal morbidity and mortality stemming from increased pulmonary hypertension. Incidence of congestive heart failure (CHF) in feedlot cattle has paralleled these increases in production levels. This CHF that occurs in feedlot cattle has been termed feedlot heart disease (FHD) and manifests itself in either subclinical performance losses or death due to heart failure. Additionally, feedlot cattle suffering from FHD tend to exhibit symptoms similar to respiratory illness which is traditionally treated with antibiotics. Animals experiencing FHD in the absence of any respiratory illness, however, would not respond to antimicrobial treatments resulting in the ineffective over-use of antibiotics.

Causes of FHD have not been characterized. The investigators hypothesize that both genetic and non-genetic factors influence FHD, and to make improvements in FHD an improved understanding of the disease is required.

Successful completion of the project will ultimately result in characterization of individuals susceptible to FHD that cattle feeders can use to identify problematic groups, selection tools that breeders can use to screen potential sires for FHD resistance and an assay that can be used to identify individuals of unknown origin to determine their risk of developing FHD.

Successful completion will give cattle producers tools to reduce the incidence of FHD through selection, and management, ultimately improving the sustainability of beef production through improved animal welfare, the reduction of disease incidence and reduced use of antibiotics.

Liver Abscess Working Group

Raghavendra Amachawadi, Liver abscesses in feedlot cattle: Further delineation of the etiology and pathogenesis

Liver abscesses in cattle fed high grain diets occur because of entry, via portal vein, growth and establishment of pyogenic bacteria into the liver. The origin of the pathogens is believed to be the rumen and their entry into the portal circulation is facilitated by ruminal wall compromised by chronic acidity. An aspect of the pathogenesis that has not been explored is whether the pathogens could originate from the hindgut. The hindgut mucous membrane is lined by a single layer of epithelial cells, hence, likely more vulnerable to bacterial translocation compared to the stratified ruminal epithelium. *Fusobacterium necrophorum* and *Trueperella pyogenes* are the primary and secondary etiologic agents, respectively. Additionally, a number of other bacterial species are frequently isolated. In our experience, four bacterial species, *Salmonella enterica*, *Escherichia coli*, *Klebsiella pneumoniae* and *Pseudomonas aeruginosa*, are isolated more frequently than others. A study that selectively targets isolation of these bacterial species is needed to determine their prevalence and their potential involvement in abscess formation. An improved understanding of the etiology and the origin of the pathogens could likely lead to identification of novel targets and provide opportunities to develop interventions.

Paul [Rand] Broadway, Development of a non-invasive model to induce liver abscess formation in cattle

Liver abscesses are a chronic problem in the beef and dairy industries that has not improved over time. This condition results not only in the condemnation of livers at harvest facilities but also impacts animal productivity and overall animal well-being. Currently, there are limited tools available to combat liver abscesses. Therefore, the aims of this project are to better understand the genesis of liver abscesses, elucidate a causal link between acidosis and liver abscess formation, and ultimately develop a minimally invasive liver abscess model that can be utilized to evaluate intervention strategies in commercial production.

Kristen Hales, Novel Strategies to Improve the Understanding of Liver Abscess Formation in Beef Cattle

Liver abscesses are the primary reason for liver condemnation in cattle harvested in the U.S. Recently, there has been an upward trend in the prevalence of liver abscesses in beef steers. The pathogenesis of liver abscesses is alleged to be initiated by ruminal acidosis from feeding high-concentrate diets, which can lead to lesions in the rumen that predispose cattle to hepatic disease by the invasive, ruminally ubiquitous bacteria, *Fusobacterium necrophorum*. Tylosin phosphate is a macrolide antimicrobial continuously fed to feedlot cattle as a prophylactic antimicrobial, intended to reduce *F. necrophorum*, which is commonly isolated from liver abscesses and thought to be the primary causative agent. Our overall objective is to increase the understanding of the causes of liver abscesses and explore novel mitigation strategies. Our specific objectives are to: 1) develop an understanding of the gastrointestinal location, concentration and movement of *F. necrophorum* and *Salmonella enterica* and the gastrointestinal microbiome in cattle with liver abscesses; 2) demonstrate methodology to reduce *F. necrophorum* in the rumen, by using a direct-fed microbial, which may lead to a decrease in liver abscesses. Replacing the use of dietary antimicrobials with a novel direct-fed microbial would align with the ICASA working group goals.

Vinicius Machado, Pathogen-host interaction during the development of liver abscesses; local and systemic immune and metabolic responses during *Fusobacterium necrophorum* challenges

Liver abscess is one of the major disorders affecting feedlot cattle. It is a prevalent disease that causes major economic losses due to impaired performance, carcass value, and liver condemnation. Liver abscesses are caused primarily by *Fusobacterium necrophorum*. Control and prevention of liver abscess is highly dependent on the use of antimicrobial drugs, and more research is needed to develop new preventative strategies, alternative to antibiotics, that will effectively reduce the incidence of liver abscess in feedlot cattle. For that, we should further understand how the animal's immune system responds to the pathogen insult during the development of liver abscess. Hence, herein, we propose to evaluate how the animal's local and systemic immune response to different levels of *F. necrophorum* challenge. We will use a high throughput sequencing technology that will reveal a comprehensive picture regarding the gene expression of circulating immune cells and liver during the pathogenic insult. This will enable us to describe in detail potential pathways in which the pathogen subverts the host defenses during the development of liver abscess. This work will lay the foundation for the development of novel approaches, such as immunomodulators, which could potentially replace antimicrobials in liver abscess control and prevention strategies.

Kendall Samuelson, Defining the contribution of acidosis to the liver abscess complex using novel challenge model to delineate impacts of diet composition and feeding management on liver abscess pathogenesis

Current paradigm for liver abscess etiology indicates ruminal acidosis is a necessary precursor, but the relationship has not been extensively evaluated. Furthermore, the contribution of dietary starch concentration and/or feed intake pattern on ruminal acidosis and subsequent effects on liver abscess prevalence is poorly understood. We propose a novel challenge model to improve understanding and provide a benchmark for future liver abscessation research. A total of 720 steers will be assigned to treatments in a 2 × 2 factorial arrangement using a randomized complete block design. Treatment pens (n=12/treatment) will consist of control (A1) or a high starch/low roughage (A2) diet fed to cattle receiving either typical feeding management (B1) or an erratic feed management challenge (B2). Research outcomes will include cattle health, performance and carcass traits concomitant with continuous rumination, activity and ruminal pH. The rumen and liver of each animal will be assessed using our unique scoring systems to determine the relationship between ruminal acidosis, rumenitis and liver abscessation. Additionally, validation of a model to induce liver abscesses in feedlot cattle that can be applied in both research and commercial settings will improve future evaluation of management techniques, antibiotic alternatives and prevention strategies for liver abscesses.

Appendix D Working Group Members

Names in **bold** *indicate the 2021 Working Group Chair*

Scientific Program Director, Tim Kurt Scientific Program Associate, Nikki Dutta

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