Antimicrobial Use and Stewardship AUS

ANNUAL REPORT 2024

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https://www.cdfa.ca.gov/ahfss/AUS/

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California Department of Food and Agriculture - Antimicrobial Use and Stewardship
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Thank You

AUS would like to thank the **California Legislature** for the foresight to create our first-in-nation program and to protect the efficacy of antimicrobial drugs. Our progress and success is a direct outcome from the trust and support from our leaders, lawmakers, and stakeholders.

&

Thank you to

livestock producers and veterinarians

who participate in our studies voluntarily and assist with our monitoring and stewardship efforts that contribute to the success of our program.

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AUS
ANTIMICROBIAL USE AND STEWARDSHIP

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A REPORT & PROGRAM SCOPE

2024 Annual Report

The California Department of Food and Agriculture (CDFA) Antimicrobial Use and Stewardship (AUS) program reports annually on the program's priorities and accomplishments. This AUS 2024 Annual Report focuses on the 2023-2024 fiscal year (FY 23-24), spanning July 1, 2023 - June 30, 2024. This report continues the practice of informing legislators and stakeholders about the program's leadership in innovative approaches to antibiotic resistance and responsible antibiotic use associated with livestock in California.

The Antimicrobial Use & Stewardship Program

Since its inception in 2017, the AUS program has endeavored to support California stakeholders in its shared goal of preserving the efficacy of antibiotic drugs through a multi-faceted antibiotic stewardship and monitoring program to meet the mandates of California's law, Livestock: Use of Antimicrobial Drugs (Food and Agricultural Code [FAC] Sections 14400-14408). The AUS program consists of a team of veterinarians, epidemiologists, and specialists working collaboratively to support California's agricultural stakeholders.

AUS is proud to announce the publication of its first peer-reviewed journal articles, which describe the program's extensive work in livestock-specific antibiogram development to assist veterinarians to make targeted decisions in the use of various antibiotics for their clients. Antibiograms assess trends in antimicrobial resistance, to maximize treatment success and preserve the efficacy of currently available pharmaceuticals. Targeted use of antimicrobials is important to minimize the spread of antimicrobial resistance, and AUS is excited to offer these additional tools and guides to veterinarians.

While continuing its involvement in the national discussion surrounding antibiotics, AUS has also spent significant time working on the needs of California's rural communities that have veterinary shortages with its work on national programs such as the Veterinary Medical Loan Repayment Program (VMLRP) and the Veterinary Services Grant Program (VSGP). Through these important funding programs, agricultural communities can gain more access to veterinary care for food-producing animals. AUS has expanded its collaborations with international partners through its involvement with the Hubert H. Humphrey Fellowship program and hosted a veterinarian who specializes in livestock and agriculture from the Ministry of Agriculture in Chile. By engaging in shared experiences and discussions on public and animal health, along with food safety practices in California, a relationship was forged that will enable the ongoing exchange of best practices with international professionals in the field.

AUS staff actively supported USDA's National Animal Health Monitoring System (NAHMS) Sheep 2024 study this year by helping coordinate the outreach to California sheep producers for both the survey side of the study and biologic sampling. AUS continued to assist CDFA's ongoing efforts to respond to emerging threats to California livestock with staff dispatched to assist in mitigating the spread of highly pathogenic avian influenza.

The following sections in this report provide a description of the AUS program's work and accomplishments during FY 23-24, including select highlights from various projects.

B PROGRAM HIGHLIGHTS

Program Products

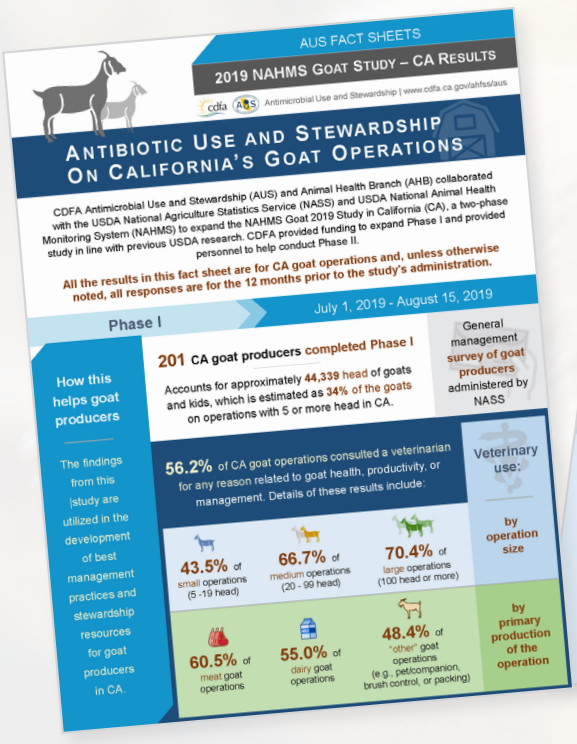
What materials and information have been produced?

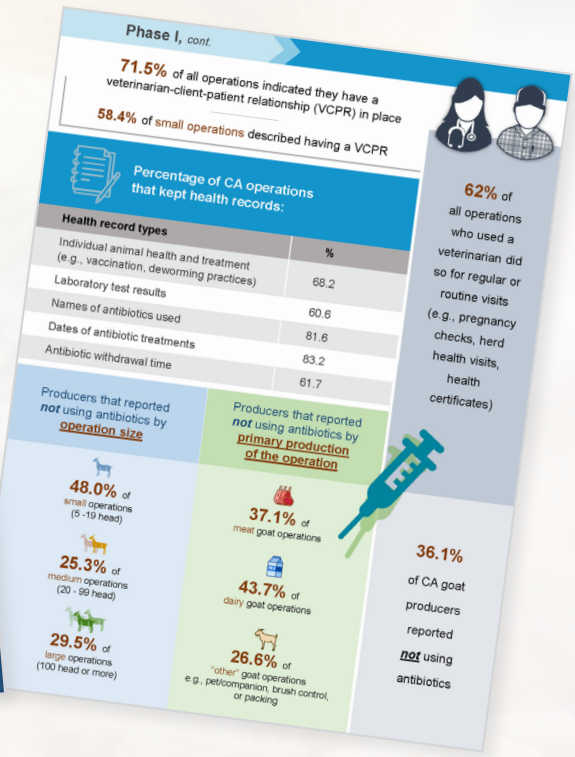
The AUS program has produced and distributed various materials and educational resources to advance antibiotic stewardship. AUS materials present evidence-based information regarding the current use of antibiotic drugs and how to preserve future antibiotic availability and efficacy. AUS is continually thankful for valuable information received from voluntary contributions and participation from livestock producers, veterinarians, and other stakeholders in data collection, trainings, educational outreach, and engagement efforts.

AUS Fact Sheets: 2019 NAHMS Goat Study—California Results

Summary results from USDA NAHMS' 2019 two-phase study of antibiotic use and stewardship in California's goat operations. CDFA AUS provided funding to expand Phase I and, with CDFA's Animal Health Branch, personnel to conduct Phase II.

https://www.cdfa.ca.gov/AHFSS/AUS/docs/AUS_FactSheets_2019NAHMSGoatStudy-CAResults.pdf





Above is a selection of highlights from the work AUS completed over FY 23-24; it is not comprehensive. Ongoing studies report results over a number of years; results presented here were compiled in FY 23-24.

AUS Publications

AUS-authored, peer-reviewed journal articles describing the benefit and use of livestock-specific antibiograms in veterinary treatment decisions

https://www.cdfa.ca.gov/AHFSS/AUS/Outreach.html#publications

JAVMA Currents in One Health Leading at the intersection of animal, human, and environmental health AVMA

Antibiograms as one-health tools for antimicrobial stewardship: California's experience with livestock antibiogram development

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ABSTRACT

Antibiograms are collections of antimicrobial susceptibility data for a particular bacterial organism and host species. Antibiograms are important tools for antimicrobial stewardship, as they may be used to guide empiric antimicrobial therapy and assess trends in antimicrobial resistance, maximizing treatment success and preserving the efficacy of currently available pharmaceuticals. Targeted use of antimicrobials is critically important to minimize the spread of antimicrobial resistance, which may be conveyed between animals and humans directly but may also be spread through the environment and ecological niches, such as soil, water, and wildlife reservoirs. To effectively utilize antibiograms as part of a comprehensive antimicrobial stewardship plan, veterinarians need to know data characteristics, including the source population, body site (when possible), and number of isolates included, in addition to the animal species and bacterial organisms for which each breakpoint was developed. Although widely used in human health systems, antibiograms are not often available in veterinary medicine. This paper describes antibiogram creation and use, discusses antibiogram development by US veterinary diagnostic laboratories, and shares California's process to create and promote livestock antibiograms. The companion Currents in One Health article by Burbick et al, *AJVR*, September 2023, addresses the benefits and challenges associated with developing veterinary antibiograms.

Keywords: antibiogram, veterinary antimicrobial stewardship, antimicrobial susceptibility testing, livestock, antimicrobial resistance

Background

Bacterial resistance to antimicrobial drugs is a serious and complex health threat requiring a one-health approach. Antimicrobial resistance (AMR) has the potential to affect humans, animals, and the environment through transfer of resistance genes and resistant pathogens, including those that cause foodborne illness. Those prescribing or administering antimicrobials (ie, physicians, veterinarians, and animal owners) can combat AMR by incorporating antimicrobial stewardship into daily activities. According to the AVMA, veterinary antimicrobial stewardship refers to "actions taken individually and as a profession to preserve the effectiveness and availability of antimicrobial drugs through conscientious oversight and responsible medical decision-making while safeguarding animal, public, and environmental health."[1] Veterinarians guide clients in implementing practical and current antimicrobial stewardship practices, informed by current literature on disease prevention, efficacy of antimicrobial alternatives, and clinical guidelines for the use of antimicrobial drugs. Optimal antimicrobial selection in veterinary settings requires consideration of numerous factors, including but not limited to pharmacokinetics, pharmacodynamics, administration routes, and legal requirements for food animals, as well as an understanding of underlying microbial resistance trends, potential for polymicrobial infection, and immune suppressive factors relevant to patient populations.

An antibiogram represents the cumulative antimicrobial susceptibility test (AST) data for a given antimicrobial drug–bacterial species–animal host

FULL TEXT LINKS

AVMA FREE ACCESS

Am J Vet Res. 2023 Jun 19:84(9):ajvr.23.05.0086. doi: 10.2460/ajvr.23.05.0086. Print 2023 Sep 1.

Benefits and challenges of creating veterinary antibiograms for empiric antimicrobial selection in support of antimicrobial stewardship and advancement of one-health goals

Claire R Burbick [1], Virginia R Fajt [2], Erin Frey [3], Heather Fritz [4], Laura B Goodman [5], Catherine Lorenz [6], Brian V Lubbers [7], Edith Marshall [6], Shelley C Rankin [8], Marissa Silva [6]

Affiliations
PMID: 37315936 DOI: 10.2460/ajvr.23.05.0086
Free article

Abstract

Antibiograms are important tools for antimicrobial stewardship that are often underutilized in veterinary medicine. Antibiograms summarize cumulative antimicrobial susceptibility testing (AST) data for specific pathogens over a defined time period; in veterinary medicine, they are often stratified by host species and site of infection. They can aid practitioners with empiric therapy choices and assessment of antimicrobial resistance trends within a population in support of one-health goals for antimicrobial stewardship. For optimal application, consideration must be given to the number of isolates used, the timeframe of sample collection, laboratory analytical methodology, and the patient population contributing to the data (eg, treatment history, geographic region, and production type). There are several limitations to veterinary antibiograms, including a lack of breakpoint availability for bacterial species, a lack of standardization of laboratory methodology and technology for culture and AST, and a lack of funding to staff veterinary diagnostic laboratories at a level that supports antibiogram development and education. It is vital that veterinarians who use antibiograms understand how to apply them in practice and receive relevant information pertaining to the data to choose the most appropriate antibiogram for their patients. This paper explores the benefits and challenges of developing and using veterinary antibiograms and proposes strategies to enhance their usability and accuracy. Further detail regarding the application of veterinary antibiograms by primary practicing clinicians is addressed in the companion Currents in One Health article by Lorenz et al (*JAVMA*, September 2023).

Keywords: antibiogram; antimicrobial resistance; antimicrobial stewardship; antimicrobial susceptibility testing; breakpoint

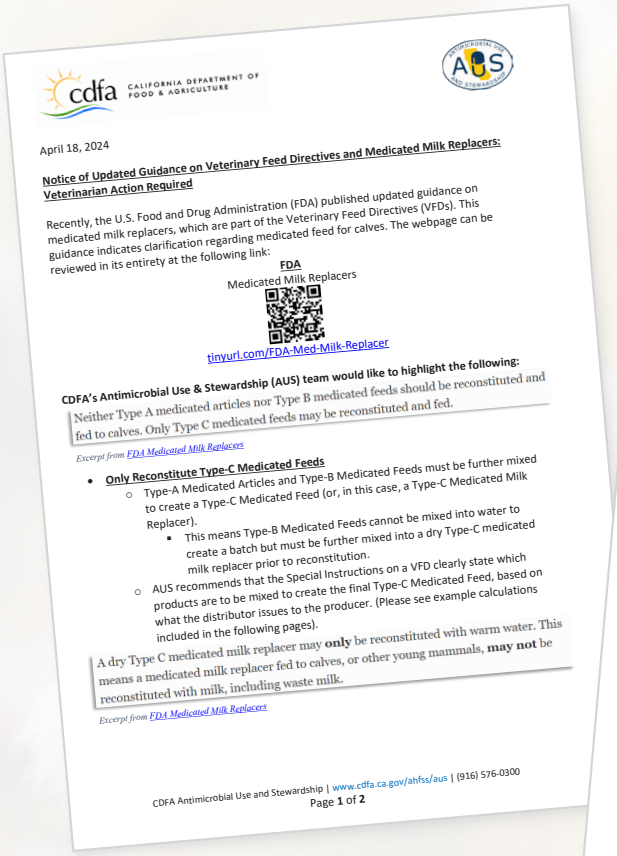
PubMed Disclaimer

LinkOut – more resources

Full Text Sources
Sheridan PubFactory

Continuously Updated Guidance for VFDs

Ongoing guidance to veterinarians regarding Veterinary Feed Directive (VFD) changes and updates by FDA
https://www.cdfa.ca.gov/ahfss/aus/vfdresources/



cdfa CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

April 18, 2024

Notice of Updated Guidance on Veterinary Feed Directives and Medicated Milk Replacers: Veterinarian Action Required

Recently, the U.S. Food and Drug Administration (FDA) published updated guidance on medicated milk replacers, which are part of the Veterinary Feed Directives (VFDs). This guidance indicates clarification regarding medicated feed for calves. The webpage can be reviewed in its entirety at the following link:

FDA
Medicated Milk Replacers

tinyurl.com/FDA-Med-Milk-Replacer

CDFA's Antimicrobial Use & Stewardship (AUS) team would like to highlight the following:

> Neither Type A medicated articles nor Type B medicated feeds should be reconstituted and fed to calves. Only Type C medicated feeds may be reconstituted and fed.

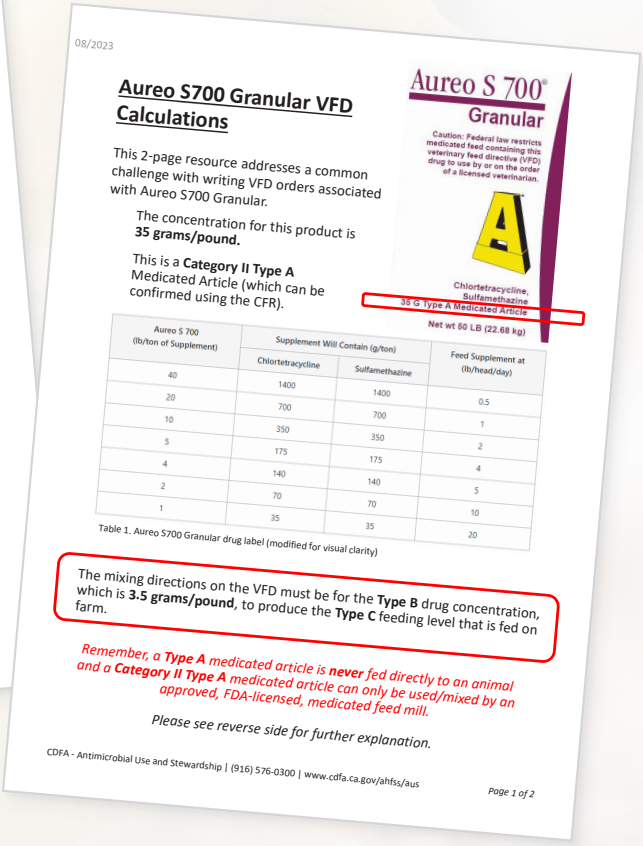
Excerpt from FDA Medicated Milk Replacers

- **Only Reconstitute Type-C Medicated Feeds**
  - Type-A Medicated Articles and Type-B Medicated Feeds must be further mixed to create a Type-C Medicated Feed (or, in this case, a Type-C Medicated Milk Replacer).
    - This means Type-B Medicated Feeds cannot be mixed into water to create a batch but must be further mixed into a dry Type-C medicated milk replacer prior to reconstitution.
  - AUS recommends that the Special Instructions on a VFD clearly state which products are to be mixed to create the final Type-C Medicated Feed, based on what the distributor issues to the producer. (Please see example calculations included in the following pages).

> A dry Type C medicated milk replacer may **only** be reconstituted with warm water. This means a medicated milk replacer fed to calves, or other young mammals, **may not** be reconstituted with milk, including waste milk.

Excerpt from FDA Medicated Milk Replacers

CDFA Antimicrobial Use and Stewardship | www.cdfa.ca.gov/ahfss/aus | (916) 576-0300
Page **1** of **2**



08/2023

Aureo S700 Granular VFD Calculations

Aureo S 700® Granular
Caution: Federal law restricts medicated feed containing this veterinary feed directive (VFD) drug to use by or on the order of a licensed veterinarian.
Chlortetracycline, Sulfamethazine
35 G Type A Medicated Article
Net wt 50 LB (22.68 kg)

This 2-page resource addresses a common challenge with writing VFD orders associated with Aureo S700 Granular.

The concentration for this product is **35 grams/pound.**

This is a **Category II Type A** Medicated Article (which can be confirmed using the CFR).

Aureo S 700 (lb/ton of Supplement)	Supplement Will Contain (g/ton)		Feed Supplement at (lb/head/day)
	Chlortetracycline	Sulfamethazine	
40	1400	1400	0.5
20	700	700	1
10	350	350	2
5	175	175	4
4	140	140	5
2	70	70	10
1	35	35	20

Table 1. Aureo S700 Granular drug label (modified for visual clarity)

The mixing directions on the VFD must be for the **Type B** drug concentration, which is **3.5 grams/pound**, to produce the **Type C** feeding level that is fed on farm.

*Remember, a **Type A** medicated article is **never** fed directly to an animal and a **Category II Type A** medicated article can only be used/mixed by an approved, FDA-licensed, medicated feed mill.*

Please see reverse side for further explanation.

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AUS' VFD Summary Report Issued by Inspection Services

Summary of veterinary feed directive (VFD) orders in California
https://www.cdfa.ca.gov/is/ffldrs/pdfs/vfd_summary_report_2023.pdf

AUS Outreach & Engagement

Farms Engaged

112 farms engaged across **13** studies

Outreach & Presentations

In-person outreach & presentations reaching over **500** people

Online and In-Person Livestock and Prescription Drug Inspections in 2023*

391 inspections of retailers that sell livestock drugs and **56** annual VFD inspections* to ensure compliance with California laws and regulations

** Number of inspections for calendar year 2023*

Ongoing Educational Resources

Ongoing **educational resources** and **customized materials** available to all California veterinarians regarding veterinary feed directives (VFDs) and **livestock-specific antibiograms**

Find AUS publications, as well as scientific research papers resulting from AUS-funded projects, on our **website**: https://www.cdfa.ca.gov/ahfss/AUS/Outreach.html

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Animal Management Strategies

What health promotion and infection prevention practices can be used or further developed in California to combat antimicrobial resistance and optimize antibiotic usage?

Through its academic research collaborations, veterinarian input, and voluntary stakeholder participation, AUS continues to keep abreast of current best management practices to limit antibiotic resistance and promote animal health. Through ongoing review of the latest research from California, the nation, and world-wide, AUS supports stakeholders with the most current and effective scientific information. The following are highlights from AUS' work in this area over the past fiscal year. Please refer to the Appendix for additional details; more information will be provided in separate publications, described later in this report.

Aquaculture

Antimicrobial susceptibility testing methods for white sturgeon gastrointestinal bacteria are currently being optimized. This testing is one component of a dietary model being created to comprehensively assess the impact of diet on white sturgeon production and health. Future publications and extension resources developed from this research will serve as vital tools for aquaculture practitioners, industry leaders, and producers, highlighting the crucial role of diet in aquaculture and its significance in disease management and stewardship efforts.

Communities of Practice

After a Communities of Practice (CoP) program was pilot tested at five different farms, researchers developed a series of narrated presentations that will be available through the University of California Cooperative Extension websites to describe strategies and lessons learned in development of CoPs in the future. These materials will be available to livestock producers and Cooperative Extension professionals in California and nationally.

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Beef Calves

Workshops and webinars held by researchers to educate veterinarians and producers in best management practices for neonatal calves attracted 205 attendees. Medical illustrations and step-by-step guides are currently being finalized for distribution to stakeholders to aid in identification and implementation of appropriate interventions on their ranches. Updates to this project can be found at the following website: https://ucanr.edu/sites/Rangelands/CattleHealth/#Neonatal

Dairy Cows

Preliminary drafts of a six-part, interactive, online training series on the judicious use of antimicrobials for new and existing dairy farmworkers were created. The next steps to finalize the series, which includes English and Spanish versions, have already begun.

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Antibiotic Sales & Use

Which antibiotics are sold and how are they used in California?

The sale and use of antibiotics intended for livestock evolves in California on an annual basis. Through the efforts of CDFA's Animal Health and Food Safety Services (AHFSS) and Inspection Services (IS), AUS programs provide a closer look at antibiotic sales and the collection and analysis of veterinary feed directives (VFDs), as well as surveys of producers regarding their on-farm practices. These activities improve the understanding of the use of antibiotic drugs in livestock and guide the development of relevant materials to promote antibiotic stewardship and judicious use practices.

Indications of Antibiotic Use

As Authorized in VFDs

- Respiratory Disease (143)
- Gastrointestinal Disease (129)
- Either/Both (319)
- Other (40)

**Number of VFDs collected for calendar year 2023. For more information, see AUS' VFD Summary Report.*

Commercial Sheep

For the National Animal Health Monitoring System (NAHMS) Sheep study, CDFA and USDA staff visited numerous operations throughout the state to collect survey and biologic information, with the intention to yield California-specific results.

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Antibiotic Resistance

How are we looking at trends in antibiotic resistance?

This fiscal year, AUS-funded research evaluated antibiotic resistance trends through multi-year studies and newly commissioned projects.These antibiotic resistance trends are explored and analyzed using data from samples collected on-farm, as well as other clinical samples. Multi-year studies allow AUS to follow antibiotic resistance trends from on-farm samples collected at the same operations over time to gain valuable insight into the effects of antibiotic use and other management practices on antibiotic susceptibility. These trends pinpoint areas where the AUS stewardship team can further identify effective strategies that may be implemented by California's livestock producers and veterinarians to help mitigate the development and spread of antibiotic resistance. The following are highlights from AUS' work in this area during the past fiscal year.

Beef Cattle

Results from the first objective of this study demonstrate that different feeding systems (conventional grain-fed, grass-fed and grain-finished, and grass-fed for varying durations) and associated differences in antimicrobial exposures gave rise to distinct antibiotic resistance gene profiles. The duration of grazing time served as a critical factor in shaping antibiotic resistance genes within various grass-feeding systems. Cattle raised under comparable feeding systems had a similar composition and distribution of antibiotic gene classes in their feces, which indicates conventional feedlots have significant potential to restructure the antibiotic resistance genes within a short-term period.

The second objective of this study was to evaluate the effects of a supplemental blend of essential oils and 25-hydroxyvitamin D3 on the fecal resistome of Holstein steers. There were three groups: control, conventional monensin feed additive, and mixture of essential oils plus 25-hydroxyvitamin D3 feed additive. Findings revealed that although the dietary supplementation of essential oil or monensin was not found to affect resistome composition, there are some differences in the abundance of fecal antimicrobial resistance determinants in cattle.

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Beef-on-Dairy

252 calf-fed beef-on-dairy calves were enrolled in a study to evaluate the effects of extended colostrum feeding during the production cycle. The first round of fecal collections was completed, with *E. coli* prevalence tests yielding 410 presumptive *E. coli* isolates that will be further analyzed.

Emerging Industry Trends

Beef-on-dairy:
Term used for when dairy farmers breed their dairy cows with beef bulls

Beef-on-dairy calves often show **greater feed efficiency** (as compared to dairy calves entering the beef supply), which lowers the environmental footprint and overall costs from their production.[1]

Compared to purebred dairy calves, beef-on-dairy calves may **provide higher quality-grade beef products** without impacting current milk production efficiencies.[1]

18-20% of the annual US beef supply (~5 million head) come from **dairy origins**.[2]

Industry trends indicate that beef-on-dairy is a **rapidly growing** segment of beef production.[3]

[1] https://www.drovers.com/news/industry/beef-dairy-revolution-american-beef-production
[2] https://www.dairyherd.com/news/dairy-production/crossbreeding-improves-most-dairy-beef-issues
[3] Drovers State of the Beef Industry 2023 Report

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Dairy Cows

Sample collection activities for a study piloting the creation of antibiograms for individual dairies were completed, with a total of 315 samples collected from participating dairies across two years. Farm-specific antibiograms were generated for all participating dairies.

Dairy Calves

337 milk and colostrum samples were collected from a total of 38 conventional and organic dairies across the state, which will be screened for important milk pathogens along with nutritional and immunological testing.

Commercial Poultry

Litter samples were collected from participating broiler farms, where no antibiotics were used, in California. The litter samples were cultured for *E. coli*, *Enterococcus*, *Salmonella*, and *Campylobacter*. Isolates of *E. coli* and *Enterococcus* were recovered from all litter samples, with all bacterial isolates tested for antimicrobial susceptibility. Isolates of *Salmonella* and *Campylobacter* were also recovered. The main serotypes of *Salmonella* recovered during this period were *S.* Kentucky, *S.* Enteritidis, and *S.* Senftenberg. *Enterococcus* isolates that have been tested for antimicrobial susceptibility showed no resistance against the antimicrobials ampicillin, avilamycin, linezolid, and vancomycin; resistance was detected to the antimicrobials erythromycin and tetracycline. For the *E. coli* isolates, no resistance was detected against the antimicrobials cefoxitin, ceftriaxone, and ciprofloxacin; resistance was detected to the antimicrobials ampicillin and tetracycline.

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Swine

Analysis of the gut microbiota community indicates antibiotic and probiotic supplementation had different impacts on fecal microbiota diversity and resulted in identification of *Bacillus subtilis* as a viable nutritional intervention to reduce the incidence of *E. coli* diarrhea in weaned pigs. Supplementation of *Bacillus subtilis* enriched the relative abundance of more favorable bacteria, such as *Lactobacillus amylovorus,* in fecal samples of newly weaned pigs compared with antibiotics.

MIC Data Analysis

A statistical program has been developed to model changes in minimum inhibitory concentration (MIC) data over time, with initial model application and validation performed on California bovine respiratory disease (BRD) data. This project is anticipated to help AUS make better use of MIC values from various projects, as well as to aid monitoring of early resistance trends. Future plans include making the statistical package publicly available for use by collaborators.

CAHFS Testing

AUS funding helped support the California Animal Health & Food Safety (CAHFS) Laboratory to perform 829 antimicrobial susceptibility tests for clinical samples submitted from multiple livestock sources.

AUS bolsters federal monitoring programs for antibiotic resistance through CAHFS' work with USDA, which contributes to publicly available antibiotic resistance data in specialized dashboards: https://www.aphis.usda.gov/labs/nahln/antimicrobial-resistance-pilot

Above is a selection of highlights from the work AUS completed over FY 23-24; it is not comprehensive. Ongoing studies report results over a number of years; results presented here were compiled in FY 23-24.

Communication & Engagement

How are we reaching people and improving our outreach efforts?

Key components of the AUS program mission include continuous communication with and education of livestock owners, livestock drug retailers, and veterinarians on the requirements of the law, which helps to foster antibiotic stewardship. AUS encourages feedback on the program's outreach, which it uses to adapt and create resources to reach a wider audience, as well as meet the evolving needs of those it seeks to engage further in its education efforts. During FY 23-24, AUS prepared and presented several infographic resources in both English and Spanish to facilitate the distribution of materials into the hands of those working directly with livestock in California. The following highlights are from AUS' work in this topic area over the past fiscal year.

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Funding Opportunities

Addressing Veterinary Shortages in California

Annually, AUS solicits local, county, and state input to nominate counties to USDA as designated shortage situations in need of food animal veterinary services. In exchange for a minimum of 3-year service commitment in these communities, USDA offers a repayment award for qualifying veterinary student loans through the Veterinary Medicine Loan Repayment Program (VMLRP). This year, a veterinarian received an award for the Mendocino County designation.

This process also allows for continued availability of federal funds for veterinary practices within these veterinary shortage designations through USDA's Veterinary Services Grant Program (VSGP).

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Youth in Agriculture

Animal Poo and You Curriculum

AUS' additional funding to complete the final steps of this five-part educational package will yield a comprehensive module for each lesson, which uses the power of storytelling via a cast of whimsical characters, musical vignettes, interactive written activities, and specialized educator guides, to help convey scientific concepts to 5- to 8-year-olds. The final Animal Poo and You curriculum will consist of

five lessons on microbes, fecal-oral pathogens, respiratory zoonotic illnesses, the importance of hand washing, and veterinary care. Once the five-module curriculum has been completed, it will be made available free to educators via the AUS website and other dissemination outlets.

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National Engagement

AUS staff continued **national engagement** on antimicrobial resistance and work to alleviate the veterinary shortages in rural areas through positions on various national committees and review panels, in addition to providing experience- and science-based analyses and recommendations to government agencies.

Podcasts

AUS continues to utilize **podcasts** to distribute programmatic information to veterinarians and other interested stakeholders.

Inspiring Future Food Animal Vets
https://www.youtube.com/watch?v=DgG7n9Y9EBs

Veterinary Antibiograms for Empiric Antimicrobial Selection
https://www.buzzsprout.com/2047448/13506744

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AUS-Funded Research Publications & Presentations

How are our researchers building on current scientific knowledge?

Part of AUS' mission is to fund research projects on specific topics curated to reflect the needs of California's livestock sectors, as determined by surveys, outreach efforts, and its mandates. Peer-reviewed journal publications are critical to ensure the materials AUS produces are thoroughly researched, trusted by animal scientists and livestock veterinarians, and disseminated to the scientific community. AUS is excited to share these publications and poster presentations written by AUS-funded researchers that help inform solutions or future needs, and to share this knowledge with the wider scientific community. Detailed below are the publications and presentations that have been released in the 2023-2024 fiscal year. Of note, due to publishing cycles and timing, some of the research detailed in the publications and presentations below may have occurred in prior fiscal years. For more information, please click on the links provided.

Branco-Lopes, R., Bernal-Córdoba, C., Valldecabres, A., Winder, C., Canozzi, M.E., & Silva-Del-Río, N. (2023). **Characterization of controlled trials on probiotic supplementation to dairy calves: A scoping review.** *Journal of Dairy Science,* 106(8), 5388-5401. https://doi.org/10.3168/jds.2022-23017

Keywords: calf, direct-fed microbial, feed additive, review

Description: This scoping review summarizes the breadth of controlled trials evaluating probiotic supplementation in dairy calves. Control clinical trials evaluating the efficacy of probiotics in calves' health and growth were identified. However, differences in intervention design (mode of probiotic administration, dose, and duration of probiotic supplementation) and outcomes evaluation (type and methods) justify future efforts toward standardized guidelines in clinical trials. Results from this scoping review support a future meta-analysis.

Busch, R.C., Karle, B.M., Meehan, C.L., Smith, M.H. **Addressing AMU on-farm with Communities of Practice - A Case Study**. (2024, May). Abstract presented at the Lightning Talks at the National Institute of Antimicrobial Resistance Research and Education (NIAMRRE) Annual Conference, Columbus, OH.

Keywords: antimicrobial stewardship, communities of practice, change management, employee engagement, professional development

Description: The objective of the project was to implement a community of practice-based approach to help influence farm employee decision-making behavior change towards judicious use of antimicrobials on participating farms. Communities of Practice (CoPs) are structured networks of peers and represent a model for professional development whereby groups of individuals work toward shared goals. CoPs, especially when implemented as short, direct meetings, may be an effective method to improve employee engagement on farms. Some of the greatest value of the CoPs were in the intangible outcomes such as a spirit of inquiry, strengthening relationships, and a sense of belonging and identity within the organization.

Keywords: Bayesian network analysis, *Pasteurella multocida, Mannheimia haemolytica, Histophilus somni,* antibiotic, antimicrobial drug, antimicrobial resistance, dairy management practices, bovine respiratory disease

Morgan Bustamante, B.L., Chigerwe, M., Martínez-López, B., Aly, S.S., McArthur, G., ElAshmawy, W.R., Fritz, H., Williams, D.R., Wenz, J., Depenbrock, S. (2024). **Antimicrobial susceptibility in respiratory pathogens and farm and animal variables in weaned California dairy heifers: Logistic regression and Bayesian network analyses.** *Antibiotics.* 13(1):50. https://doi.org/10.3390/antibiotics13010050

Description: Weaned dairy heifers are a relatively understudied production group. Bovine respiratory disease (BRD) is the most common cause of antimicrobial drug (AMD) use, morbidity, and mortality in this production group. The study of antimicrobial resistance (AMR) is complicated because many variables that may affect AMR are related. This study generates hypotheses regarding the farm- and animal-level variables (e.g., vaccination, lane cleaning, and AMD use practices) that may be associated with AMR in respiratory isolates from weaned dairy heifers. A cross-sectional study was performed using survey data and respiratory isolates (*Pasteurella multocida, Mannheimia haemolytica,* and *Histophilus somni*) collected from 341 weaned dairy heifers on six farms in California. Logistic regression and Bayesian network analyses were used to evaluate the associations between farm- and animal-level variables with minimum inhibitory concentration (MIC) classification of respiratory isolates against 11 AMDs. Farm-level variables associated with MIC classification of respiratory isolates included the number of source farms of a calf-rearing facility, whether the farm practiced onsite milking, the use of lagoon water for flush lane cleaning, and respiratory and pinkeye vaccination practices. Animal-level variables associated with a MIC classification included whether the calf was BRD-score-positive and time since the last phenicol treatment.

Keywords: antibiogram, antimicrobial resistance, antimicrobial stewardship, antimicrobial susceptibility testing, breakpoint

Burbick, C.R., Fajt, V.R., Frey, E., Fritz, H., Goodman, L.B., Lorenz, C., Lubbers, B.V., Marshall, E., Rankin, S.C., Silva, M. (2023). **Benefits and challenges of creating veterinary antibiograms for empiric antimicrobial selection in support of antimicrobial stewardship and advancement of one-health goals.** *Am J Vet Res.* 84(9):ajvr.23.05.0086. PMID: 37315936. https://doi.org/10.2460/ajvr.23.05.0086

Description: Antibiograms are important tools for antimicrobial stewardship that are often underutilized in veterinary medicine. Antibiograms summarize cumulative antimicrobial susceptibility testing (AST) data for specific pathogens over a defined time period; in veterinary medicine, they are often stratified by host species and site of infection. They can aid practitioners with empiric therapy choices and assessment of antimicrobial resistance trends within a population in support of one-health goals for antimicrobial stewardship. For optimal application, consideration must be given to the number of isolates used, the timeframe of sample collection, laboratory analytical methodology, and the patient population contributing to the data (eg, treatment history, geographic region, and production type). There are several limitations to veterinary antibiograms, including a lack of breakpoint availability for bacterial species, a lack of standardization of laboratory methodology and technology for culture and AST, and a lack of funding to staff veterinary diagnostic laboratories at a level that supports antibiogram development and education. It is vital that veterinarians who use antibiograms understand how to apply them in practice and receive relevant information pertaining to the data to utilize the most appropriate antibiogram for their patients. This paper explores the benefits and challenges of developing and using veterinary antibiograms and proposes strategies to enhance their applicability and accuracy.

Keywords: *Mannheimia haemolytica, Pasteurella multocida, Histophilus somni,* bovine, airway, fluoroquinolone, ceftiofur, macrolide, tetracycline

Depenbrock, S., Schlesener, C., Aly, S., Williams, D., ElAshmawy, W., McArthur, G., Clothier, K., Wenz, J., Fritz, H., Chigerwe, M., Weimer, B. (2024). **Antimicrobial resistance genes in respiratory bacteria from weaned dairy heifers.** *Pathogens.* 13(4):300.
https://doi.org/10.3390/pathogens13040300

Description: Bovine respiratory disease (BRD) is the leading cause of mortality and antimicrobial drug (AMD) use in weaned dairy heifers. Limited information is available regarding antimicrobial resistance (AMR) in respiratory bacteria in this population. This study determined AMR gene presence in 326 respiratory isolates (*Pasteurella multocida, Mannheimia haemolytica,* and *Histophilus somni*) from weaned dairy heifers using whole genome sequencing. Concordance between AMR genotype and phenotype was determined. Twenty-six AMR genes for 8 broad classes of AMD were identified. The most prevalent, medically important AMD classes used in calf rearing, to which these genes predict AMR among study isolates, were tetracycline (95%), aminoglycoside (94%), sulfonamide (94%), beta-lactam (77%), phenicol (50%), and macrolide (44%). The co-occurrence of AMR genes within an isolate was common; the largest cluster of gene co-occurrence encodes AMR to phenicol, macrolide, elfamycin, β-lactam (cephalosporin, penam cephamycin), aminoglycoside, tetracycline, and sulfonamide class AMDs. Concordance between genotype and phenotype varied (Matthew's Correlation Coefficient ranged from -0.57 to 1) by bacterial species, gene, and AMD tested, and was particularly poor for fluoroquinolones (no AMR genes detected) and ceftiofur (no phenotypic AMR classified while AMR genes present). These findings suggest a high genetic potential for AMR in weaned dairy heifers; preventing BRD and decreasing AMD reliance may be particularly important in this population.

Hoyos-Jaramillo, A., Garzon, A., Fritz, H.M., Byrne, B.A., Miramontes, C.A., Lehenbauer, T.W., Aly, S., and Pereira, R.V. (2024). **Agreement among deep nasopharyngeal sampling culture results for 3 different swab types in preweaning dairy calves,** *JDS Communications,* Volume 5, Issue 1, Pages 57-60, ISSN 2666-9102.
https://doi.org/10.3168/jdsc.2023-0425

Keywords: *Mannheimia haemolytica, Pasteurella multocida,* deep nasopharyngeal swabs, double-guarded culture swab, single-guarded culture swab

Description: Accurate isolation and identification of pathogens for an animal with bovine respiratory disease are of critical importance to direct appropriate decision-making related to the treatment of individual animals, as well as control and prevention options in a herd setting. The objective of this study was to compare nasopharyngeal sampling approaches to evaluate accuracy and agreement for the recovery of *Mannheimia haemolytica* (MH) and *Pasteurella multocida* (PM) from deep nasopharyngeal swabs (DNS) using 3 different swabs. Deep nasopharyngeal samples were collected from 45 dairy calves using 3 swabs: (1) double-guarded culture swab (DGS); (2) single-guarded culture swab (SGS); and (3) unguarded culture swab (UGS). To evaluate the degree of agreement between DGS, SGS, and UGS, culture results were compared for each calf sampled by using a kappa agreement test. Overall, findings from our study support that when using either SGS or DGS for DNS sampling of preweaning calves, a high agreement for recovery of PM is observed. A low recovery of MH was observed in the study, limiting the conclusion comparing the 3 DNS methods. Use of UGS is considered a potential alternative; however, a higher percentage of polymicrobial growth was found with UGS samples.

Karle, B. **Pre-weaned calf management: Colostrum & passive immunity.** (2024, February). Presentation at the World Ag Expo in Tulare, CA.

Keywords: colostrum, dairy, antimicrobial stewardship, mortality, health

Description: This project collected data on pre-weaned dairy calf health management practices for heifer and bull calves in conventional and organic dairies, including colostrum management, milk/milk replacer management, record-keeping practices, morbidity and mortality, calf rearing practices, antibiotic and probiotic use, and determination of treatment protocols. The data from this study will be used to fill in knowledge gaps on preweaning calf management factors affecting antimicrobial use and form a basis for future studies on antibiotic resistance and improvement of antimicrobial stewardship.

Lorenz, C., Silva, M., Frey, E., Fritz, H., and Marshall, E. (2023). **Antibiograms as one-health tools for antimicrobial stewardship: California's experience with livestock antibiogram development.** *J Am Vet Med Assoc.* 261(9):1272-1280. PMID: 37400072. https://doi.org/10.2460/javma.23.05.0228

Keywords: antibiogram, antimicrobial resistance, antimicrobial susceptibility testing, livestock, veterinary antimicrobial stewardship

Description: Antibiograms are collections of antimicrobial susceptibility data for a particular bacterial organism and host species. Antibiograms are important tools for antimicrobial stewardship, as they may be used to guide empiric antimicrobial therapy and assess trends in antimicrobial resistance, maximizing treatment success and preserving the efficacy of currently available pharmaceuticals. Targeted use of antimicrobials is critically important to minimize the spread of antimicrobial resistance, which may be conveyed between animals and humans directly but may also be spread through the environment and ecological niches, such as soil, water, and wildlife reservoirs.

To effectively utilize antibiograms as part of a comprehensive antimicrobial stewardship plan, veterinarians need to know data characteristics, including the source population, body site (when possible), and number of isolates included, in addition to the animal species and bacterial organisms for which each breakpoint was developed. Although widely used in human health systems, antibiograms are not often available in veterinary medicine. This paper describes antibiogram creation and use, discusses antibiogram development by United States veterinary diagnostic laboratories, and shares California's process to create and promote livestock antibiograms.

Pereira, R.V., Fritz, H.M., Toohey-Kurth, K., and Clothier, K.A. (2024). ***Salmonella enterica serovar Dublin from cattle in California from 1993 to 2019: Characterization and analysis of antimicrobial resistance diversity.*** *Antibiotics.* 13, 22. https://doi.org/10.3390/antibiotics13010022

Pereira, R.V., Fritz, H.M., Toohey-Kurth, K., and Clothier, K.A. ***Salmonella enterica serovar Dublin from cattle in California from 1993 to 2019: Characterization and analysis of antimicrobial resistance diversity.*** (2024, May). Poster presentation at the World Buiatrics Congress for the World Association for Buiatrics, Cancun, Mexico.

Pereira, R.V. ***Salmonella Dublin and One Health: Antibiotic resistance concerns for both animals and humans.*** (2024, June). Presentation at the American Veterinary Medical Association (AVMA) Convention, Austin, TX.

Keywords: *Salmonella* Dublin, One Health, antibiotic resistance

Description: For this study, antimicrobial susceptibility data for *Salmonella enterica* subsp. *enterica* serovar Dublin (*S.* Dublin)—a well-known cattle-adapted pathogen with current concerns for multidrug resistance—were recovered from cattle at the California Animal Health and Food Safety Laboratory System (CAHFS) over

the last three decades (1993-2019) and were evaluated using tools to capture diversity in antimicrobial resistance. For this purpose, minimum inhibitory concentration (MIC) testing was conducted for 247 clinical *S.* Dublin isolates using two panels (drugs of relevance to livestock and humans) over time. Antimicrobial resistance (AMR) profiles revealed a predominant core multidrug-resistant pattern in the three most common AMR profiles observed. Antimicrobial resistance richness, diversity, and similarity analysis revealed patterns for changes in AMR profiles for different age groups. Discriminant analysis using MIC log2-transformed data revealed changes in MIC for year groups, with a time-sequence pattern observed. Drivers for reduced susceptibility were observed for 3rd generation cephalosporins and quinolones for more recent year groups (2011-2015 and 2016-2019) when compared to older year groups (1993-1999 and 2000-2005). Together, these results highlight the changes in the diversity of AMR profiles, as well as changes in susceptibility of S. Dublin over time for critical antimicrobials of importance to both animals and humans, and support the need for continued monitoring and efforts that will support judicious use of antimicrobials, especially for these two drug classes.

Pereira, R.V. **Bovine respiratory disease: update on diagnosis, surveillance, and treatment.** (2024, March). Presented at the California Veterinary Medical Association's Food Animal Medicine Seminar, Yosemite, California.

Pereira, R.V. **Bovine respiratory disease: update on diagnosis, surveillance, and treatment.** (2024, May). Presented at the World Buiatrics Congress for the World Association for Buiatrics, Cancun, Mexico.

Keywords: BRD, bovine respiratory disease, microbiome

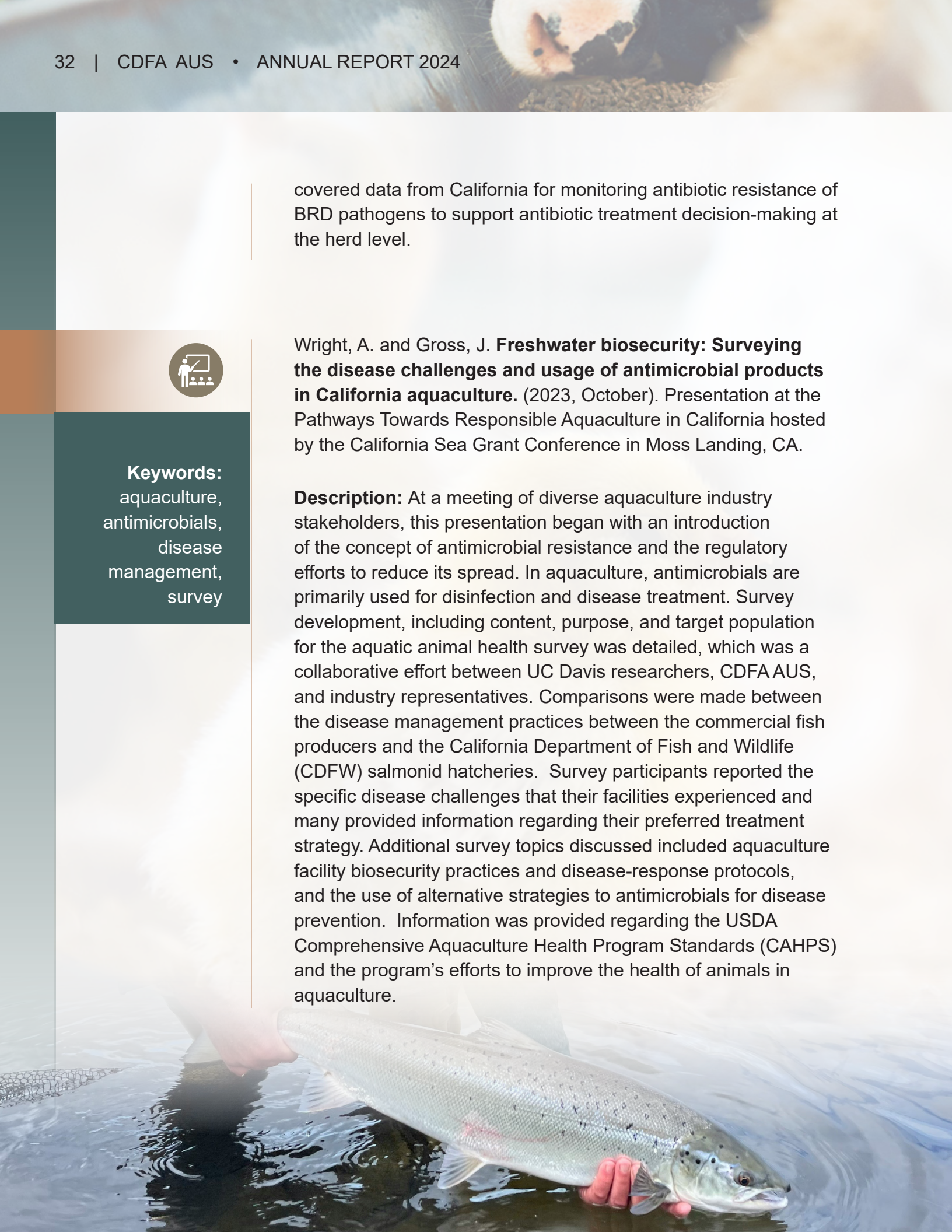
Description: Recent updates on sampling methods for diagnosis and surveillance of bovine respiratory disease (BRD) in cattle. This talk presented data from current evidence-based research for sampling approaches for BRD pathogen identification, as well as

covered data from California for monitoring antibiotic resistance of BRD pathogens to support antibiotic treatment decision-making at the herd level.

Wright, A. and Gross, J. **Freshwater biosecurity: Surveying the disease challenges and usage of antimicrobial products in California aquaculture.** (2023, October). Presentation at the Pathways Towards Responsible Aquaculture in California hosted by the California Sea Grant Conference in Moss Landing, CA.

Keywords: aquaculture, antimicrobials, disease management, survey

Description: At a meeting of diverse aquaculture industry stakeholders, this presentation began with an introduction of the concept of antimicrobial resistance and the regulatory efforts to reduce its spread. In aquaculture, antimicrobials are primarily used for disinfection and disease treatment. Survey development, including content, purpose, and target population for the aquatic animal health survey was detailed, which was a collaborative effort between UC Davis researchers, CDFA AUS, and industry representatives. Comparisons were made between the disease management practices between the commercial fish producers and the California Department of Fish and Wildlife (CDFW) salmonid hatcheries. Survey participants reported the specific disease challenges that their facilities experienced and many provided information regarding their preferred treatment strategy. Additional survey topics discussed included aquaculture facility biosecurity practices and disease-response protocols, and the use of alternative strategies to antimicrobials for disease prevention. Information was provided regarding the USDA Comprehensive Aquaculture Health Program Standards (CAHPS) and the program's efforts to improve the health of animals in aquaculture.



Looking Ahead

What's next?

AUS has accomplished much in FY 23-24 and is looking forward to continuing this success in FY 24-25. Several ongoing projects will have valuable results to report in the next 1-2 years. AUS continues to partner with researchers, producers, veterinarians, and other stakeholders to learn more about livestock-associated antibiotic resistance and to continue the promotion of animal and public health in California. The following highlights describe a selection of upcoming AUS projects anticipated for the next fiscal year.

NATIONAL ANTIMICROBIAL RESISTANCE MONITORING SYSTEM (NARMS) DATA
Release pathogen-specific reports of NARMS data from California for public audience

EDUCATIONAL VIDEOS
Creation of interactive educational packages targeted at youth to encourage and enhance knowledge of scientific concepts and how to stay healthy when working with livestock

SPECIES-SPECIFIC DIETS
Provide research results to support antimicrobial stewardship goals by aiding in disease prevention through species-specific diets for aquaculture animals

Above is a selection of highlights from the work AUS completed over FY 23-24; it is not comprehensive. Ongoing studies report results over a number of years; results presented here were compiled in FY 23-24.

ANTIBIOGRAMS

Provide educational materials and continue to expand database of clinical isolates to help veterinarians apply best practices in targeting antibiotic use and to assess antibiotic resistance trends

California-licensed veterinarians can have access to livestock-specific antibiograms by responding to this survey: http://tinyurl.com/AntibiogramSignup

VFD COLLECTION

Continue collection, reporting, and analysis of VFD orders

VFD OUTREACH TO VETERINARIANS

Continue to provide educational outreach to veterinarians in California that have written incomplete or incorrect VFDs and share strategies to help veterinarians incorporate best practices and improve VFD accuracy

Above is a selection of highlights from the work AUS completed over FY 23-24; it is not comprehensive. Ongoing studies report results over a number of years; results presented here were compiled in FY 23-24.

C | GETTING INVOLVED & ACKNOWLEDGEMENTS

How to Get Involved

Participation in AUS surveys and studies is voluntary! Your participation in our efforts to gather information is essential to the program's success and ensures that the program's work reflects what is currently happening with California livestock. If you receive a survey or an invitation to participate in one of our on-farm studies, please consider participating! Your participation provides valuable information that the program incorporates into publications and recommendations, impacting California agriculture. Antibiotic resistance is a concern for both human and animal health. By working together, we can find ways to minimize the risk and preserve the effectiveness of antibiotics for the future.

For more information on the AUS program or to **download our educational materials**, please visit https://www.cdfa.ca.gov/AHFSS/aus/

If you have **feedback** or would like to keep in touch, contact us: cdfa_aus@cdfa.ca.gov

Acknowledgements

This past fiscal year was successful thanks to the dedication and support of many individuals and organizations. The AUS program would like to thank everyone who contributes to our progress. Our stakeholders, including veterinarians, livestock owners, academics, and others, play a key role in providing guidance and support at all stages of our research, outreach, and education efforts. They are crucial to our success as they continue to participate in our studies and promote our outreach materials. We would also like to extend our gratitude to all the researchers who share their expertise with us and work each day to help us accomplish our goals.

Special Thanks

AUS would like to give special thanks to the following individuals who contributed to this Annual Report:

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Dr. Naif Alhawiti	*California Animal Health and Food Safety Laboratory System*
Dr. Daniela Bruno	*University of California Cooperative Extension Fresno County*
Dr. Rosie Busch	*University of California, Davis*
Dr. Pedro Carvalho	*Colorado State University – AgNext*
Dr. Munashe Chigerwe	*University of California, Davis*
Dr. Sarah Depenbrock	*University of California, Davis*
Dr. Curtis Fritz	*California Department of Public Health*
Dr. Heather Fritz	*California Animal Health and Food Safety Laboratory System*
Dr. Jackson Gross	*University of California, Davis*
Dr. Greg Habing	*The Ohio State University*
Dr. Meera Heller	*University of California, Davis*
Dr. Ashley Hill	*California Animal Health and Food Safety Laboratory System*
Dr. Peng Ji	*University of California, Davis – CLEAR Center, Dept. of Nutrition*
Betsy Karle	*University of California, Davis – Cooperative Extension*
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Dr. Gabriele Maier	*University of California, Davis*
Dr. Cheryl Meehan	*University of California, Davis*
Alec Michael, Ph.D. candidate	*University of California, Davis*
Dr. Frank Mitloehner	*University of California, Davis – CLEAR Center*
Allyx Nicolici	*California Department of Public Health*
Dr. Emmanuel Okello	*University of California, Davis*
Dr. Richard Pereira	*University of California, Davis*
Dr. Alda Pires	*University of California, Davis*
Dr. Noelia Silva del Rio	*University of California, Davis*
Dr. Randall Singer	*University of Minnesota*
Dr. Martin Smith	*University of California, Davis*
Alex Wright, Ph.D. candidate	*University of California, Davis*
Dr. Xiang (Crystal) Yang	*University of California, Davis*
Yating (David) Zhao, graduate student	*University of California, Davis – CLEAR Center*
Project Staff	*NAHMS Goat 2024 study*

D | APPENDIX

The following pages represent high-level summaries of a selection of the studies and projects supported by AUS during FY 23-24. These include information regarding the purpose, design, impact, and progress for each project. Summary findings are described where appropriate, dependent upon project progress. These summary documents are meant to provide detailed background information and progress updates for AUS' varied efforts and do not represent final reports or results for the studies included.

I. Unveiling the Risk of Co-Selecting Antibiotic Resistance Associated with Alternative Growth Promoters in the Swine Production

The project aims to assess the potential risks of elevating antimicrobial resistance associated with the use of alternative growth promoters, namely pharmacological levels of zinc oxide and copper, which are commonly used in postweaning swine to prevent diarrhea

Questions

The study aims to assess the prevalence and underlying mechanisms of developing dual resistance in enterotoxigenic *E. coli* (ETEC) pathogens and gut microbiome of postweaning pigs in response to dietary metal overexposure.

Research Team

University of California, Davis CLEAR Center researchers and specialists with extensive experience with swine production systems, management practices, and antibiotic resistance.

Summary

The project will commence with a series of proof-of-concept in vitro experiments, examining the impact of metal overexposure on antimicrobial resistance in ETEC pathogens isolated from infected pigs. Subsequently, a metagenomic analysis will be conducted in vivo on fecal and digesta samples collected from postweaning pigs fed diets high in zinc and copper. The metagenome will be assembled, annotated, and aligned with the antimicrobial resistance and resistance gene databases to identify antibiotic and metal-resistant genes, respectively.

Study Progress

The team has finished the extraction of DNA from fecal samples and has submitted the purified samples to the University of California, Davis Genome Center for shotgun metagenome sequencing.

Next Steps

For in vitro research, complete all minimum inhibitory concentration assays and part of cellular assay for pathogen adhesion and gut barrier function. For in vivo research, finish taxogenomic classification and identification of antimicrobial resistance and metal-resistant genes.

Photo credit: UC Davis CLEAR Center

Significance to CA

California has an inventory of 177,000 pigs valued at over $15 million dollars and cash receipts over $23 million annually. Although California makes up less than 1% of the total US pork production, it accounts for 13% of the national pork consumption. A significant portion of therapeutic antibiotics used in pigs combats postweaning diarrhea (PWD) primarily caused by ETEC infection. Reducing the dependence on therapeutic antibiotics and curbing antimicrobial resistance dissemination are paramount for ensuring the sustainability of swine production. Despite the overall effectiveness of zinc and copper in controlling PWD, debates persist regarding their impact on the gut microbiome. Considering the widespread use of zinc in postweaning diet, it is imperative to evaluate the potential risk and gain understanding of mechanisms involved in antibiotic resistance in swine production.

How This Helps AUS

This project supports the welfare of postweaning piglets in swine production and uncovers the genomic mechanisms underlying the co-selection of antimicrobial resistance and metal resistance in zinc and copper overexposure. This information will be used to help combat antibiotic resistance in agricultural animals in California.

II. Ingested Organic Acids Through Diet or Water to Ensure a Smooth Transition at Weaning of Piglets

Short chain fatty acids (SCFA) have exhibited strong in vitro antimicrobial effects against enterotoxigenic *E. coli* (ETEC); however, limited research has investigated the efficacy of SCFA on intestinal health and disease resistance of weaned pigs

Questions

This study will seek to answer whether SCFA enhance intestinal development and integrity, enrich for microbiomes associated with robust animals, and reduce intestinal inflammation caused by post-weaning ETEC, thus improving overall disease resistance, welfare, and growth of newly weaned pigs.

Research Team

University of California, Davis CLEAR Center researchers and specialists with extensive experience with swine production systems, management practices, and antibiotic resistance.

Summary

Newly weaned pigs will receive water or feed supplemented with SCFA derivatives. All pigs will be challenged with ETEC and gut health (integrity, inflammation, microbial diversity, and mucosal metabolites) will be evaluated relative to whether animals were given antibiotics/antimicrobials. Pigs will also be examined for the expression of SCFA receptors in the small intestine. Metagenomic analysis targeting antimicrobial resistance genes will be analyzed for fecal samples collected at the end of the experiment.

Study Progress

Serum and colon digesta samples have been successfully submitted for metabolomics analysis.

Next Steps

DNA sample isolation and library preparation for genetic sequencing analysis will be conducted.

Photo credit: UC Davis CLEAR Center

Significance to CA

California has an inventory of 177,000 pigs valued at over $15 million dollars and cash receipts over $23 million annually. Although California makes up less than 1% of the total US pork production, it accounts for 13% of the national pork consumption. The proposed research project will target one of the critical stages in pig production and an economically important enteric disease, ETEC infection. ETEC infection also significantly contributes to the therapeutic use of antibiotics in swine production. All the information collected, and all knowledge gained from this research program, addresses the needs of the industry and facilitates better management strategies to enhance swine sustainability and to reduce the need for antibiotic use and risk of antibiotic resistance in pork production.

How This Helps AUS

Outcomes of this research will advance basic and applied information about organic fatty acid derivatives as a nutritional and health intervention to keep pigs healthy, and subsequently may increase profitability for pork producers by providing alternative ingredients to antibiotics traditionally used in feed, thereby reducing antibiotic usage while maintaining animal welfare.

III. Animal Poo and You—Staying Healthy Around Animals: A Multimedia Primer on Zoonotic Disease Prevention for Youth in Agriculture

A continuation of a previous project, featuring a new collaboration with the University of California Agriculture and Natural Resources (UC ANR) and creative teams, to complete a comprehensive curriculum aimed toward youth aged 5 to 8 years old engaging in agricultural activities about zoonotic diseases and antibiotic drug resistance in an interactive and engaging format

Questions

How do we educate youth regarding zoonotic diseases? What are the most important lessons to be learned that would be understood by this age group? How do you engage youth in the 5 to 8-year-old age range in learning about zoonotic diseases and pathogens, including antibiotic drug resistance?

Research Team

CDFA AUS has contracted with UC ANR and creative teams to complete the final module for the five-part collection that will be a comprehensive package to be distributed to educators.

Summary

Animal Poo and You is an animated curriculum designed to introduce basic concepts of zoonotic disease prevention to youth engaged in organized agricultural education. Lessons are designed and developed using vocabulary and images, presented in a musical narrative, appropriate to youth aged 5-8 years.

Each video lesson presents the youth with information on a specific area of zoonotic disease prevention and may be viewed individually or as a complete series of videos. An *Instructor's Guide* provides a summary of the video lesson, additional information on the topic, and activities and resources that the classroom teachers can use to further reinforce the learning objectives. In addition, a *Facilitator's Guide for Nonformal Educators* aids in meeting the goals of the lesson for both youth and educators, such as 4-H leaders and parents

Study Progress

The team has developed the song script and storyboards and is recording the audio. Final storyboards and audio recording are anticipated to be sent to the animators in January 2025.

Next Steps

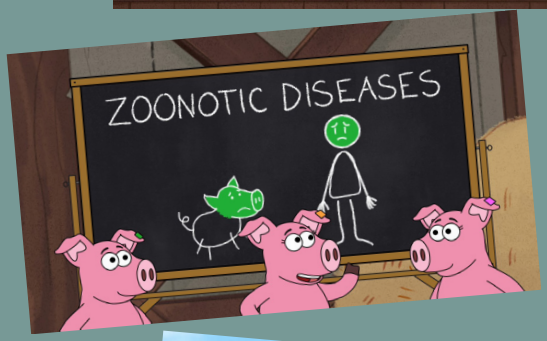
Once the last module is complete, the finalized package will be available via AUS' website for free, public use.

Significance to CA

There is a lack of educational materials regarding zoonotic diseases, and how to stay healthy while being around livestock, for the 5- to 8-year-old age group. The completion of this engaging curriculum seeks to fill this known knowledge gap for this age range and is meant to be utilized by agricultural teachers and general educators alike. The final module will continue to use the power of storytelling via a cast of whimsical characters, musical vignettes, and interactive written activities to help convey scientific concepts. This educational package will be released for free, public use once completed.

How This Helps AUS

Education of youth on the importance of zoonotic diseases and antibiotic resistance helps raise awareness of these key concepts that they will carry into their future in agriculture. By educating youth at a young age about the importance of these concepts, AUS will be able to better support California's livestock community through science-based learning and a One Health approach.



IV. Antimicrobial Stewardship on the Dairy: Development and Implementation of On-Farm Training for Farmworkers

Professional development and promotion of six interactive, online training modules related to antimicrobial usage in dairy cattle that are geared towards entry-level farm workers, available in both English and Spanish

Questions

Can professionally developed, interactive training modules enhance farmworkers' skills, knowledge, and perceptions related to judicious antimicrobial use? Will making the modules free and easily accessible online reach a broader audience of dairies throughout California?

Research Team

This project is led by veterinarian researchers with relevant expertise at University of California (UC), Davis, School of Veterinary Medicine and The Ohio State University, College of Veterinary Medicine. The team is joined by investigators from UC Cooperative Extension and collaborators from UC Davis, School of Veterinary Medicine who have extensive backgrounds in dairy production and medicine.

Summary

Six professionally developed training modules will cover the following topics: antibiotic resistance, treatment protocols, health assessments, clinical mastitis, metritis, and lameness. As described by Garzon et al. (2023), the six draft modules were preliminarily tested on 12 California and Ohio dairy farms as proof-of-concept for further development of an on-farm framework for dairy farmworkers.

The finalized modules will be provided in both English and Spanish, with the target audience being entry-level farmworkers in dairies. The modules, and any accompanying extension materials, will be published online and available free of charge. A certificate of completion will be awarded to learners. The team will also host a producer webinar, a veterinarian-focused meeting, conference presentation(s), and ongoing working group meetings to promote and disseminate the curriculum to interested stakeholders.

Study Progress

The training modules are currently being converted into professional, interactive modules. The anticipated module completion timeframe is fall 2024 with web publication to follow and promotion to dairy producers through June 2025.

Next Steps

A working group will be established and meet quarterly for the continued promotion and dissemination of the project curriculum and related materials.

Significance to CA

Effective training for new and existing dairy farm employees can support the advancement of antimicrobial stewardship practices in California dairies. The average tenure of California dairy workers is 3.5 years with 35% of workers having been on the farm less than a year. With Spanish being a frequently spoken language for most of the agricultural work force in the United States, providing free resources in both English and Spanish allows the modules to reach a broader audience.

How This Helps AUS

The availability and promotion of this training curriculum supports the advancement of antimicrobial use and stewardship practices in California dairies, as outlined in AUS' mandate. Successful outcomes, as demonstrated in Garzon et al. (2023), will include development of dairy farmworkers' knowledge and skills of disease identification, recognition of the importance of implementation of a farm veterinarian's established treatment protocol, improved animal health outcomes, and optimized antimicrobial use.

V. Impacts of dietary protein source on the physiological health of white sturgeon, *Acipenser transmontanus:* additional considerations for selecting the optimal diet

Validating a nutritional approach for enhancing both production parameters and disease resistance to promote better aquaculture stewardship practices

Questions

Can a model be developed to comprehensively and reliably assess species-specific aquaculture diets? Specifically, how does dietary protein source impact the health and production parameters of white sturgeon? Do dietary protein sources affect the susceptibility of potentially pathogenic enteric bacteria of fish to standard antimicrobials?

Research Team

This project involves collaboration among various subject matter experts at the University of California, Davis. The team includes a principal investigator who is a Cooperative Extension Aquaculture Specialist with strong connections to California's aquaculture industry, as well as a co-principal investigator who is skillful in characterizing foodborne pathogens. Together, the project team has expertise in the fields of aquaculture medicine and health, food safety, and antimicrobial resistance and susceptibility.

Summary

This research aims to better understand the relationship between diet and overall fish health to support the California sturgeon aquaculture industry's sustainability and production goals. The study seeks to develop a practical model incorporating diverse endpoints to comprehensively evaluate experimental diets, indicating a dietary effect on the antimicrobial susceptibility of enteric bacteria. A key objective is to disseminate findings through peer-reviewed publications and regional aquaculture conferences. Additionally, extension resources, such as an article and a video, will be produced to explain the significance of diet in fish health and how new diet formulations could help prevent disease and promote responsible use of antimicrobials.

Study Progress

This project is currently in the early stages of study execution, which involve obtaining research supplies, coordinating sample submissions, and optimizing laboratory testing methods.

Next Steps

Once testing methodology is complete, the project team will finalize their dietary model based on data from a related study and begin experimental diet trials in early 2025.

Significance to CA

Almost 85% of domestic white sturgeon are raised in California, generating nearly $8.8 million in revenue in 2018, making them an important component of California's growing aquaculture industry. Providing an optimal species-specific diet is one strategy that can enhance the production of fish while simultaneously improving health, resulting in improved protection against disease and reducing pressures for development of antimicrobial resistance.

How This Helps AUS

This research aims to catalyze a positive change in California's growing aquaculture industry. By developing a model for creating species-specific diets, these findings can enhance both fish production parameters and support antimicrobial stewardship goals by aiding in disease prevention. The findings of this study will be shared with industry members and the public through scientific literature and various extension efforts, inspiring a new approach to maintaining healthy fish in aquaculture. By optimizing animal health throughout the production cycle with these enhanced diets, the occurrence of diseases and the need for antimicrobial therapy can be reduced, paving the way for a healthier and more sustainable industry.