



ANNUAL REPORT

2019

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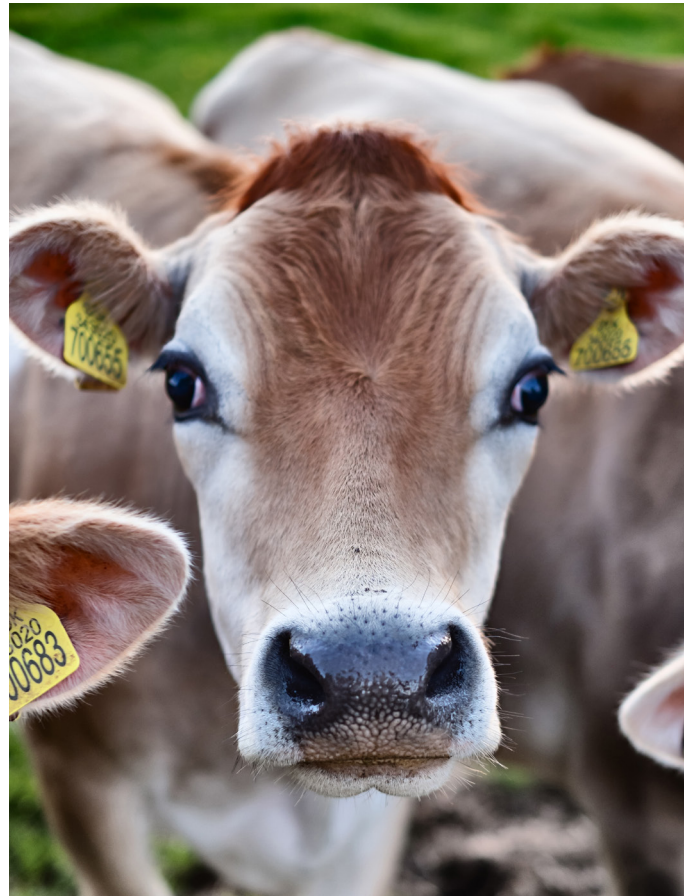
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REPORT & PROGRAM SCOPE

2019 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 2019 Annual Report focuses on the 2018 - 2019 fiscal year (FY 18 - 19), spanning July 1, 2018 - June 30, 2019. The following sections in this report provide a description of the work AUS has completed during this timeframe, including highlights from different projects. Additionally, the Appendix provides more detailed information for a selection of AUS' studies and projects.



The Antimicrobial Use & Stewardship Program

In response to growing concern surrounding antibiotic resistance, the California Legislature passed a first-in-the-nation law requiring veterinary oversight for all uses of medically important antibiotics in livestock. California Senate Bill 27 (SB 27, Hill), signed by Governor Brown in 2015, resulted in additions to the California Food and

Agricultural Code that address the sales and use of medically important antibiotics for livestock, development of voluntary antibiotic stewardship guidelines and best management practices, and monitoring of antibiotic use, as well as patterns of antibiotic resistance in bacteria.

CDFA established the AUS program, which consists of a team of veterinarians, epidemiologists, and specialists working to preserve the efficacy of antibiotic drugs by establishing a comprehensive antibiotic stewardship and monitoring program.



PROGRAM HIGHLIGHTS



Our Objectives

The AUS program works collaboratively to meet the mandates of California's law, Livestock: Use of Antimicrobial Drugs (Food and Agriculture Code [FAC] Sections 14400 - 14408). This includes supporting the collection, generation, and/or aggregation of data and information related to antibiotic sales, use, and resistance associated with livestock to further the development of resources and efforts to mitigate resistance. The program

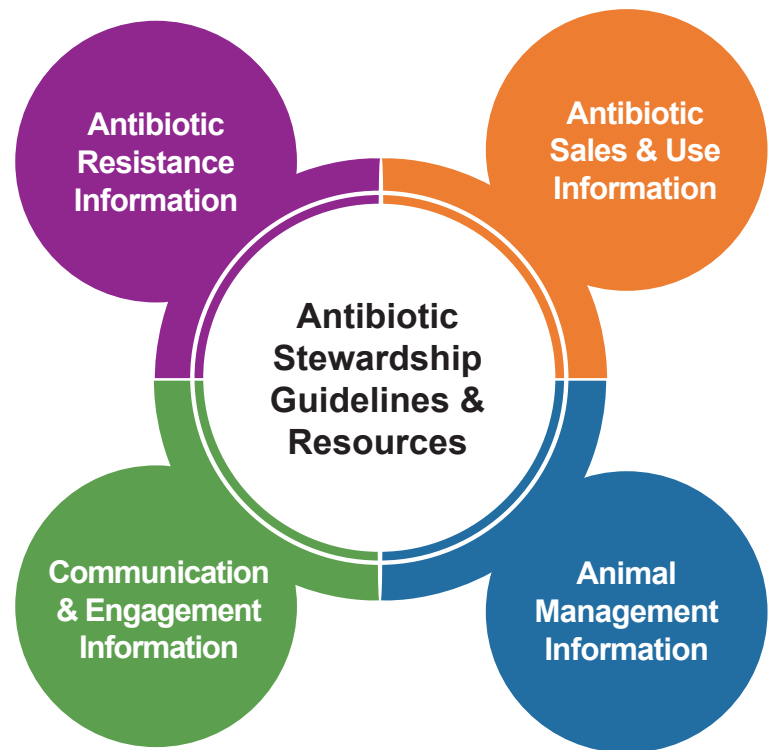
evaluates both its short- and long-term strategic needs, as well as gaps in scientific knowledge and other available sources of information, when determining how to allocate its limited resources. This is done with a focus on providing a range of information to California stakeholders, as intended by the law. In addition to synergizing with other partners and activities as opportunities arise, AUS applies its resources to the creation of a long-term, sustainable framework for antibiotic use and resistance monitoring and stewardship that generates evidence for future decision-making.



How We're Accomplishing Our Objectives

Over the past fiscal year, AUS focused on engaging the major livestock industries in California, extending our reach to key organizations and experts, and continuing contact with retail sales and feed production facilities. The program has worked diligently to gather information on animal management practices, antibiotic sales, use, and resistance, and to improve our communication and outreach efforts.

A major part of the program's success has come from our collaborative spirit. AUS partners with academia, industry experts, and state and federal entities. The information AUS has gathered thus far supports our evidenced-based approach to promoting responsible antibiotic use in California's animal agricultural industries and mitigating the emergence and persistence of antibiotic resistance. Antibiotic resistance is an issue that spans multiple disciplines and requires a unique and tailored approach. The array of projects developed by AUS' collaborative efforts are as diverse as California's livestock industries and appropriately varied to tackle the complexity of the issue at hand. This report provides highlights from these efforts with additional information available in the supplemental appendix. More comprehensive results will be published as separate reports and in peer-reviewed scientific literature.





Program Products

What materials and information have we produced?

The AUS program has produced materials, including informational documents, aimed at increasing awareness and understanding of the changing legal requirements for the purchase and use of antibiotics, communicating what AUS does, promoting antibiotic stewardship, and encouraging engagement in our data collection efforts. Additionally, findings from research supported by AUS will be published in peer-reviewed journals, contributing to current scientific knowledge. The following are highlights from the products our program has produced over the past fiscal year. Please refer to the Appendix for additional detail.



Report to the Legislature

AUS' approach to and results from outreach and monitoring efforts

VFD Summary Report

Summary of veterinary feed directive (VFD) orders in California

Guidelines for Judicious Use of Antimicrobials in Livestock

Informs responsible decision-making for antibiotic use, based on current scientific principles and state and federal requirements



AUS Outreach & Engagement

1,260 people
attended **27** presentations



1,630 farms participated
across **6** projects



507
livestock drug
retailers visited



VCPR Practice Model

Supports creative solutions within the context of a veterinarian-client-patient relationship (VCPR) in California, especially in youth agriculture

Regulations for CDFA-licensed drug retailers finalized and effective

Regulations for CDFA-licensed retailers to sell medically important antimicrobial drugs (MIADs)



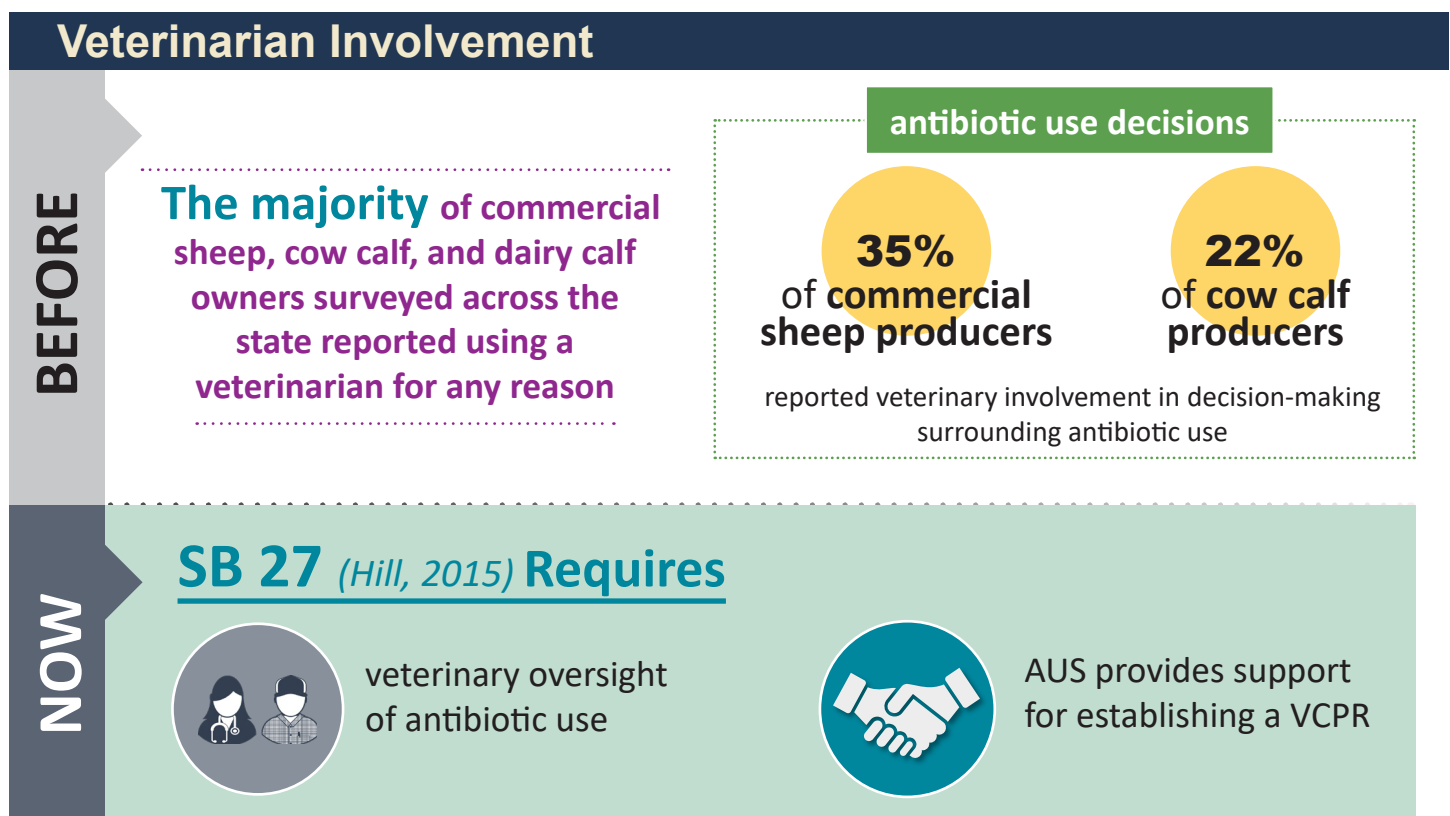
Find AUS publications and materials on our
website: <https://www.cdfa.ca.gov/ahfss/AUS/>

Above is a selection of highlights from the work AUS completed over FY 18 - 19; it is not comprehensive.

Animal Management Strategies

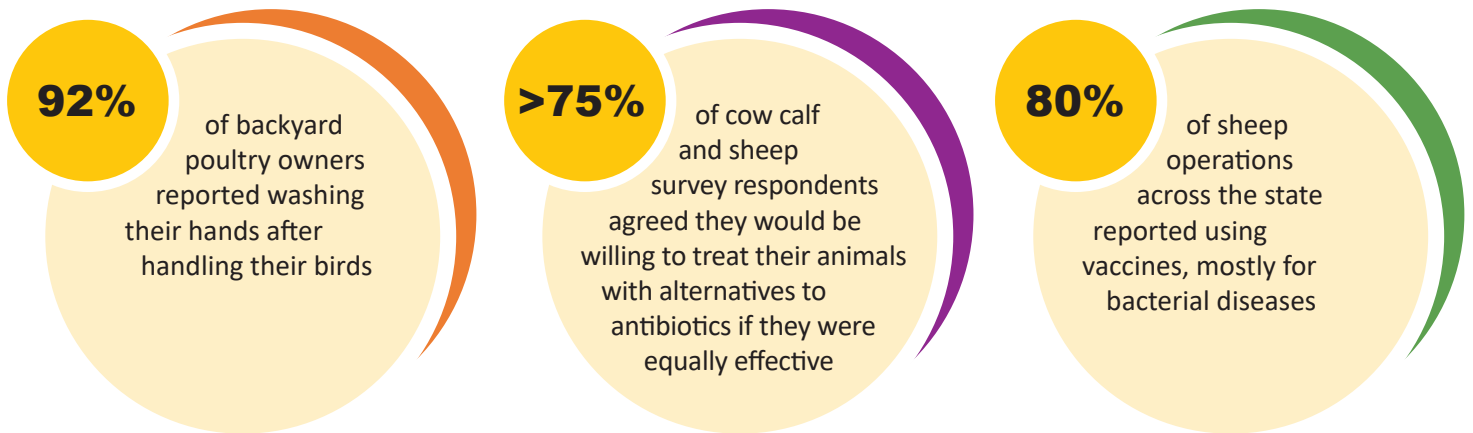
What health promotion and infection prevention practices are being used in California?

A major component of achieving judicious use of antibiotics is understanding how California livestock are managed. Good management practices promote animal health and are a crucial step in a holistic approach to antibiotic stewardship. Gathering information on these practices as they are currently implemented in California helps to identify methods that may impact antibiotic resistance, as well as opportunities for education and outreach. Systematic review of existing literature also provides scientific basis for AUS' animal management recommendations. The following infographics highlight AUS' work in this area over the past fiscal year, including information gathered on veterinary involvement and on-farm practices and the systematic review process. Please refer to the Appendix for additional detail; more information will be provided in separate publications.



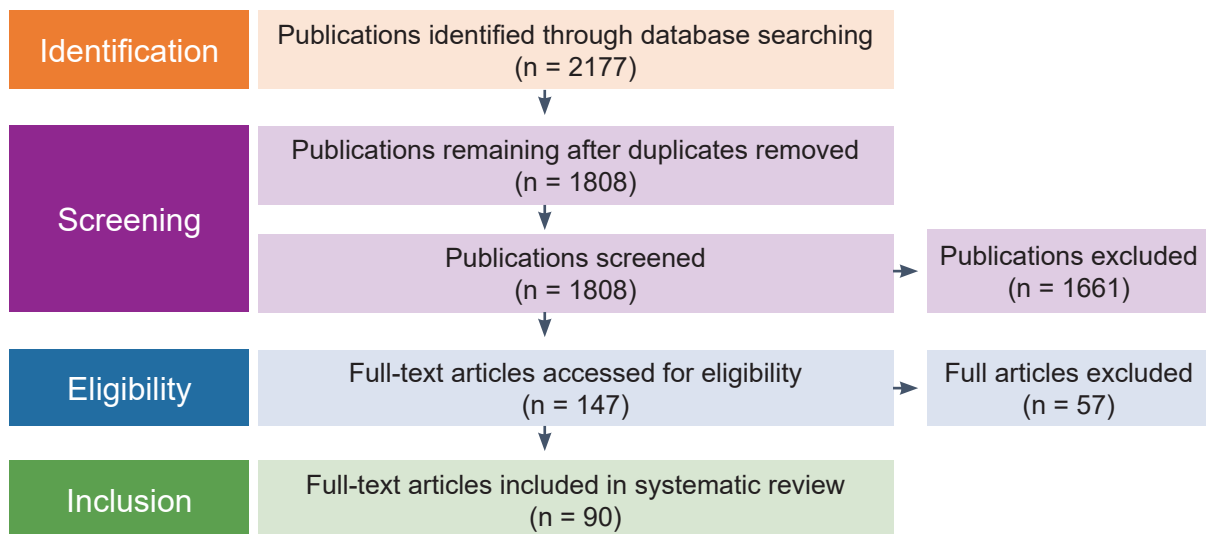
Above is a selection of highlights from the work AUS completed over FY 18 - 19; it is not comprehensive.

On-farm Practices



Systematic Reviews

The below diagram, taken from an AUS project reviewing direct-fed microbial supplementation for dairy calves, represents the time-intensive steps involved for this type of thorough literature review.



Above is a selection of highlights from the work AUS completed over FY 18 - 19; it is not comprehensive.

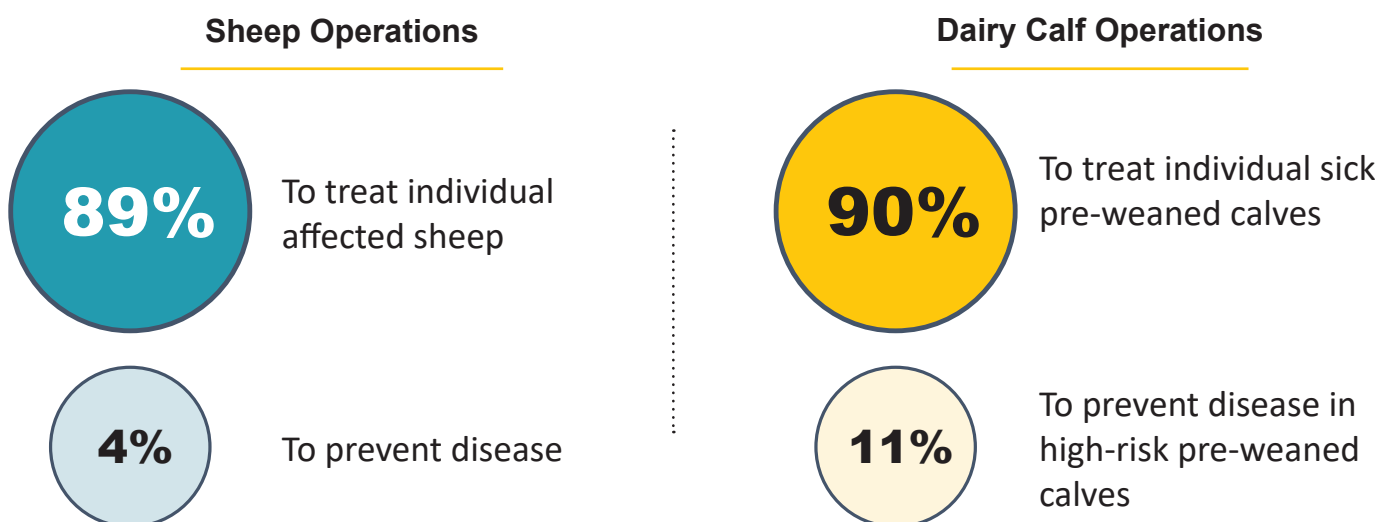
Antibiotic Sales & Use

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

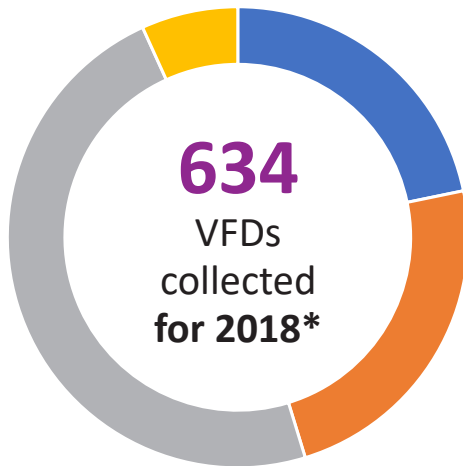
Understanding how antibiotics are being used in California allows us to monitor trends, develop relevant education materials, and promote antibiotic stewardship and judicious use practices. AUS has gathered information on antibiotic use through surveys of livestock producers, on-farm evaluations of antibiotic use, and veterinary feed directives (VFDs), which authorize antibiotic sales. By collecting VFDs issued in the state, the program can look at the antibiotics authorized for use in feed. This data provides an estimate of the antibiotics that may have been dispensed in medicated feed for various species and indications, rather than the actual amount of medicine administered to the animal or group. Surveying and collaborating with producers to learn more about their on-farm antibiotic use practices allows AUS to complement VFD data and gain a more complete picture of animal health. The following are highlights from AUS' work in this topic area over the past fiscal year. Please refer to the Appendix for additional detail; more information will be provided in separate publications.

Antibiotic Use Decision-making Before 2018 CA Law Changes

Understanding how and why antibiotics are used is essential for antibiotic stewardship. For example, survey participants were asked how antibiotics were most commonly used on their operations.



Above is a selection of highlights from the work AUS completed over FY 18 - 19; it is not comprehensive.



Indications for Antibiotic Use

As Authorized in Veterinary Feed Directives (VFDs)

- Respiratory Disease (138)
- Gastrointestinal Disease (149)
- Both (304)
- Other (43)

TOP 3

Reported Diseases/Disorders for Which Antibiotics Were Used



LAMBS

- 1 Respiratory Disease
- 2 Diarrhea
- 3 Injury



EWES

- 1 Respiratory Disease
- 2 Lameness
- 3 Reproductive Issues



PRE-WEANED CALVES

- 1 Pink Eye
- 2 Respiratory Disease
- 3 Diarrhea / Scours



COWS AND REPLACEMENT HEIFERS

- 1 Pink Eye
- 2 Lameness
- 3 Respiratory Disease

This information on oral and injectable antibiotic use has helped in guiding literature reviews to provide evidence-based resources on sustainable management practices for disease prevention

Operations reported using antibiotics in water



sheep
7%



cow calf
1%

Operations reported using antibiotics in feed



sheep
7%



cow calf
2%

Above is a selection of highlights from the work AUS completed over FY 18 - 19; it is not comprehensive.
*Number of VFDs collected for calendar year 2018. For more information, see AUS' VFD Summary Report.

Antibiotic Resistance

How are we looking at trends in antibiotic resistance?

Over the FY 18 - 19, AUS began collecting antibiotic susceptibility information from bacterial samples, with an eye toward future data needs. In many of our studies, antibiotic drug use data is paired with findings from on-farm sampling and testing for antibiotic resistance. This type of on-farm resistance data is not generally available on a broader scale, especially as accompanied by information on clinical disease and husbandry practices. Further, when on-farm samples are available from the same operations and are collected repeatedly, we can gain valuable insight on the effects of antibiotic use and other management practices on antibiotic resistance over time. AUS also leverages existing sources for samples when available, including stored clinical samples, to describe historic and ongoing trends in the sampled populations. The following are highlights from AUS' work in this topic area over the past fiscal year. Please refer to the Appendix for additional detail; more information will be provided in separate publications.



Dairy Calves

456 on-farm fecal samples were collected from dairy calves resulting in **1,406** *E. coli* isolates to test for resistance characteristics

Backyard Poultry



238 samples were collected by backyard poultry owners and tested for *E. coli*, *Enterococcus*, *Salmonella*, and *Campylobacter*, resulting in **473** isolates to test for resistance characteristics



Salmonella Dublin

250 isolates of *Salmonella* Dublin, isolated from cattle between 1993-2019, are being tested by the California Animal Health & Food Safety Laboratory System (CAHFS) for resistance characteristics

CAHFS MICs



AUS funding enables CAHFS to offer more robust antibiotic susceptibility testing. An average of **100** MIC* tests per month have been performed for clinicians, since December 2017

Above is a selection of highlights from the work AUS completed over FY 18 - 19; it is not comprehensive.

**Minimum inhibitory concentration (MIC).*

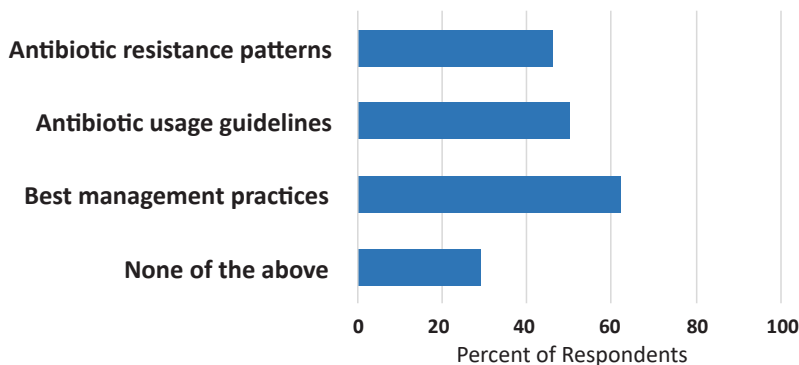


Communication & Engagement

How are we reaching people and improving our efforts?

AUS continues to communicate and educate livestock owners, livestock drug retailers, and veterinarians on the requirements of the law and the foundations of antibiotic stewardship. Across AUS' surveys of agricultural populations in California, the program continually seeks feedback on what information and education materials would be most useful and how people would like to receive this information. AUS uses this feedback to improve our methods of communication, engage more volunteers to participate in our studies, and disseminate information to larger audiences. The following are highlights from AUS' work in this topic area over the past fiscal year. Please refer to the Appendix for additional detail; more information will be provided in separate publications.

Topics of Interest to Backyard Livestock Owners in San Luis Obispo



Cow calf and sheep producers across California prefer to receive educational materials via

Website & Newsletter
paper

Online Training
for livestock drug retailers
in development
(English & Spanish)

Continuing Education on antibiotic use and stewardship provided for California veterinarians through **webinars & in-person presentations**

>35% of cow calf and sheep producers surveyed across California indicated interest in staff training materials

A study of backyard poultry utilized an existing network of livestock owners & tested methods for having owners submit samples from their own flocks over time

Above is a selection of highlights from the work AUS completed over FY 18 - 19; it is not comprehensive.

Looking Ahead

What's next?

The FY 18 - 19 was full of accomplishments and successes for AUS. However, our work is just beginning. To combat antibiotic resistance associated with livestock and contribute to the protection of both animal and public health, we must continue collecting and sharing information that is meaningful and actionable. Further, we must continue our endeavors in outreach and evidence-based education that ensure current and future success of the program. The following highlights describe a selection of upcoming AUS projects anticipated for the next fiscal year.



Bovine Respiratory Disease in Dairy Heifers

A study looking at antibiotic use and resistance in dairy heifers with and without bovine respiratory disease, assessing resistance in respiratory tract bacteria with information on farm management and fecal bacteria



Commercial Poultry

A study of commercial poultry operations in California exploring antibiotic use and resistance



National Goat Study

Expansion of the USDA National Animal Health Monitoring System 2019 Goat Study to triple the number of goat producers surveyed and obtain a representative sample from California



Decision-support Tool for Managing Mastitis

A tool that incorporates economic, herd history, and other factors to support herd-level mastitis management decisions on California dairies



VFD Collection

Continued collection and analysis of VFD orders



Species-specific Antibiotic Stewardship Guidelines

Resources for veterinarians and livestock owners that are based on scientific evidence, taking into account the unique disease concerns and animal management strategies of specific species

Above highlights describe a selection of upcoming AUS projects anticipated for FY 19 - 20; it is not comprehensive.



GETTING INVOLVED & ACKNOWLEDGEMENTS

How to Get Involved

Participation in AUS surveys and studies is both confidential and voluntary! Your participation in our efforts to gather information is essential to the program's success and ensures 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! The program's goal is to use real-world, accurate information to provide producers and veterinarians with practical recommendations in support of antibiotic stewardship. Antibiotic resistance is a threat to 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.



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



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

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 advisory boards and stakeholders play a key role in providing guidance and support at all stages of our research, outreach, and education efforts. Veterinarians, livestock owners, and other stakeholders 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:

Sarai Acosta	<i>University of California, Davis</i>
Dr. Sharif Aly	<i>University of California, Davis</i>
Dr. Kris Clothier	<i>California Animal Health and Food Safety Laboratory System</i>
Dr. Heather Fritz	<i>California Animal Health and Food Safety Laboratory System</i>
Dr. Ashley Hill	<i>California Animal Health and Food Safety Laboratory System</i>
Dr. Emmanuel Okello	<i>University of California, Davis</i>
Philip Paulson	<i>California Polytechnic State University, San Luis Obispo</i>
Dr. Maurice Pitesky	<i>University of California, Davis</i>
Dr. Noelia Silva del Rio	<i>University of California, Davis</i>
Dr. Randall Singer	<i>University of Minnesota</i>
Dr. Jennifer Wishnie	<i>California Polytechnic State University, San Luis Obispo</i>



APPENDIX

The following pages represent high-level summaries of a selection of the studies and projects supported by AUS during FY 18 - 19. 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 more detailed background information and progress updates for AUS' varied efforts and do not represent final reports or results for the studies included.



I. Dairy Calf

Surveillance Model for Antimicrobial Drug Use and Resistance in California Dairy Calves

Question: How has on-farm management and antibiotic use changed since implementation of the US Food and Drug Administration's Veterinary Feed Directive (VFD) and what impact might future regulations have? What are the trends in antibiotic use and antibiotic resistance in dairy calves from birth to weaning?

Significance to CA: Antibiotic resistance is a growing concern for animal and human health, with antibiotic use in livestock the focus of new national and state policies. California is the largest dairy-producing state in the US, representing an important segment of the state's economy. Better understanding the industry, animal management practices, and animal health in California dairies, and how new policies affect them, will help to inform Department decisions and recommendations.

Research Team: The UC Davis investigators on this project have extensive experience working in dairy cattle production medicine, infectious disease, and management practices, and have conducted numerous statewide surveys to cattle producers.

Summary: To study antibiotic use, antibiotic resistance, changes in dairy cattle management, and perceptions following state and federal legal changes, UC Davis researchers conducted a survey of California dairy calves in conjunction with fecal sample collection from a subset of herds.

Study Progress: A total of 1,361 surveys were mailed to licensed Grade A dairies in California in 2017, with 169 (12%) responses received. The survey investigated dairy characteristics, calf health management, antibiotic use, and knowledge and opinions regarding current regulations. Responding dairies had an average of 246 (range: 160 - 332) pre-weaned calves. Most producers (83%) were aware of the changes in regulations promoting stewardship and judicious use of antibiotics. A large majority of producers reported using antibiotics in pre-weaned calves for treatment of sick animals and following label instructions. Approximately 97% of respondents reported that veterinarians were the principal consultants on disease management decisions and over 70% reported that veterinarians prescribed the use of antibiotics in feed or water. Respondents also provided information on the antibiotics most commonly delivered via liquid feed, solid feed, and water. From this initial survey, a select number of operations were enrolled for fecal sample collection to study antibiotic use and phenotypic antibiotic resistance of *E. coli* in pre-weaned dairy calves. Across the sampling period, 456 fecal samples were collected, resulting in 1,406 *E. coli* isolates. Findings will be presented in future publications.

How This Helps AUS: This study provides information on antibiotic use in pre-weaned dairy calves and the prevalence of antibiotic resistance among bacterial isolates from California dairies, helping further the Department's understanding of the industry's needs and expectations for the availability and effectiveness of antibiotics for pre-weaned calves. This study guides future monitoring efforts in the dairy industry, and the findings will feed directly into recommendations on best practices to promote the judicious use of antibiotics.

Next Steps: Peer-reviewed publications as well as UC Cooperative Extension (UCCE) and outreach efforts including newsletters, website updates and articles, and professional society meetings are underway. The results of this study will feed directly into AUS surveillance and stewardship activities.

II. Adult Dairy

Epidemiology of antimicrobial resistance on California dairies and the impact of antimicrobial treatments on phenotypic and genotypic resistance traits in commensal bacteria

Question: How are antimicrobial drugs being used to treat adult cattle on California dairies and how does this use affect antimicrobial resistance?

Significance to CA: As California is the largest dairy-producing state in the nation, the industry represents an important segment of California's food security and economy. Better understanding the effects of antimicrobial treatments on antimicrobial resistance on dairy farms will help to inform dairy producers and their veterinarians as they implement judicious use principles of these drugs.

Research Team: The UC Davis investigators on this project have extensive experience working in dairy cattle production medicine, infectious disease, and management practices, and have conducted numerous statewide surveys of cattle producers.

Summary: To study antimicrobial drug use and antimicrobial resistance, UC Davis researchers have conducted surveys, evaluations of treatment records, and repeated sampling of adult dairy cattle and their environment at participating farms. Bacterial isolates from these samples are being analyzed for phenotypic and genotypic susceptibility to antibiotics. Associations between antimicrobial drug use and antimicrobial resistance will be statistically evaluated.

Study Progress: Surveys to evaluate antimicrobial use and other characteristics were mailed in 2018 to 1,282 licensed Grade A dairies in the state of California, with a total of 149 (12%) responses received. A follow-up survey of the same dairies to evaluate changes in antimicrobial use was mailed in 2019. A total of 240 cows on selected dairies statewide have been enrolled (120 cows each during summer and winter cohorts) in longitudinal studies of antimicrobial treatments and resistance. Fecal sampling of these cows across multiple seasons is in progress. Phenotypic antimicrobial susceptibility testing of indicator organisms in fecal samples is also in progress. Five hundred stored samples from an earlier study of mastitis pathogens have been tested for phenotypic antimicrobial susceptibility. Genotypic analysis of samples collected from cattle and their environment as part of the overall study is pending.

How This Helps AUS: This study provides information on antimicrobial drug use and antimicrobial resistance among bacterial isolates from adult cattle on California dairies, helping to identify trends and inform future monitoring efforts in the dairy industry. The findings will feed directly into recommendations on best practices to promote the judicious use of antimicrobial drugs.

Next Steps: Meetings with participating producers to share results and discuss findings are already underway. Peer-reviewed publications reporting on the study findings and presentation of results at professional meetings are planned. The results of this study will feed directly into AUS surveillance and stewardship activities.

III. *Salmonella* Dublin

Retrospective Analysis of Trends in Antimicrobial Resistance in Salmonella Dublin from Clinical Bovine Isolates in California 1993 - 2019

Question: The purpose of this study was to evaluate *S. Dublin* isolated from cattle between 1993 - 2019 for trends in AMR and evaluate the predicted efficacy of veterinary drugs used in the treatment of this pathogen.

Significance to CA: *Salmonella* Dublin is a host-adapted *Salmonella* causing significant morbidity and mortality in calves and adult cattle. In addition to acutely infected animals shedding the organism in feces, milk, and colostrum, development of a carrier state with intermittent shedding over months or years has also been reported. Human infections from this serovar are often severe, with septicemia and death as common sequelae; and, antimicrobial therapy is critical to maximize successful outcomes in these patients.

Research Team: California Animal Health and Food Safety (CAHFS) Laboratory

Summary: Microbroth dilution minimum inhibitory concentration (MIC) testing was performed on 250 isolates to provide clinically relevant data for veterinarians, as well as surveillance information for comparison with national databases. Susceptibility of *Salmonella* Dublin to many commonly used veterinary antimicrobial drugs has declined across the timeframe represented by the samples tested, sometimes markedly.

Study Progress: Testing of isolates is completed and statistical analysis is ongoing. Final results are anticipated to be submitted for peer-review scientific publication.

How This Helps AUS: Although these data were obtained from a sample of diagnostic laboratory isolates for which animals likely had previous antimicrobial therapy, and so may not be representative of all populations of animals nor *Salmonella* Dublin bacteria present in healthy animals, this information indicates that empirical antimicrobial therapy for *S. Dublin* in veterinary patients is not likely to be effective. Alternative intervention strategies are needed to control this pathogen in bovine herds, particularly as antimicrobial drug stewardship principles are followed, and to minimize risks of exposure in humans.

Next Steps: The results of this work will be presented at the American Association of Veterinary Laboratory Diagnosticians' annual conference, held in Fall 2019 in conjunction with the US Animal Health Association's 2019 annual meeting, and the associated manuscript is in progress.

IV. Beef Cow Calf

AUS 2017 Cow Calf Survey

Question: Prior to federal and state legal changes regarding antibiotic use in livestock, how and why were antibiotics and veterinarians being utilized by cow calf producers in California?

Significance to CA: California raises an estimated 1,570,343 beef cattle and calves, with 10,254 ranches across the state (NASS 2017). This represents an important livestock industry in California and includes cow calf operations. In order for AUS to develop practical and evidence-based guidelines and materials, it is essential to understand how antibiotics and veterinarians were being utilized by cow calf producers prior to changes in the law and how we can use this information in promoting and monitoring progress toward closer relationships and improved antimicrobial stewardship moving forward.

Research Team: CDFA Antimicrobial Use and Stewardship (AUS) team, in consultation with subject matter experts and collaboration with the California Cattlemen's Association (CCA).

Summary: AUS researchers conducted an anonymous, mail-out survey asking cow calf producers across the state to voluntarily provide information on their antibiotic use and animal health management practices for calendar year 2016. The survey also gathered information regarding record keeping, antibiotic purchasing habits, relationship with a veterinarian, and decision-making surrounding these topics, as well as how respondents would prefer to access educational and training materials in the future.

Study Progress: In Fall 2017, the AUS 2017 Cow Calf Survey was mailed out to 11,589 presumed beef cattle producers across the state, with the intent to reach all cow calf producers. Through early 2018, 937 surveys were completed and returned, representing a response rate of 8%. These 937 participating cow calf operations reported on 180,690 beef cattle and calves for calendar year 2016, providing antimicrobial use and animal management information for 9% of beef cow ranches and 12% of total beef cattle and calves in California (beef cattle and calves include cattle on cow calf operations; NASS 2017). Most respondents (92%) indicated they were the owner of the operation.

Of those respondents who reported herd size, total herd size (including pre-weaned calves, replacement heifers, and cows) ranged from 1 to 4,500 cattle, with an average (mean) herd size of 197 cattle and a median of 61 cattle. The majority of respondents indicated they routinely recorded which antibiotics they used and when antibiotic use began. Most information was kept in paper form (including pocket notebooks).

A majority (58%) of respondents reported using the services of a veterinarian in 2016, prior to the implementation of state and federal antibiotic use laws. Of those who indicated use of a veterinarian: 51% reported their veterinarian made regular or routine visits, 34% reported the veterinarian was called out only for emergencies, and 12% indicated the veterinarian was primarily contacted over the phone or by email (3% of respondents did not indicate how their veterinarian was primarily used). Twenty-two percent of respondents reported a veterinarian was involved in decision-making surrounding antibiotic use on the operation prior to federal and state legal changes. These findings identify an opportunity for the program to support and foster these essential veterinarian-client-patient relationships moving forward, as antibiotic use now requires veterinary oversight in California.

For 2016, 2% of all respondents reported administration of antibiotics in feed and 1% reported administration in water. Sixty percent of respondents reported individual animal administration via oral (i.e., bolus or drench) or injectable routes: 52% of all respondents reported administering oral and/or injectable antibiotics to their

pre-weaned calves (**Figure 1**) and 43% reported oral and/or injectable use in their cows and replacement heifers (**Figure 2**). Without considering any other factors, such as herd size or geographic location, the overall top diseases or disorders for which oral or injectable antibiotics were reported to have been individually administered in pre-weaned calves were: pink eye, respiratory disease, and diarrhea/scours or other digestive issue. The overall top diseases or disorders leading to oral or injectable antibiotic administration reported for cows and replacement heifers were: pink eye, lameness, and respiratory disease. Eighty percent of respondents agreed that they would be willing to treat their animals with alternatives to antibiotics if they were equally effective.

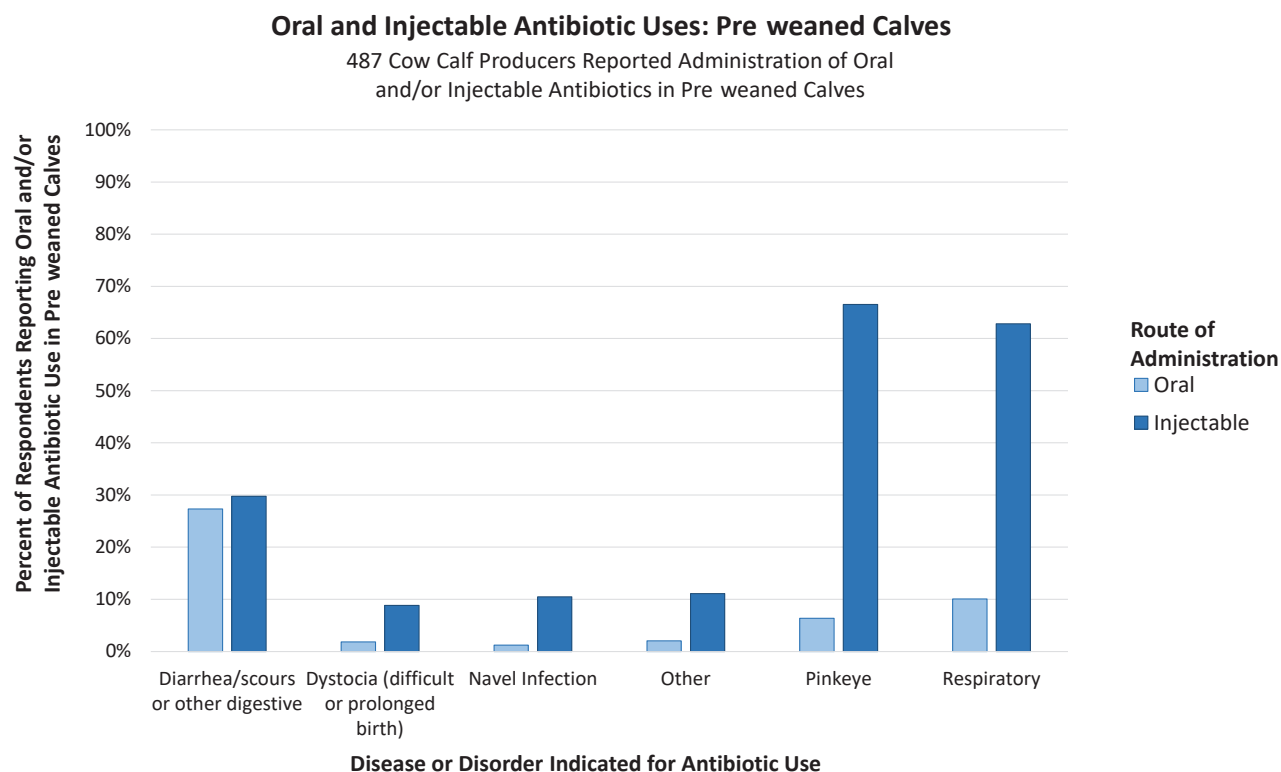


Figure 1. Oral and Injectable Antibiotic Uses: Pre-weaned Calves. Figure shows reported indications for use of oral (bolus/drench) and injectable antibiotics in pre-weaned calves. Data from AUS survey of California cow calf producers. Overall, 487 of 937 surveys (52%) reported use of oral and/or injectable antibiotics in pre-weaned calves in 2016, prior to state and federal antibiotic use law changes, for any of the six disease/disorder options provided (including “Other”). Respondents could select more than one antibiotic used for a single disease or disorder.

Oral and Injectable Antibiotic Uses: Cows and Replacement Heifers

403 Cow Calf Producers Reported Administration of Oral and/or
Injectable Antibiotics in Cows and Replacement Heifers
California, 2016

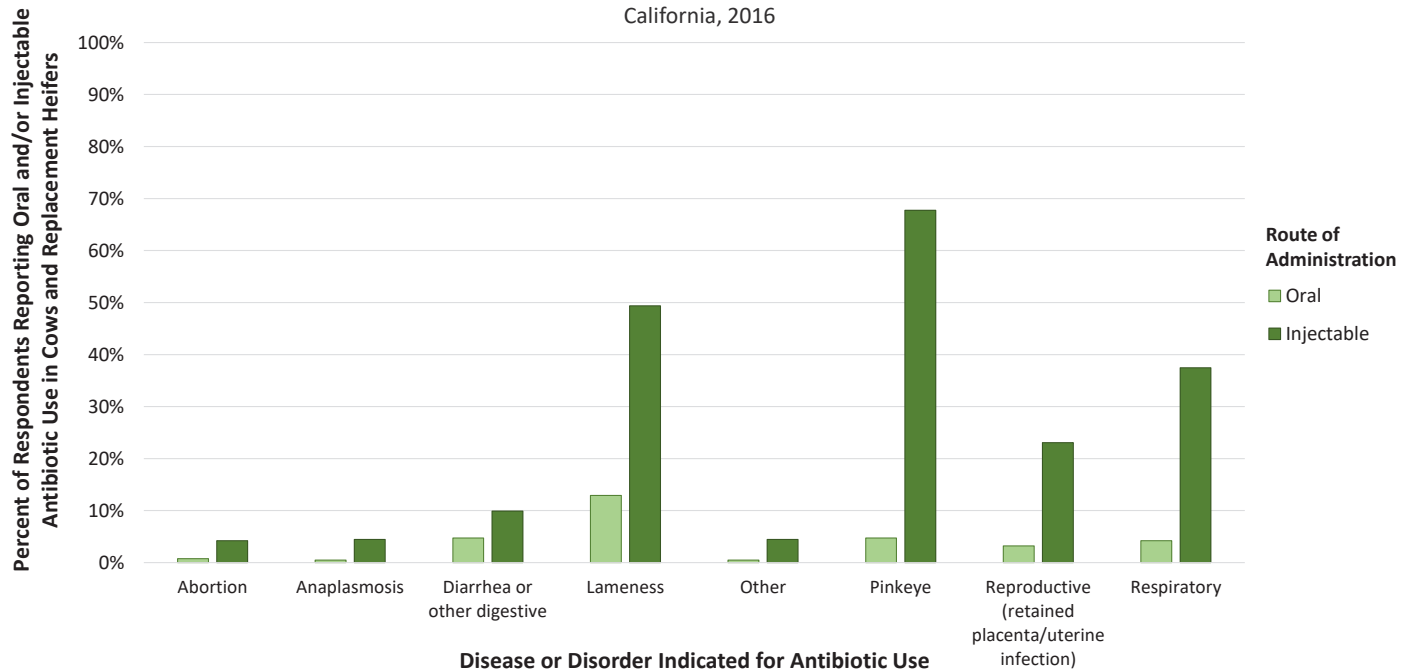


Figure 2. Oral and Injectable Antibiotic Uses: Cows and Replacement Heifers. Figure shows reported indications for use of oral (bolus/drench) and injectable antibiotics in cows and replacement heifers. Data from AUS survey of California cow calf producers. Overall, 403 of 937 surveys (43%) reported use of oral and/or injectable antibiotics in cows and replacement heifers in 2016, prior to state and federal antibiotic use law changes, for any of the eight disease/disorder options provided (including “Other”). Respondents could select more than one antibiotic used for a single disease or disorder.

How This Helps AUS: AUS integrates information gathered from this survey when creating evidence-based educational materials and guidelines, as well as using it to inform program activities and reporting. Findings from the AUS 2017 Cow Calf Survey have directly informed the priorities for literature review and educational material development of AUS’ Beef Focus Group, comprised of a panel of subject matter experts. In addition to informing materials developed, survey results also guide how AUS communicates and disseminates information. For instance, 30% of respondents reported belonging to specific Beef Quality Assurance (BQA) programs and 37% indicated that their practices were influenced by BQA standards. Respondents also reported preferring to access information via paper newsletter or website and 41% indicated interest in training materials for staff. Additionally, as this survey asked about calendar year 2016, it provides a starting point for assessing trends in California over time.

Next Steps: Analysis of survey responses is ongoing and will continue to feed directly into AUS stewardship activities. Findings are not final and more information regarding survey responses, as well as resulting materials and guidelines, will be provided in future publications.

V. Commercial Sheep

AUS 2018 Commercial Sheep Survey

Question: Prior to state legal changes regarding antibiotic use in livestock, how and why were antimicrobials and veterinarians being utilized by commercial sheep producers in California?

Significance to CA: California has the second-largest number of sheep in the nation and ranks #5 for the number of sheep operations nationally (NASS 2017 Census). Better understanding of antimicrobial use and animal health management practices on sheep operations will inform development of best management guidelines and judicious use principles for sheep producers and their veterinarians.

Research Team: CDFA Antimicrobial Use and Stewardship (AUS) team, in consultation with subject matter experts and collaboration with the California Wool Growers Association (CWGA) and the California Sheep Commission.

Summary: AUS researchers conducted an anonymous mail-out survey to provide information on antimicrobial use and animal health management practices associated with commercial sheep in California. Information was captured regarding antimicrobial use practices, purchasing habits, record keeping, and decision making for calendar year 2017. Other information was also gathered, including operation demographics, vaccination practices, veterinarian usage, and best ways to communicate information to the industry in the future.

Study Progress: The survey was mailed out to 658 commercial sheep producers across California; 108 surveys were completed and returned (response rate 16%). These responses provided information on antimicrobial use and health management practices for operations responsible for 110,715 total sheep, representing 23% of all sheep in California (per NASS 2017 Census). Ninety-one percent of respondents indicated they were the owner of the operation.

Average herd size was 1,044 sheep and median herd size was 102 (range: 1 - 33,282). The majority of respondents indicated they routinely recorded which antibiotics they used, the start date of treatment, and the ID or group number of the animal(s) being treated. Most information was kept in paper form.

The majority (59%) of respondents reported using the services of a veterinarian in 2017, prior to the implementation of state antibiotic use laws. Of those sheep producers who indicated use of a veterinarian: 64% used them for emergency calls, 63% consulted them over the phone or by e-mail, and 36% used them in a regular or routine fashion. Thirty-five percent of all commercial sheep producers reported veterinary involvement in decision-making surrounding antibiotic use prior to state legal changes. These findings identify an opportunity for the program to support and foster these essential veterinarian-client-patient relationships moving forward, as antibiotic use now requires veterinary oversight in California.

For 2017, 7% of all survey respondents reported administering antibiotics in feed and 7% reported administering them in water. Most (71%) reported administering antibiotics to individual animals via oral (i.e., bolus or drench) or injectable routes. Fifty-eight percent of respondents reported administering oral and/or injectable antibiotics to their lambs (**Figure 1**) and 64% reported oral and/or injectable use in their ewes (**Figure 2**). Survey participants were asked how antibiotics were most commonly used on their operations: 89% to treat individual affected sheep and 4% to prevent disease. Without considering any other factors, such as herd size or geographic location, the overall top diseases or disorders for which oral or injectable antibiotics were reported to have been individually administered in lambs were: respiratory disease, diarrhea,

and injury. The overall top diseases or disorders for which oral or injectable antibiotics were reported to have been individually administered in ewes were: respiratory disease, lameness, and reproduction issues. Greater than 75% of sheep survey respondents agreed they would be willing to treat their animals with alternatives to antibiotics if they were equally effective. Eighty percent of sheep operations across the state reported using vaccines, mostly for bacterial diseases.

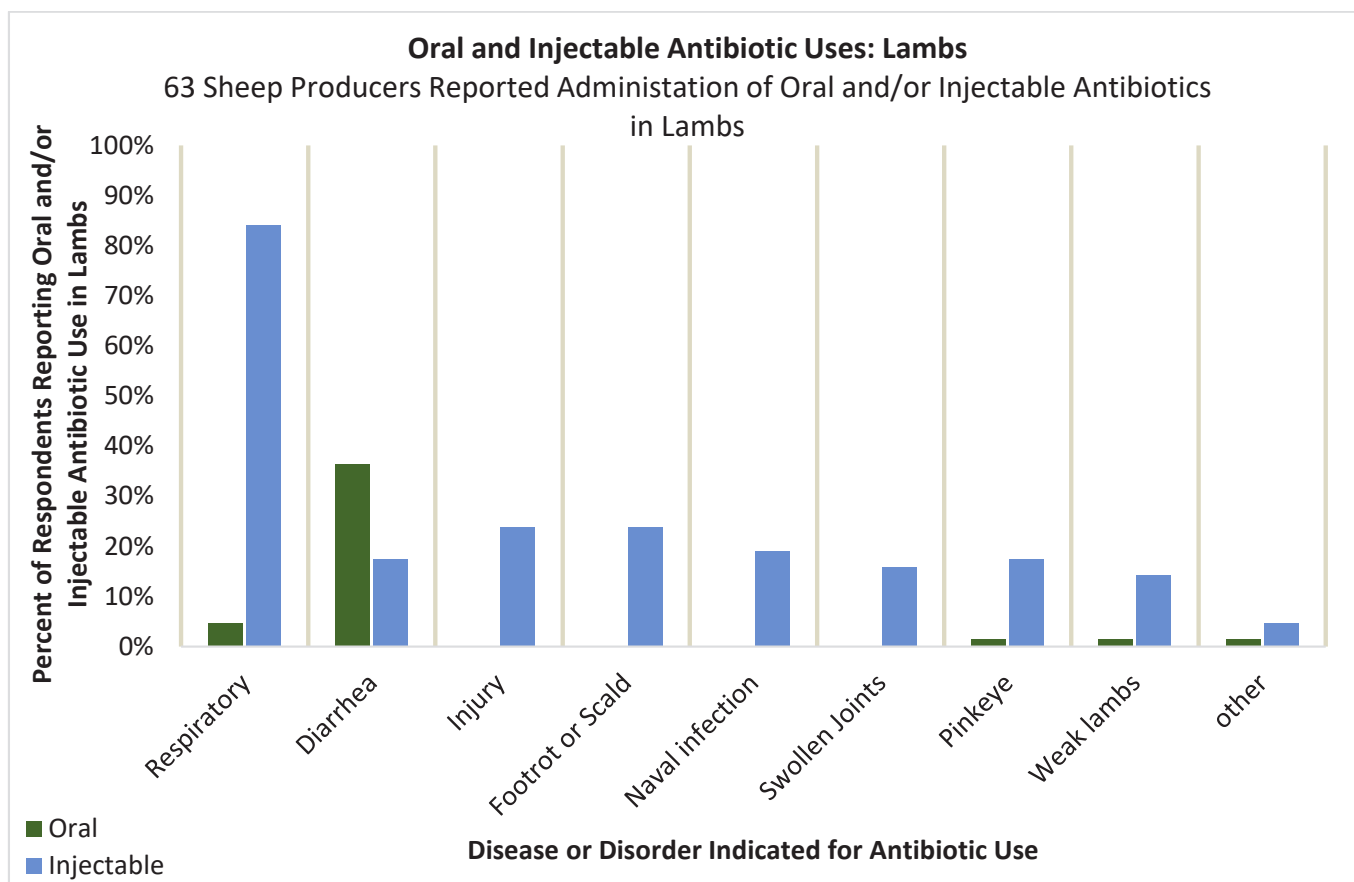


Figure 1. Oral and Injectable Antibiotic Uses: Lambs. Figure shows reported indications for use of oral (bolus/drench) and injectable antibiotics in lambs. Data from AUS survey of California commercial sheep producers. Overall, 63 of 108 surveys (58%) reported use of oral and/or injectable antibiotics in lambs in 2017, prior to state antibiotic use law changes, for any of the nine disease/disorder options provided (including “Other”). Respondents could select more than one antibiotic used for a single disease or disorder.

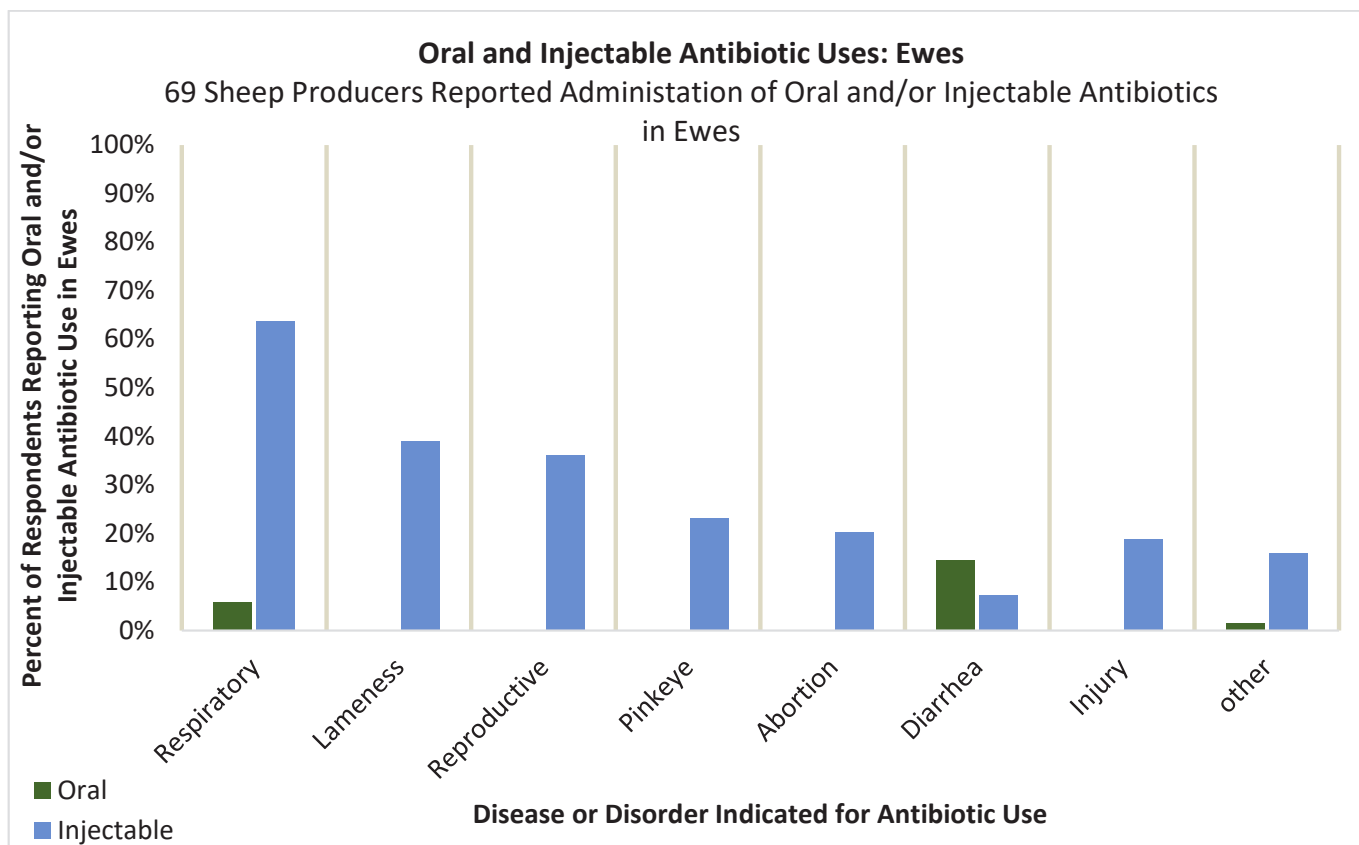


Figure 2. Oral and Injectable Antibiotic Uses: Ewes. Figure shows reported indications for use of oral (bolus/drench) and injectable antibiotics in ewes. Data from AUS survey of California commercial sheep producers. Overall, 69 of 108 surveys (64%) reported use of oral and/or injectable antibiotics in ewes in 2017, prior to state antibiotic use law changes, for any of the eight disease/disorder options provided (including “Other”). Respondents could select more than one antibiotic used for a single disease or disorder.

How This Helps AUS: AUS integrates information gathered from this survey when creating evidence-based educational materials and guidelines, as well as using it to inform program activities and reporting. Findings from the AUS 2018 Commercial Sheep Survey have directly informed the priorities for literature review and educational material development of AUS’ Sheep Steering Committee, comprised of a panel of subject matter experts. In addition to informing materials developed, survey results also guide how AUS communicates and disseminates information. For instance, 69% of respondents indicated they would be interested in obtaining information on relevant bacterial antibiotic resistance patterns, antibiotic usage guidelines, and best management practices developed by AUS. And over 35% of sheep producers surveyed across California indicated interest in staff training materials. The top ways respondents would be interested in receiving such information are: website, paper newsletters, printed handbooks, and workshops/presentations/talks. Additionally, as this survey asked about calendar year 2017, it provides a starting point for assessing trends in California over time.

Next Steps: Analysis of survey responses is ongoing and will continue to feed directly into AUS stewardship activities. Findings are not final and more information regarding survey responses, as well as resulting materials and guidelines, will be provided in future publications.

VI. Commercial Poultry

Longitudinal On-Farm Broiler Antimicrobial Resistance Investigation in California

Question: How have changes in antibiotic use from both consumer demand as well as changes in federal and California law, impacted antibiotic resistance in *Salmonella* and *Campylobacter* in California's commercial poultry industry?

Significance to CA: The California commercial poultry industry is one of the state's agricultural leaders and ranks 12th in the nation in broiler production. In California and across the nation, poultry producers are responding to consumer demand as well as changes of both California and federal laws promoting the judicious use of antibiotics in livestock. Understanding how this change impacts resistance is critical to both public health and the health of California's commercial poultry industry, which has an enormous economic impact and produces sales more than \$2.5 billion annually.

Research Team: The research team leading this project at University of Minnesota has a long-standing relationship with most California poultry producers and has coordinated many nationwide studies of poultry producers for the US Food and Drug Administration.

Summary: This study is tracking trends in antibiotic usage within poultry farms in California and relating these usage patterns to matched biological samples to test for antibiotic resistance. Farms across the state are sampled multiple times over a two-year period and analyzed for the presence of resistant *Salmonella*, *Campylobacter*, and *E. coli*, as well as resistance genes. This project is an extension of a national, on-farm study of poultry producers that has been ongoing since 2016.

Study Progress: Eighty broiler chicken houses and 21 turkey houses have been sampled across California, some more than once. More than 50 isolates of *Campylobacter* and 80 isolates of *Salmonella* are being analyzed for antibiotic resistance profiles. Thus far, the majority of the *Campylobacter* isolates are *C. jejuni* and a diversity of *Salmonella* serotypes has been recovered. The information gathered from the genetic analysis will be matched with antibiotic use data that has been gathered from all houses included in the project.

How This Helps AUS: California law mandates that AUS gather information from the major livestock segments, regions with considerable livestock production, and representative segments of the food production chain regarding antibiotic use and implement surveillance for antibiotic resistance. This study provides AUS with crucial insight into the antibiotic administration practices and bacterial resistance patterns of important pathogens found at commercial poultry farms across the state. The findings from this study will help AUS develop appropriate antibiotic stewardship guidelines and best management practices for the commercial poultry industry.

Next Steps: The number of enrolled broiler and turkey farms will be expanded, and layer operations around California will be added to the study. Peer-reviewed publication regarding study findings and presentation at professional meetings are anticipated. The results of this study will also feed directly into AUS monitoring and stewardship activities.

VII. Backyard Poultry

Survey of antibiotic resistance and the subsequent promotion of judicious use of antibiotics in backyard poultry (BYP)

Question: How are antibiotics used in backyard poultry flocks in California and are there trends in antibiotic susceptibility associated with these flocks?

Significance to CA: Ownership of backyard poultry is increasing nationally and in California. Currently little is known about the status of antibiotic use and antibiotic resistance associated with backyard flocks; gathering information regarding antibiotic use and susceptibility from this group is an important component of food safety and public health in California that has not been studied to this point.

Research Team: UC Davis researchers whose specialties and previous work include focus on poultry health, antibiotic resistance in food animals, and food safety and veterinary epidemiology.

Summary: To provide information on antibiotic use and susceptibility associated with backyard poultry in California, UC Davis researchers surveyed a group of backyard poultry owners across the state, with parallel collection of biological samples. Biological samples were collected from the same flocks over four seasons (Summer 2018, Fall 2018, Winter 2019, Spring 2019) and bacterial isolates from these samples are being analyzed for phenotypic and genotypic susceptibility to antibiotics.

Study Progress: An initial survey was distributed to the approximately 600 backyard producers on the California BYP Census mailing list, as well as promoted through other related groups and social media. A total of 162 responses were received, providing historical antibiotic use information, as well as other poultry management and biosecurity practices, for flocks across California, including 34 counties. Average flock size for respondents was 14 birds (range: 1 - 180). Twelve percent of respondents reported having used antibiotics. Results showed a range of practices that were encouraging (92% of respondents wash their hands after handling their birds) to areas needing improvement (only 8% wear clothes other than their regular clothing when handling their birds). From this initial survey, a group was chosen to participate in repeated biological sampling, including 16 antibiotic treated and 20 antibiotic free flocks. Across the sampling periods, 238 samples were collected, and *E. coli*, *Enterococcus*, *Campylobacter*, and *Salmonella* were isolated for phenotypic susceptibility testing and genetic analysis. Analysis of the biological sampling (both molecular and non-molecular) and survey results is ongoing.

How This Helps AUS: Backyard producers represent an important segment of California's livestock owners and key opportunity for outreach and education. These findings will help in generating evidence-based outreach materials and provide a starting point for assessing trends in California over time. Additionally, AUS' efforts rely on voluntary participation from livestock and poultry owners. The success of this study design, with backyard poultry owners voluntarily collecting and submitting their own samples multiple times over the course of a year, informs AUS' approach to future monitoring.

Next Steps: Along with contributing to scientific literature through peer-reviewed publication(s), the findings from this study can serve as the basis for additional studies, with the possibility of leveraging the isolates and data already gathered to address other research questions. Additionally, study findings and antibiotic resistance information will be presented at conferences and UC Cooperative Extension (UCCE) events, and will feed directly into AUS resources and activities. Outreach will also be provided directly to study participants and posted on the UCCE Poultry website.

VIII. Assessment of Outreach Opportunities

California livestock owners: an assessment of familiarity with new antimicrobial rules and access to educational outreach

Question: How might CDFA characterize the small-scale livestock owners who were not associated with livestock groups (e.g., FFA, 4-H, state livestock associations) and understand their communication networks?

Significance to CA: Identifying the best ways to disseminate information is crucial, especially to livestock owners with no official livestock organization affiliation. Efficient and effective distribution of key information to all livestock owners will improve compliance with new laws, promote participation in voluntary antimicrobial stewardship and monitoring, and streamline communication channels in the event of an animal disease outbreak.

Research Team: A public health veterinarian within the College of Agriculture, Food, and Environmental Sciences at California Polytechnic State University, San Luis Obispo, and a California Polytechnic State University, San Luis Obispo master's degree student conducted this study. This work was completed with support from the Agricultural Research Institute.

Summary: The overarching goal of this study was to develop and implement a strategy to assess gaps in knowledge backyard producers may have and facilitate their access to the best practices. To accomplish this, an anonymous survey was administered to livestock owners in San Luis Obispo County. The survey was administered in-person at local farm supply stores, as well as online using livestock Facebook groups relevant to the area. Questions on the survey asked about respondents' level of understanding of antimicrobial rules, the types of livestock owned, how respondents accessed information about animal health and care, and whether they had connections to livestock groups and organizations.

Study Progress: The survey administration and analysis are completed. Overall, respondents unfamiliar with California laws related to antimicrobial use were also unfamiliar with federal rules and had lower self-assessed knowledge about the effects of antimicrobial use in livestock. Respondents with a connection to 4-H and FFA had greater familiarity with both federal and state rules concerning antimicrobial use in livestock.

How This Helps AUS: The most used sources of information by respondents unfamiliar with California laws related to antimicrobial use were other livestock owners, websites, veterinarians, and farm supply stores. There was no major difference in use of veterinarians between familiar and unfamiliar respondents. The results of this study will help CDFA better understand information networks used by small-scale livestock owners and design educational outreach materials and programs.

Next Steps: Tailor program outreach strategy to include more non-traditional methods, while continuing current strategy of outreach through structured agricultural and community organization channels, to leverage producer-to-producer communication. This study explored the importance of feed store outreach and underscores the utility of informal channels of communication in getting a message out early and often, to permeate the culture and become a part of casual conversations and community expectations.

IX. Literature Reviews

Analysis of scientific literature available for specific species to inform evidence-based recommendations for antibiotic stewardship and best management practices

Question: For a specific livestock population, what is the evidence to support the use of antibiotics, antibiotic alternatives, or management practices to improve animal health, response to therapy, or mitigate antibiotic resistance?

Significance to CA: AUS is mandated to develop evidence-based antibiotic stewardship guidelines to reduce the need for use of antibiotics. This may be accomplished by both implementing livestock management practices that aid in the prevention of infectious disease and using antibiotics selectively and responsibly. Together, optimizing animal health and minimizing the risk for developing antibiotic resistance.

Research Team: Based on species or disease of interest, a focus group of experts is established. These include university researchers whose specialties and work include focus on animal management and health, objective evaluation of research, translation of research, and development of educational resources.

Summary: A multidisciplinary focus group of experts who are knowledgeable on relevant diseases and livestock production will adopt a transparent process for the development of antibiotic stewardship guidelines. In the development of guidelines, it is critical to understand the breadth and quality of information available to set the foundation for recommendations of sound practices. This process includes a robust literature review, evidence analysis, formulation of evidence-based recommendations, and incorporation of expert consensus, with opportunity for stakeholder review and comment prior to publication. The scope of the materials produced are based on data collected from AUS surveys and studies, available evidence, legal considerations, and consensus made by the focus group of experts.

Study Progress: Currently, three focus groups of experts have convened for dairy calves, beef cows and calves, and sheep. Multiple structured literature searches are currently underway to provide a thorough review of available data with methods for excluding manuscripts that did not meet the standards for inclusion. For example, two systematic reviews have been conducted: one focused on probiotics supplementation for dairy calves and one on antimicrobial usage for the treatment of respiratory diseases in calves. For each review, the comprehensive search of the scientific literature retrieved over 2,000 publications, which were further analyzed to reveal those meeting the inclusion criteria (90 and 33 published manuscripts, respectively).

How This Helps AUS: AUS is mandated to develop evidence-based antibiotic stewardship guidelines to reduce the need for use of antibiotics and promote the judicious use of antibiotics when they are necessary. These focus groups of experts help the program develop and disseminate antibiotic stewardship guidelines that are based on a solid foundation of evidence, weighing the bulk of findings across multiple studies.

Next Steps: Along with contributing to scientific literature through peer-reviewed publications, findings and guidelines will be presented at conferences and workshops, incorporated into statewide quality assurance programs, and will feed directly into AUS resources and activities.

X. Regulated Use

Veterinary Feed Directive (VFD) Data Collection, Regulations for Livestock Drug Sales, and Drug Retailer Outreach

Research Team: CDFA Inspection Services Division staff on the Antimicrobial Use and Stewardship (AUS) team including environmental scientists, field inspectors, and other staff.

Summary: Since 2017, the AUS program has been working closely with livestock drug retailers and the feed industry to fulfill the mandates of California law regarding the sale of medically important antimicrobial drugs (MIADs) used in livestock species. These activities are accomplished through working directly with retailers and firms regarding antibiotic sales and use and through outreach and education regarding the law, antimicrobial resistance, and drug residues.

VFD Data Collection & Summary Report: VFDs authorize the use of animal feed containing MIADs. Collection of VFD orders began in 2017 with CDFA staff visiting all California feed mills and distributors, including visits to 507 livestock drug retailers. For calendar years 2017 and 2018, CDFA collected VFD data from all animal feed facilities that had filed a letter of intent to manufacture or distribute animal feed containing MIADs. VFD information collected is documented and analyzed for accuracy and completeness. Findings are utilized to identify areas for outreach and education and ensure compliance, as well as being summarized and reported. The first VFD report, “Summary Report: Veterinary Feed Directives, 2017-2019 Q1”, provides detailed information regarding VFD data collected and can be accessed on the AUS website.

Regulations for Drug Sales: Regulations developed by AUS were final and effective on August 16, 2018, with the program adopting California Code of Regulation (CCR) Title 3, Sections 5007-5015. These clarify the requirements for CDFA-licensed retailers to sell MIADs. In order to ensure compliance with these regulations, AUS held four trainings for retailers throughout 2018 and 2019, including two in Sacramento, one in Tulare, and one in San Diego. The program is currently working on offering these trainings online in both English and Spanish.

Drug Residue & Best Practice Visits: In 2018, California was one of seven states selected to receive funding from the US Food and Drug Administration to participate in their Drug Residue Prevention Program cooperative agreement. This agreement was implemented to help prevent illegal drug residues (including antibiotic residues) in animal-derived foods. CDFA has conducted 25 visits to firms having a recent drug residue violation. In addition to addressing recent violations, CDFA is contracted to conduct Best Practice visits to firms that have had a historical drug residue violation. These visits are conducted to get information on what firms have changed to avoid future violations, strengthen partnerships with firms, and provide targeted outreach and educational trainings.

How This Helps AUS: AUS’ work surrounding regulated use helps the program to fulfill the mandates of California law regarding sale and use of antibiotics, further identify and mitigate antimicrobial resistance in food-producing animals, and maintain a high standard in promoting public health and welfare.

Next Steps: AUS will continue to collect VFD orders issued in the state and enforce compliance according to state and federal requirements surrounding sales and use of antibiotics for livestock.