ANNUAL REPORT

2023

AUS
ANTIMICROBIAL USE
AND STEWARDSHIP

cdfa

1220 N Street, Sacramento, CA 95814
(916) 576-0300

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.*

also

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.*

Suggested citation:

California Department of Food and Agriculture. Antimicrobial Use and Stewardship Program Annual Report 2023. Sacramento, California, 2023.

To access this report online:
https://www.cdfa.ca.gov/ahfss/AUS/

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REPORT & PROGRAM SCOPE

2023 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 2023 Annual Report focuses on the 2022 - 2023 fiscal year (FY 22 - 23), spanning July 1, 2022 - June 30, 2023. This report continues the practice of informing legislators and stakeholders about the program's progression in its goal of becoming the leader 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.

This year, AUS celebrated 5 years since California law brought all medically important antimicrobial drugs (MIADs) under veterinary oversight and continued its success in providing science-based outreach to support California's livestock communities. During this time, AUS has collaborated with all major livestock sectors in California, including some minor species. AUS worked to survey and create resources for the aquaculture sector, a first-time collaboration for the program, gaining unique insights into this industry. AUS looks forward to continued opportunities to cooperate with industry and research partners.

The beginning of the calendar year brought unprecedented rain which caused widespread impacts to California livestock producers. While some of our projects were affected, the ever-resilient researchers and internal team kept projects progressing.

AUS ACHIEVEMENTS SINCE PROGRAM INCEPTION

through June 30, 2023

Awarded over **$6,100,000** to support AUS-focused research

Nearly **$2,600,000** to fund antimicrobial susceptibility testing capacities at CAHFS

Over **8,430** bacterial isolates tested in AUS-funded projects

Over **23** peer-reviewed papers published on AUS-funded research

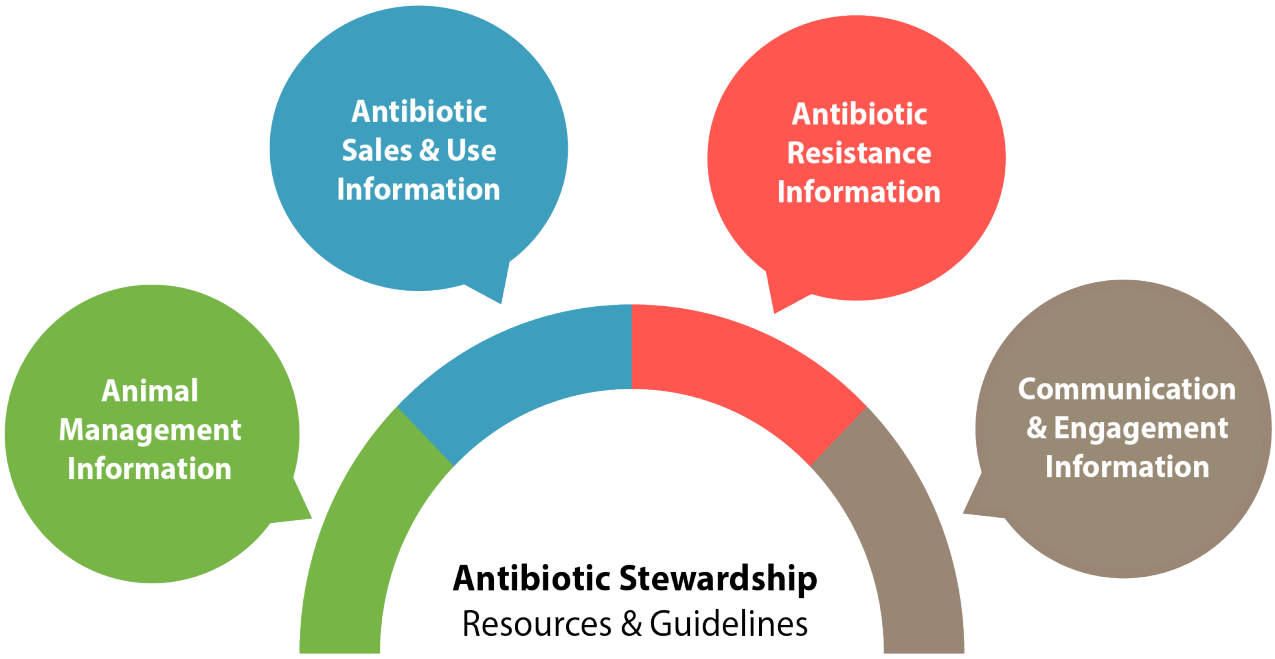
Over **2,530** producers and farms engaged

Over **3,270** attendees reached

June 2023: FDA follows California in bringing MIADs under veterinary oversight nationally

As the Food and Drug Administration implemented Guidance for Industry #263 towards the end of this fiscal year, the rest of the United States joined California in bringing all forms of medically important antimicrobials under veterinary oversight. AUS continues to contribute to the national conversation regarding antimicrobial resistance and science-based guidelines to help guide the judicious use of antimicrobials and slow the development of antimicrobial resistance.

The following sections in this report provide a description of the AUS program's work and accomplishments during FY 22 - 23, including select highlights from various projects.



PROGRAM HIGHLIGHTS

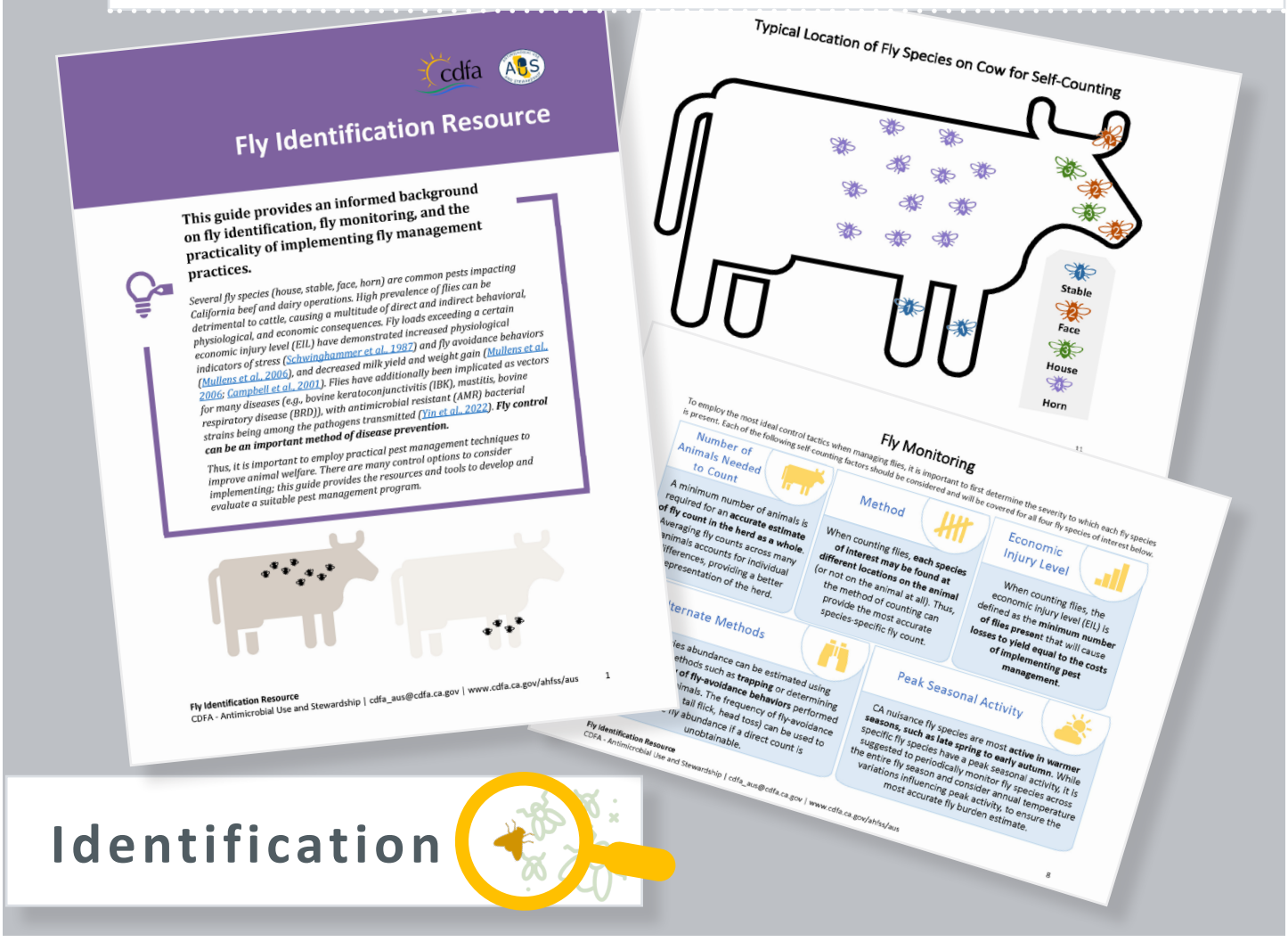
Program Products

What materials and information have we produced?

The AUS program has produced and distributed various materials this fiscal year, including infographic references to assist both producers and veterinarians with disease detection and management protocols to advance antibiotic stewardship, as well as educational materials on the use and development of clinical tools, such as antibiograms. AUS materials present evidence-based information regarding the 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 studies, trainings, educational outreach, and engagement efforts.

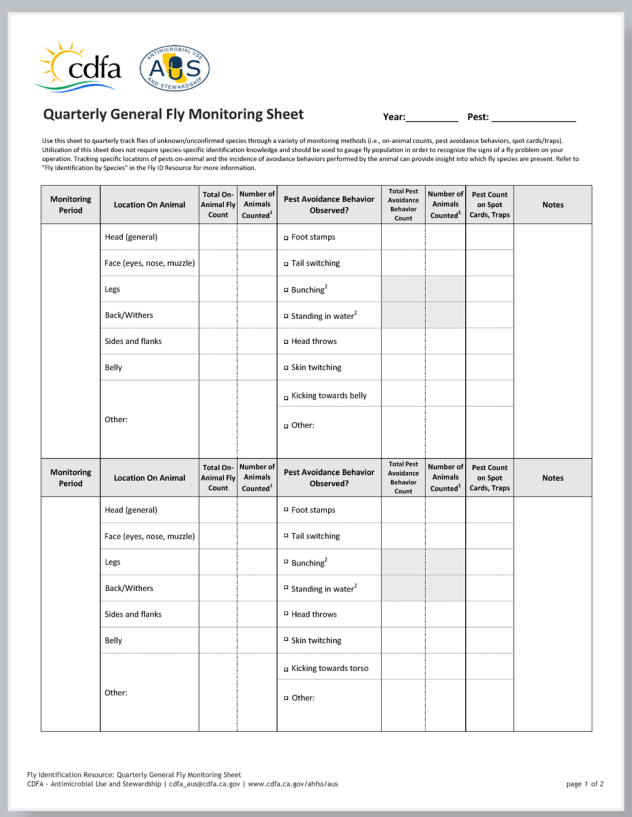
FLY IDENTIFICATION, MONITORING, AND TRACKING RESOURCES

Fly burden is a huge contributor to disease spread. To help alleviate this burden, AUS created engaging **cattle-specific fly resources** designed to support producers in identification, monitoring, and tracking of common cattle fly pests, as well as provide the framework for development and evaluation of on-farm pest management plans.



Above is a selection of highlights from the work AUS completed over FY 22 - 23; it is not comprehensive. Ongoing studies report results over a number of years; results presented here were compiled in FY 22 - 23.

FLY ID RESOURCES: Monitoring



Quarterly General Fly Monitoring Sheet

Year:_____ Pest: _____

Use this sheet to quarterly track flies of unknown/unconfirmed species through a variety of monitoring methods (i.e., on-animal counts, pest avoidance behaviors, spot cards/traps). Utilization of this sheet does not require species-specific identification knowledge and should be used to gauge fly population in order to recognize the signs of a fly problem on your operation. Tracking specific locations of pests on-animal and the incidence of avoidance behaviors performed by the animal can provide insight into which fly species are present. Refer to "Fly Identification by Species" in the Fly ID Resource for more information.

Monitoring Period	Location On Animal	Total On-Animal Fly Count	Number of Animals Counted[1]	Pest Avoidance Behavior Observed?	Total Pest Avoidance Behavior Count	Number of Animals Counted[1]	Pest Count on Spot Cards, Traps	Notes
	Head (general)			▫ Foot stamps				
	Face (eyes, nose, muzzle)			▫ Tail switching				
	Legs			▫ Bunching[2]				
	Back/Withers			▫ Standing in water[2]				
	Sides and flanks			▫ Head throws				
	Belly			▫ Skin twitching				
	Other:			▫ Kicking towards belly				
				▫ Other:				
Monitoring Period	Location On Animal	Total On-Animal Fly Count	Number of Animals Counted[1]	Pest Avoidance Behavior Observed?	Total Pest Avoidance Behavior Count	Number of Animals Counted[1]	Pest Count on Spot Cards, Traps	Notes
	Head (general)			▫ Foot stamps				
	Face (eyes, nose, muzzle)			▫ Tail switching				
	Legs			▫ Bunching[2]				
	Back/Withers			▫ Standing in water[2]				
	Sides and flanks			▫ Head throws				
	Belly			▫ Skin twitching				
	Other:			▫ Kicking towards torso				
				▫ Other:				

Fly Identification Resource: Quarterly General Fly Monitoring Sheet
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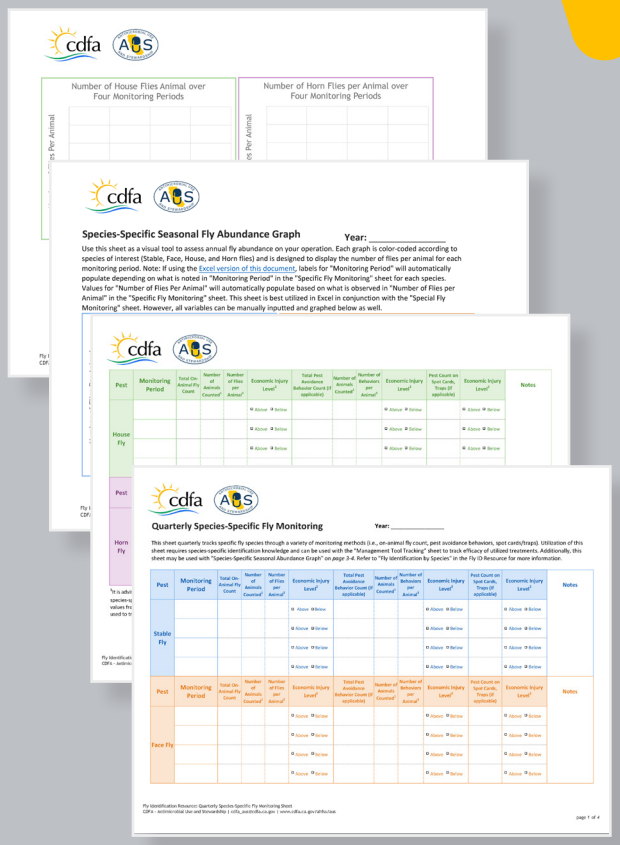

Species-Specific Seasonal Fly Abundance Graph

Year: _____

Use this sheet as a visual tool to assess annual fly abundance on your operation. Each graph is color-coded according to species of interest (Stable, Face, House, and Horn flies) and is designed to display the number of flies per animal for each monitoring period. Note: If using the Excel version of this document, labels for "Monitoring Period" will automatically populate depending on what is noted in "Monitoring Period" in the "Specific Fly Monitoring" sheet for each species. Values for "Number of Flies Per Animal" will automatically populate based on what is observed in "Number of Flies per Animal" in the "Specific Fly Monitoring" sheet. This sheet is best utilized in Excel in conjunction with the "Special Fly Monitoring" sheet. However, all variables can be manually inputted and graphed below as well.

Quarterly Species-Specific Fly Monitoring

Year: _____

This sheet quarterly tracks specific fly species through a variety of monitoring methods (i.e., on-animal fly count, pest avoidance behaviors, spot cards/traps). Utilization of this sheet requires species-specific identification knowledge and can be used with the "Management Tool Tracking" sheet to track efficacy of utilized treatments. Additionally, this sheet may be used with "Species-Specific Seasonal Abundance Graph" on page 3-4. Refer to "Fly Identification by Species" in the Fly ID Resource for more information.

Pest	Monitoring Period	Total On-Animal Fly Count	Number of Animals Counted[1]	Number of Flies per Animal[1]	Economic Injury Level[2]	Total Pest Avoidance Behavior Count (if applicable)	Number of Animals Counted[1]	Number of Behaviors per Animal[1]	Economic Injury Level[2]	Pest Count on Spot Cards, Traps (if applicable)	Economic Injury Level[2]	Notes
Stable Fly					▫ Above ▫ Below				▫ Above ▫ Below		▫ Above ▫ Below	
					▫ Above ▫ Below				▫ Above ▫ Below		▫ Above ▫ Below	
					▫ Above ▫ Below				▫ Above ▫ Below		▫ Above ▫ Below	
					▫ Above ▫ Below				▫ Above ▫ Below		▫ Above ▫ Below	
Face Fly					▫ Above ▫ Below				▫ Above ▫ Below		▫ Above ▫ Below	
					▫ Above ▫ Below				▫ Above ▫ Below		▫ Above ▫ Below	
					▫ Above ▫ Below				▫ Above ▫ Below		▫ Above ▫ Below	
					▫ Above ▫ Below				▫ Above ▫ Below		▫ Above ▫ Below	

Fly Identification Resource: Quarterly Species-Specific Fly Monitoring Sheet
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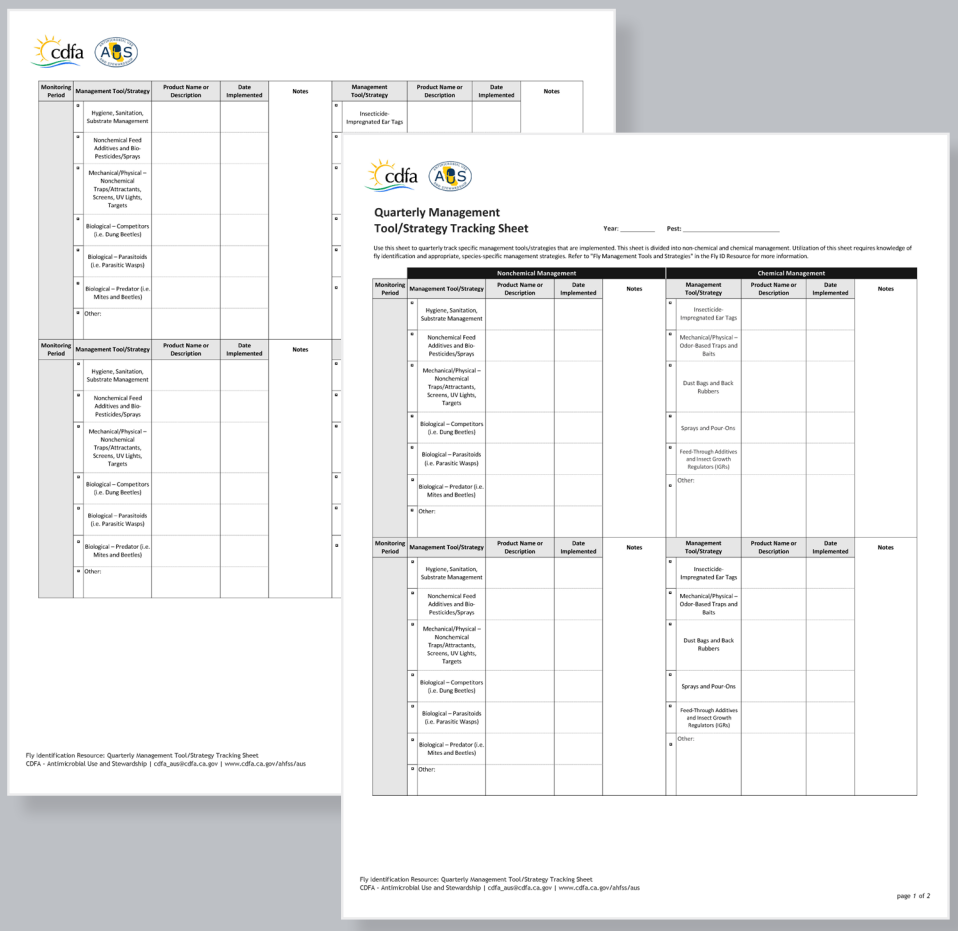
General

Fly Species-Focused

Above is a selection of highlights from the work AUS completed over FY 22 - 23; it is not comprehensive. Ongoing studies report results over a number of years; results presented here were compiled in FY 22 - 23.

FLY ID RESOURCES: Tracking



Quarterly Management
Tool/Strategy Tracking Sheet

Year: _____ Pest: _____

Use this sheet to quarterly track specific management tool/strategies that are implemented. This sheet is divided into non-chemical and chemical management. Utilization of this sheet requires knowledge of fly identification and appropriate, species-specific management strategies. Refer to "Fly Management Tools and Strategies" in the Fly ID Resource for more information.

Monitoring Period	Nonchemical Management: Management Tool/Strategy	Product Name or Description	Date Implemented	Notes	Chemical Management: Management Tool/Strategy	Product Name or Description	Date Implemented	Notes
	▫ Hygiene, Sanitation, Substrate Management				▫ Insecticide-Impregnated Ear Tags			
	▫ Nonchemical Feed Additives and Bio-Pesticides/Sprays				▫ Mechanical/Physical – Odor-Based Traps and Baits			
	▫ Mechanical/Physical – Nonchemical Traps/Attractants, Screens, UV Lights, Targets				▫ Dust Bags and Back Rubbers			
	▫ Biological – Competitors (i.e. Dung Beetles)				▫ Sprays and Pour-Ons			
	▫ Biological – Parasitoids (i.e. Parasitic Wasps)				▫ Feed-Through Additives and Insect Growth Regulators (IGRs)			
	▫ Biological – Predator (i.e. Mites and Beetles)				▫ Other:			
	▫ Other:							
Monitoring Period	Management Tool/Strategy	Product Name or Description	Date Implemented	Notes	Management Tool/Strategy	Product Name or Description	Date Implemented	Notes
	▫ Hygiene, Sanitation, Substrate Management				▫ Insecticide-Impregnated Ear Tags			
	▫ Nonchemical Feed Additives and Bio-Pesticides/Sprays				▫ Mechanical/Physical – Odor-Based Traps and Baits			
	▫ Mechanical/Physical – Nonchemical Traps/Attractants, Screens, UV Lights, Targets				▫ Dust Bags and Back Rubbers			
	▫ Biological – Competitors (i.e. Dung Beetles)				▫ Sprays and Pour-Ons			
	▫ Biological – Parasitoids (i.e. Parasitic Wasps)				▫ Feed-Through Additives and Insect Growth Regulators (IGRs)			
	▫ Biological – Predator (i.e. Mites and Beetles)				▫ Other:			
	▫ Other:							

Fly Identification Resource: Quarterly Management Tool/Strategy Tracking Sheet
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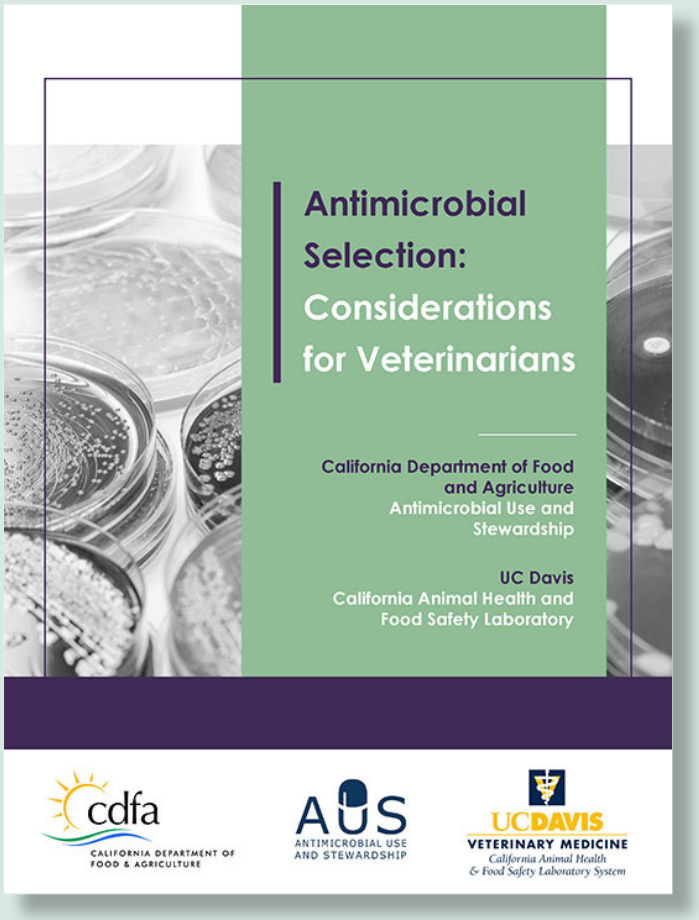
ANTIMICROBIAL SELECTION: CONSIDERATIONS FOR VETERINARIANS

This **veterinarian-focused guide** provides an overview of concepts to consider when using antimicrobial susceptibility test data to guide clinical decisions.



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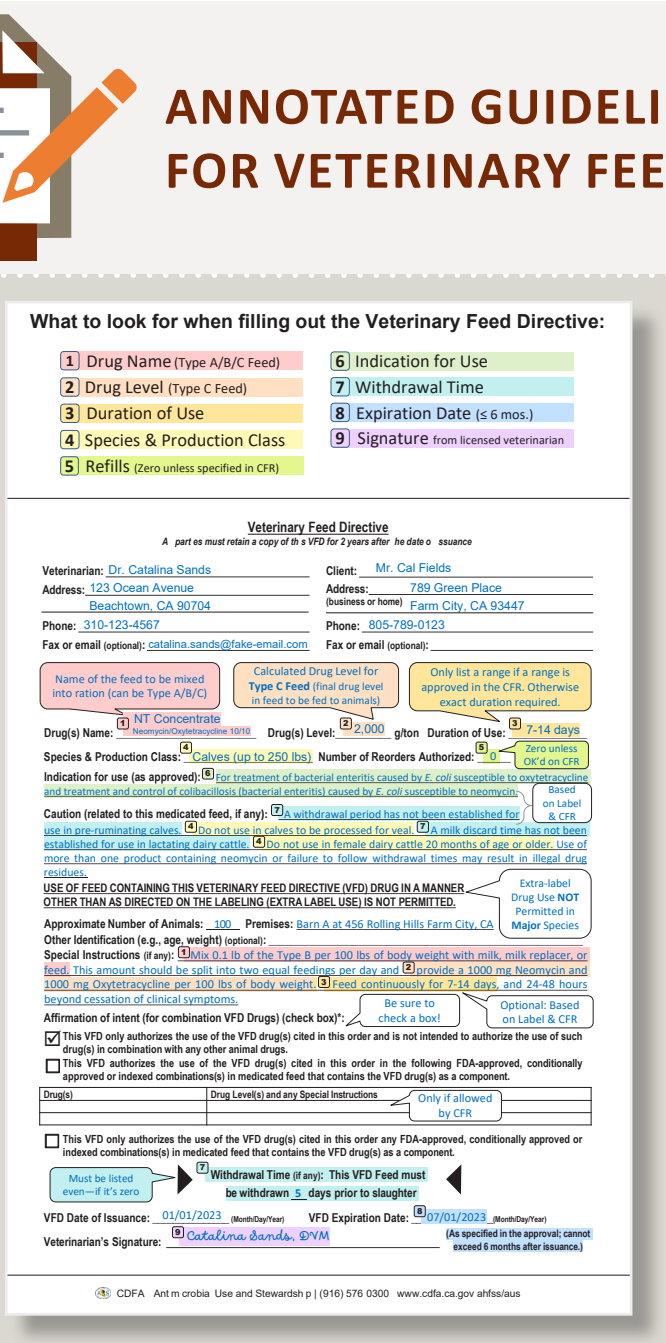
ANNOTATED GUIDELINE FOR VETERINARY FEED DIRECTIVES (VFDs)



What to look for when filling out the Veterinary Feed Directive:

1. Drug Name (Type A/B/C Feed)
2. Drug Level (Type C Feed)
3. Duration of Use
4. Species & Production Class
5. Refills (Zero unless specified in CFR)
6. Indication for Use
7. Withdrawal Time
8. Expiration Date (≤ 6 mos.)
9. Signature from licensed veterinarian

Veterinary Feed Directive

A part es must retain a copy of th s VFD for 2 years after he date o ssuance

Veterinarian: Dr. Catalina Sands
Address: 123 Ocean Avenue, Beachtown, CA 90704
Phone: 310-123-4567
Fax or email (optional): catalina.sands@fake-email.com

Client: Mr. Cal Fields
Address: 789 Green Place, Farm City, CA 93447 (business or home)
Phone: 805-789-0123
Fax or email (optional):

Name of the feed to be mixed into ration (can be Type A/B/C)

Calculated Drug Level for **Type C Feed** (final drug level in feed to be fed to animals)

Only list a range if a range is approved in the CFR. Otherwise exact duration required.

Drug(s) Name: [1] NT Concentrate (Neomycin/Oxytetracycline 10/10) Drug(s) Level: [2] 2,000 g/ton Duration of Use: [3] 7-14 days

Species & Production Class: [4] Calves (up to 250 lbs) Number of Reorders Authorized: [5] 0 (Zero unless OK'd on CFR)

Indication for use (as approved): [6] For treatment of bacterial enteritis caused by *E. coli* susceptible to oxytetracycline and treatment and control of colibacillosis (bacterial enteritis) caused by *E. coli* susceptible to neomycin.

Based on Label & CFR

Caution (related to this medicated feed, if any): [7] A withdrawal period has not been established for use in pre-ruminating calves. [4] Do not use in calves to be processed for veal. [7] A milk discard time has not been established for use in lactating dairy cattle. [4] Do not use in female dairy cattle 20 months of age or older. Use of more than one product containing neomycin or failure to follow withdrawal times may result in illegal drug residues.

USE OF FEED CONTAINING THIS VETERINARY FEED DIRECTIVE (VFD) DRUG IN A MANNER OTHER THAN AS DIRECTED ON THE LABELING (EXTRA LABEL USE) IS NOT PERMITTED.

Extra-label Drug Use **NOT** Permitted in **Major** Species

Approximate Number of Animals: 100 Premises: Barn A at 456 Rolling Hills Farm City, CA

Other Identification (e.g., age, weight) (optional):

Special Instructions (if any): [1] Mix 0.1 lb of the Type B per 100 lbs of body weight with milk, milk replacer, or feed. This amount should be split into two equal feedings per day and [2] provide a 1000 mg Neomycin and 1000 mg Oxytetracycline per 100 lbs of body weight. [3] Feed continuously for 7-14 days, and 24-48 hours beyond cessation of clinical symptoms.

Affirmation of intent (for combination VFD Drugs) (check box)*: Be sure to check a box! Optional: Based on Label & CFR

☑ This VFD only authorizes the use of the VFD drug(s) cited in this order and is not intended to authorize the use of such drug(s) in combination with any other animal drugs.

☐ This VFD authorizes the use of the VFD drug(s) cited in this order in the following FDA-approved, conditionally approved or indexed combinations(s) in medicated feed that contains the VFD drug(s) as a component.

Drug(s)	Drug Level(s) and any Special Instructions

Only if allowed by CFR

☐ This VFD only authorizes the use of the VFD drug(s) cited in this order any FDA-approved, conditionally approved or indexed combinations(s) in medicated feed that contains the VFD drug(s) as a component.

Must be listed even—if it's zero

[7] Withdrawal Time (if any): This VFD Feed must be withdrawn 5 days prior to slaughter

VFD Date of Issuance: 01/01/2023 (Month/Day/Year) VFD Expiration Date: [8] 07/01/2023 (Month/Day/Year)

Veterinarian's Signature: [9] Catalina Sands, DVM (As specified in the approval; cannot exceed 6 months after issuance.)

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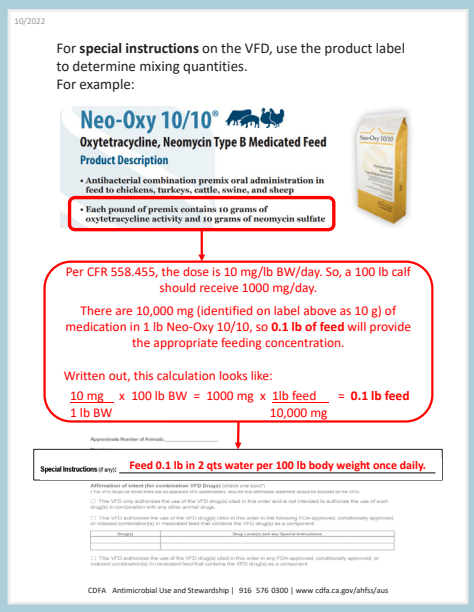
A **color-coded resource** created to assist veterinarians in successfully completing VFD orders to FDA standards. The document includes colored and numbered annotations to provide more context when filling out the VFD order.

Online Soon!

Above is a selection of highlights from the work AUS completed over FY 22 - 23; it is not comprehensive. Ongoing studies report results over a number of years; results presented here were compiled in FY 22 - 23.

VETERINARY FEED DIRECTIVE (VFD) SPECIAL INSTRUCTIONS HANDOUTS

Unique handouts created specifically to address two common conversion steps needed to write VFDs.



10/2022

For **special instructions** on the VFD, use the product label to determine mixing quantities.
For example:

Neo-Oxy 10/10®
Oxytetracycline, Neomycin Type B Medicated Feed
Product Description

- **Antibacterial combination premix oral administration in feed to chickens, turkeys, cattle, swine, and sheep**
- **Each pound of premix contains 10 grams of oxytetracycline activity and 10 grams of neomycin sulfate**

Per CFR 558.455, the dose is 10 mg/lb BW/day. So, a 100 lb calf should receive 1000 mg/day.

There are 10,000 mg (identified on label above as 10 g) of medication in 1 lb Neo-Oxy 10/10, so **0.1 lb of feed** will provide the appropriate feeding concentration.

Written out, this calculation looks like:

$$\frac{10\ mg}{1\ lb\ BW} \times 100\ lb\ BW = 1000\ mg \times \frac{1 lb\ feed}{10{,}000\ mg} = \textbf{0.1 lb feed}$$

Approximate Number of Animals: _____

Special Instructions (if any): **Feed 0.1 lb in 2 qts water per 100 lb body weight once daily.**

Affirmation of intent (for combination VFD Drugs) (check one box*):
*For VFD drugs for which there are no approved VFD combinations, only the first affirmation statement should be included on the VFD.

☐ This VFD only authorizes the use of the VFD drug(s) cited in this order and is not intended to authorize the use of such drug(s) in combination with any other animal drugs.

☐ This VFD authorizes the use of the VFD drug(s) cited in this order in the following FDA-approved, conditionally approved, or indexed combination(s) in medicated feed that contains the VFD drug(s) as a component:

Drug(s)	Drug Level(s) and any Special Instructions

☐ This VFD authorizes the use of the VFD drug(s) cited in this order in any FDA-approved, conditionally approved, or indexed combination(s) in medicated feed that contains the VFD drug(s) as a component.

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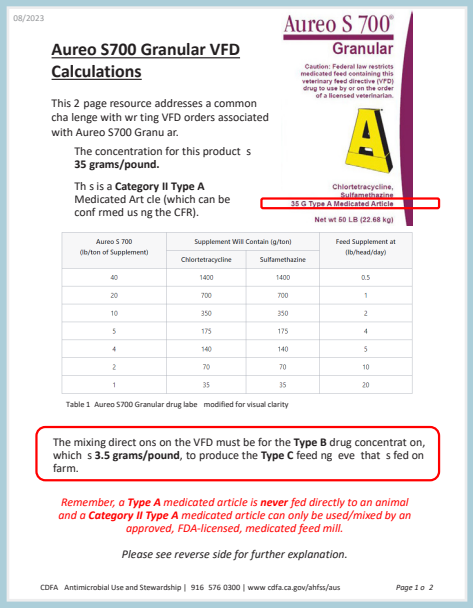
Mixing Instructions

for Type B Medicated Feed orders



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 cha lenge with wr ting VFD orders associated with Aureo S700 Granu ar.

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

Th s is a **Category II Type A** Medicated Art cle (which can be conf rmed us ng 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 labe modified for visual clarity

The mixing direct ons on the VFD must be for the **Type B** drug concentrat on, which s **3.5 grams/pound**, to produce the **Type C** feed ng eve that s 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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Conversions

Type A Medicated Articles to Type C Medicated Feeds

Above is a selection of highlights from the work AUS completed over FY 22 - 23; it is not comprehensive. Ongoing studies report results over a number of years; results presented here were compiled in FY 22 - 23.

AUS Outreach & Engagement

Online and In-Person Livestock and California Prescription Drug Inspections

380 inspections of retailers who sell livestock drugs and 70 annual VFD inspections were completed to ensure compliance with California laws and regulations

In-person outreach & presentations reaching over **618** people

142 farms engaged across **11** studies

Inspection Services VFD Summary Report 2022

Summary of veterinary feed directive (VFD) orders in California

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

Above is a selection of highlights from the work AUS completed over FY 22 - 23; it is not comprehensive. Ongoing studies report results over a number of years; results presented here were compiled in FY 22 - 23.

Animal Management Strategies

Which 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 is continually keeping abreast of, and contributing to, the body of scientific literature and resources surrounding current best management practices to limit antibiotic resistance and promote animal health. AUS supports stakeholders with the most current and effective information identified through continued review of the latest research from California, the nation, and worldwide. The following are highlights from AUS' work in this area during the past fiscal year. Please see previous Annual Reports for more detailed descriptions of ongoing projects.

Aquaculture

All California food fish aquaculture producers that participated in an AUS-sponsored survey and reported having used an antibiotic in the last three years also reported having an active veterinarian-client-patient relationship (VCPR). All facilities reporting a bacterial disease in 2021 also had a VCPR.

Participants representing three distinct sectors of the aquaculture industry in California (commercial finfish industry, California Department of Fish and Wildlife operated salmonid facilities, and the commercial shellfish industry) provided survey responses that informed extension materials on disease prevention and mitigation that were produced in English and Spanish.
Extension materials: https://www.youtube.com/watch?v=JosTt5tFeA0
Posters: https://aquaculture.ucdavis.edu/research/antimicrobials-in-ca-aquaculture/

Communities of Practice

Farm and ranch operators continue to engage in this project as a way to provide professional development to their staff of ranch and farm workers. They recognize the project's potential to improve communication and practices related to animal health and judicious use of antimicrobials in their livestock.

Above is a selection of highlights from the work AUS completed over FY 22 - 23; it is not comprehensive. Ongoing studies report results over a number of years; results presented here were compiled in FY 22 - 23.

Goat

USDA NAHMS Goat 2019 Study

Of California goat operations in the 12 months prior to the study

67.5%	23.7%*	33.5%*
administered any vaccines to any goats	routinely performed somatic cell count (SCC) testing on the milk from the herd	performed any cultures on milk produced on the operation

** Operations that milked any dairy does and had 5 or more does*

Above is a selection of highlights from the work AUS completed over FY 22 - 23; it is not comprehensive. Ongoing studies report results over a number of years; results presented here were compiled in FY 22 - 23.

Antibiotic Sales & Use

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

The sale and use of antibiotics intended for livestock is evolving in California and the United States on an annual basis. The cooperative efforts of the Animal Health and Food Safety Services (AHFSS) and Inspection Services (IS) teams of the AUS program provide a closer look at antibiotic sales within California through 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. Highlights of AUS' work from the last fiscal year are illustrated in the infographics below.

Between 2018 - 2022, the amount of VFD medicated feed manufactured and distributed in California decreased by 45%

Indications for Antibiotic Use

As Authorized in VFDs

- Respiratory Disease (136)
- Gastrointestinal Disease (106)
- Both (335)
- Other (52)

**Number of VFDs collected for calendar year 2022. For more information, see AUS' VFD Summary Report.*

Above is a selection of highlights from the work AUS completed over FY 22 - 23; it is not comprehensive. Ongoing studies report results over a number of years; results presented here were compiled in FY 22 - 23.

Aquaculture

The majority of participating facilities (82.3%) did not use antibiotics in the last year. Of those that did report use (17.6%), all reported a relationship with a veterinarian (valid VCPR).

Goat

USDA NAHMS Goat 2019 Study: Antibiotic Use

Percentage of California operations that gave kids or adults any antibiotics (other than ionophores) in water or feed to prevent, control, or treat a disease or disorder, from September 1, 2018 through August 31, 2019*

in drinking water

Kids:	0.5%
Adults:	0.2%
Either:	0.7%

in feed *(including milk, milk replacer, or starter/creep feed)*

Preweaned kids:	1.6%
Weaned kids:	0.2%
Adults:	1.1%
Any:	1.6%

24.4% of California operations** treated at dry-off with intramammary (IMM) antibiotics in the 12 months prior to the study

* *Antibiotics permissible to be given to goats in feed under CPG 615.115*

** *Operations that milked any dairy does and had 5 or more does*

Above is a selection of highlights from the work AUS completed over FY 22 - 23; it is not comprehensive. Ongoing studies report results over a number of years; results presented here were compiled in FY 22 - 23.

USDA NAHMS Goat 2019 Study: Common Conditions Reported

Common conditions reported and treated with antibiotics on California goat operations from September 1, 2018 through August 31, 2019

Preweaned kids

- Digestive problems
- Kidding problems or other perinatal conditions
- Respiratory problems

Weaned kids

- Digestive problems
- Respiratory problems

Adult does

- Mastitis
- Digestive problems
- Respiratory problems

Adult bucks & wethers

- Reproductive problems
- Respiratory problems

Key

- Digestive problems *(e.g., scours, overeating/ enterotoxemia, coccidia)*
- Kidding problems or other perinatal conditions *(e.g., floppy kid syndrome, weak kids)*
- Mastitis
- Reproductive problems *(e.g., penile or testicular disorders, urinary calculi)*
- Respiratory problems *(e.g., pneumonia, shipping fever, runny nose)*

Above is a selection of highlights from the work AUS completed over FY 22 - 23; it is not comprehensive. Ongoing studies report results over a number of years; results presented here were compiled in FY 22 - 23.

Antibiotic Resistance

How are we looking at trends in antibiotic resistance?

AUS-funded research explored antibiotic resistance trends through multi-year studies and newly commissioned projects. These antibiotic resistance trends are evaluated and analyzed through both on-farm and clinical samples. Multi-year studies allow AUS to follow antibiotic resistance trends from on-farm samples collected from the same operations over time to gain valuable insight into the effects of antibiotic use and other management practices on antibiotic susceptibility. These trends highlight 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 of antibiotic resistance. The following are highlights from AUS' work in this area during the past fiscal year. Please refer to the Appendix for additional detail.

Beef Cattle

Different practices employed in conventional or grass-fed feeding systems, as well as environmental stressors, contribute to the development of antibiotic resistance in bacteria.

Animal feces collected from grass-fed feeding systems that did not administer antibiotics exhibit great diversity in transferrable biocide and metal resistance genes.

Bioinformatic analyses of samples collected showed that certain transferable antibiotic resistance genes can emerge in cattle feces independent of antibiotic administration.

Above is a selection of highlights from the work AUS completed over FY 22 - 23; it is not comprehensive. Ongoing studies report results over a number of years; results presented here were compiled in FY 22 - 23.

Dairy Cows

112 samples were collected from participating dairy farms to create antibiograms for bovine respiratory disease (BRD) pathogens (*Mannheimia haemolytica* and *Pasteurella multocida*) for each participating farm, to be shared through established VCPR.

Dairy Calves

Kicking off a study focused on calf health and colostrum management, 36 milk and colostrum samples from conventionally fed dairy cows were collected and tested.

Commercial Poultry

Litter samples were collected from participating broiler farms in California. 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. *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 (10.4%) and tetracycline (34.8%). For the *E. coli* isolates, no resistance was detected against the antimicrobials cefoxitin and ciprofloxacin; resistance was detected to the antimicrobials ampicillin (8.9%), ceftriaxone (1.5%), and tetracycline (23.9%).

Above is a selection of highlights from the work AUS completed over FY 22 - 23; it is not comprehensive. Ongoing studies report results over a number of years; results presented here were compiled in FY 22 - 23.

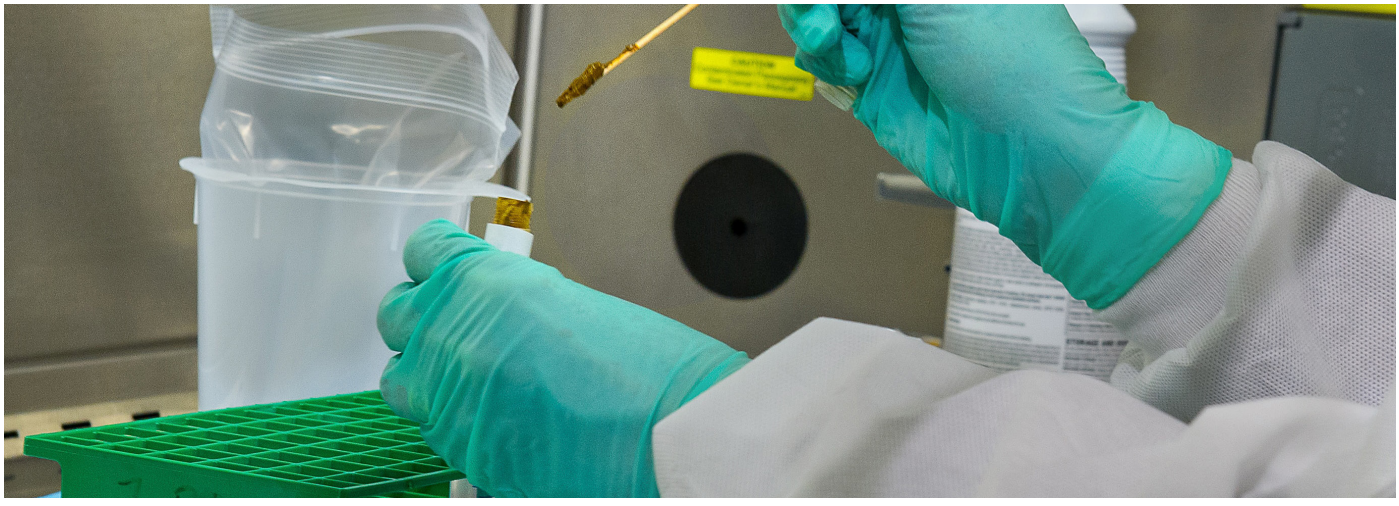
MIC Data Analysis

Antimicrobial susceptibility testing was completed for 560 isolates associated with BRD; innovative statistical models in development for analyzing trends in minimum inhibitory concentration (MIC) data will be applied to this dataset to further this research.

CAHFS Testing

AUS funding helped support the California Animal Health & Food Safety (CAHFS) Laboratory to perform 1,245 antimicrobial susceptibility tests for clinical samples submitted from multiple livestock sources.

AUS funding supports 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/aphis/dashboards/tableau/amr.



Above is a selection of highlights from the work AUS completed over FY 22 - 23; it is not comprehensive. Ongoing studies report results over a number of years; results presented here were compiled in FY 22 - 23.

Communication & Engagement

How are we reaching people and improving our outreach efforts?

Key components of the AUS program mission include continued 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. This is used to adapt and create resources to reach a wider audience and meet the needs of those we want to engage further in our education efforts. The following highlights are from AUS' work in this topic area over the past fiscal year.

AUS created **continuing education opportunities** for veterinarians and producers through its presentations

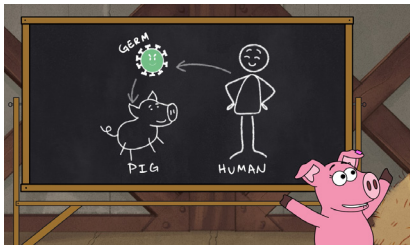
Funding opportunities

Veterinary Medical Loan Repayment Program (VMLRP)

AUS' effort helped support a veterinarian awardee in Riverside County, CA and La Paz, AZ (a combined designated veterinary shortage area). AUS also nominated seven other shortage areas in California.

Veterinary Services Grant Program (VSGP)

AUS assists in promotion of the the program where veterinary practices can apply for funds in designated veterinary shortage areas.



Council of State and Territorial Epidemiologists (CSTE)
Youth in Agriculture

AUS continued to support **California Department of Public Health's** initiative to develop, distribute, and evaluate resources on prevention of zoonotic disease transmission for youth (ages 5-8 years) in agricultural organizations, including 4-H clubs and county agricultural agencies. The *Animal Poo & You* curriculum consists of four lessons on fecal-oral pathogens, respiratory zoonotic illnesses, and the importance of handwashing and veterinary care. Each lesson package includes an animated video, song, and an instructor guide that contains additional information, quizzes, activities, and discussion questions.

Above is a selection of highlights from the work AUS completed over FY 22 - 23; it is not comprehensive. Ongoing studies report results over a number of years; results presented here were compiled in FY 22 - 23.

FFA dairy educational materials

Introduction to dairy antimicrobial stewardship and best husbandry practices were presented through discussion of two different types of dairy farm management styles. **Lesson plans** are designed for high school age FFA students that include a **video, instructor guide,** and an **interactive review game.**

AUS' articles in **industry journals** helped spread important antimicrobial stewardship information to livestock producers.
https://issuu.com/calcattleman/docs/cca_oct_2022_online/s/16966275

AUS continues to translate many of its **outreach resources into Spanish** in order to reach a wider audience of California livestock managers, producers, and farmworkers.

AUS was featured in a **podcast** this year, which helps to disseminate outreach and to further engage with stakeholders.
https://www.buzzsprout.com/1837249/11254040

AUS staff continue their **national engagement** on antimicrobial resistance through positions on various national committees and review panels, providing recommendations on proposed legislation and science-based analyses to government agencies and at national and international conferences.

Above is a selection of highlights from the work AUS completed over FY 22 - 23; it is not comprehensive. Ongoing studies report results over a number of years; results presented here were compiled in FY 22 - 23.

AUS-Funded Research Publications & Presentations

How are our researchers building on current scientific knowledge?

Part of AUS' mission is to fund or perform research projects on specific topics reflecting the needs of the California livestock sectors, as determined by surveys, outreach efforts, and our mandates. Peer-reviewed journal publications are critical to ensure the materials we produce 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 both AUS-funded researchers and AUS staff, that help inform solutions or identify 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 2022 - 2023 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.

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Bernal-Córdoba, C., Branco-Lopes, R., Latorre-Segura, L., de Barros-Abreu, M., Fausak, E. D., and Silva-del-Río, N. (2022). Use of antimicrobials in the treatment of calf diarrhea: a systematic review. Animal Health Research Reviews 23, no. 2: 101-12. https://doi.org/10.1017/S1466252322000032

Description: The objective of this study was to conduct a systematic review of the scientific literature evaluating the efficacy and comparative efficacy of antimicrobials for the treatment of diarrhea in calves. Eligible studies were non- and randomized controlled trials evaluating an antimicrobial intervention against a positive and negative control, with at least one of the following outcomes: fecal consistency score, fever, dehydration, appetite, attitude, weight gain, and mortality. The results reveal few studies evaluating the efficacy of antimicrobials for the calf diarrhea treatment, thus a meta-analysis can not be conducted.

Keywords: antimicrobials, calf diarrhea, systematic review

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Feng, Y., Yang, L., Klopatek, S. C., Oltjen, J., and Yang, X. (2023, June). Impact of grass-fed and grain-fed feeding systems on the transferrable antimicrobial resistant genes and biocide and metal resistance genes in beef cattle in western United States. Presented at the Reciprocal Meat Conference hosted by the American Meat Science Association, St. Paul, Minnesota.

Description: This study determined the profiles of transferrable antimicrobial resistance genes (ARGs) and biocide and metal resistance genes (BMRGs) in cattle feces from various production systems with different antibiotic use management practices in the western United States. The findings suggested that minerals, as the sources of heavy metals in animals' diet, may contribute to the development of metal resistance in bacteria. As the development of BMRGs occurred regardless of the exposure to the biocides, it is plausible that residues or naturally occurring sources in the environment could also have triggered their development. Additionally, findings also demonstrated

that animal feces from grain-fed feeding systems harbor more transferrable ARGs. On the other hand, those from grass-fed systems exhibit greater diversity in transferrable BMRGs, which may create selective pressure and promote the development of ARGs, even in grass-based feeding systems where antibiotics were not administered.

Keywords: cattle, antimicrobial resistant genes, biocide and metal resistance genes

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Ferreira, F. C., Martínez-López, B., and Okello, E. (2022). Potential impacts to antibiotics use around the dry period if selective dry cow therapy is adopted by dairy herds: An example of the western US. Preventive Veterinary Medicine, Volume 206, 105709, ISSN 0167-5877.
https://doi.org/10.1016/j.prevetmed.2022.105709

Description: Objectives in this cross-sectional study were to estimate the potential reduction in the use of antimicrobials if selective dry cow therapy (SDCT) was adopted in the United States by using cow-level dairy herd data and to describe the factors associated with cows being classified as high-risk for an intramammary infection at dry-off. Cow-level somatic cell score (SCS) test-day data from herds in the western United States was used to create five scenarios to classify cows as high risk for intramammary infection at dry-off. Associations between cow-level data and state were also used in logistic regression models. Calculations of the average animal-defined daily dosage of antimicrobials per cow per year around the dry period if a blanket dry cow therapy (BDCT) or SDCT approach is used, adjusting for the risk of cases of clinical mastitis in the next lactation for the SDCT approach. By extrapolating the results obtained from using data from dairies enrolled in the testing program for the western United States, it was demonstrated that, regardless of the criteria used to classify cows as high risk of intramammary infection at dry-off (scenarios 1 - 5), if selective dry cow therapy is adopted in the United States, the dairy industry could reduce the use of antimicrobials around the dry-off between 31% and 66%.

Keywords: selective dry cow therapy, intramammary infection, dry-off, antimicrobial use

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Fritz, H. M., Pereira, R. V., Toohey-Kurth, K., Marshall, E., Tucker, J., and Clothier, K. A. (2022). *Salmonella enterica* serovar Dublin from cattle in California from 1993-2019: antimicrobial resistance trends of clinical relevance. Antibiotics 11, no. 8: 1110. https://doi.org/10.3390/antibiotics11081110
https://www.mdpi.com/2079-6382/11/8/1110

Description: *Salmonella enterica* subsp. *enterica* serovar Dublin (*S.* Dublin) is a cattle-adapted pathogen that has emerged as one of the most commonly isolated and multidrug resistant (MDR) serovars in cattle. Though infections with *S.* Dublin in humans are rare, they are frequently severe, with extraintestinal spread that requires hospitalization and antimicrobial therapy. To determine minimum inhibitory concentration (MIC) and antimicrobial resistance (AMR) patterns and trends in cattle in California, broth microdilution testing was performed on 247 clinical *S.* Dublin isolates recovered from cattle at the California Animal Health and Food Safety Laboratory System (CAHFS) over the last three decades (1993 - 2019). Findings indicate an increase in AMR for the years 1993 to 2015. Notably, compared to the baseline year interval (1993 - 1999), there was an increase in resistance among quinolone and cephalosporin drugs, as well as an increased number of isolates with an MDR profile.

Keywords: *Salmonella enterica* serovar Dublin, cattle, antimicrobial resistance, trends, antimicrobial susceptibility testing, MIC

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Garzon, A., Hoyos-Jaramillo, A., Hustad, S., Byrne, B., Fritz, H., and Pereira, R.V. (2022, September). Evaluating factors affecting recovery of *Mannheimia haemolytica* and *Pasteurella multocida.* Presented at the American Association of Bovine Practitioners Conference 2022, Long Beach, California.

Garzon, A., Hoyos-Jaramillo, A., Hustad, S., Byrne, B. A., Fritz, H. M., Lehenbauer, T. W., Aly, S., and Pereira, R. (2023). In vitro evaluation of the effect of transport medium, temperature, and time on the recovery of *Mannheimia haemolytica* and *Pasteurella multocida.* JDS Communications, Short Communication: Health, Behavior, and Well-being, Volume 4, pgs 214-218.
https://www.jdscommun.org/article/S2666-9102(23)00010-8/fulltext

Description: Microbiological diagnosis is an important step in controlling and preventing bovine respiratory disease. Adequate sample transport medium, elapsed time, and storage temperature before laboratory submission are critical for optimal results. The objective was to evaluate the effect of transport storage medium, time, and storage temperature on *Mannheimia haemolytica* (MH) and *Pasteurella multocida* (PM) yield using an in-vitro model simulation. The results support the use of Aimes culture media with charcoal and Cary-Blair transport Agar for increasing recovery of PM and MH in samples, especially when samples are exposed to high temperatures during transport and longer intervals from collection to diagnostic evaluation. The combination of longer elapsed time and higher temperatures can impair diagnostic accuracy in detecting PM and MH from swabs.

Keywords: *Mannheimia haemolytica, Pasteurella multocida,* transport media, bovine respiratory disease, cattle

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Jackson, W., Marshall, E., Fritz, H., Bross, C., Tucker, J., Adams, J., Silva, M., and Lorenz, C. (August, 2022). Prevalence and antimicrobial susceptibility profiles of ovine respiratory bacteria (*Mannheimia haemolytica* and *Pasteurella multocida*) from healthy sheep. Presented at the 16th International Symposium of Veterinary Epidemiology and Economics, Halifax, Nova Scotia.

Description: A 2017 study of commercial sheep operations in California identified respiratory disease to be the main driver of antimicrobial use in both ewes and lambs; this finding was also true among respondents to a national survey of sheep producers in 2011. The purpose of this study is to determine the prevalence and antimicrobial

susceptibility of *Mannheimia haemolytica* (MH) and *Pasteurella multocida* (PM) isolated from the upper respiratory tract of healthy sheep processed in California. The California Department of Food and Agriculture (CDFA)'s Antimicrobial Use and Stewardship (AUS) program and the California Animal Health and Food Safety (CAHFS) Laboratory collaborated with a processing facility in California to sample healthy sheep carcasses at slaughter.

Keywords: ovine, sheep, respiratory disease, *Mannheimia haemolytica*, *Pasteurella multocida*

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Karle, B.M., Busch, R., Meehan, C., and Smith, M. (2023, June). Addressing on-farm antimicrobial drug use practices through a community of practice-based approach: A case study. Oral presentation at the 2023 American Dairy Science Association Annual Meeting, Ottawa, Canada.
https://www.adsa.org/Portals/0/SiteContent/Docs/Meetings/2023ADSA/Abstracts_BOOK_2023.pdf

Description: Communities of practice (CoPs) are structured networks of peers and represent a model for professional development whereby groups of individuals work toward shared goals. Innovative approaches that seek to understand and acknowledge individuals' values, social trust, and personal experience are needed to effectively empower decision makers on farm. The objective of this project was to implement a community of practice-based approach to serve as a transferable model to help influence farm employee decision-making behavior change towards judicious use of antimicrobials on participating farms. Project staff implemented two CoPs on a 1,900-cow California dairy: one focused on maternity and calf management and one focused on the hospital string. Members of the project team served as facilitators for a series of six meetings with employees responsible for each of the targeted areas on the farm. Each meeting focused on current challenges and successes in each of the management areas and employees were encouraged to take the lead to guide the informal discussion. The maternity and calf CoP had nine participants and reported increased confidence in their ability to share ideas and improved communication between shifts by the end of the facilitated CoP meeting series. Challenges implementing protocols and

biosecurity practices were addressed and a new method for identifying high risk calves by marking the calf's head with a colored paint stick was implemented after the second CoP meeting. The hospital CoP had six members and identified communication as a challenge, especially when implementing treatment protocols. Improved methods for marking sick cows with leg bands and identifying treatments were implemented as a result of the CoP. CoPs, especially when implemented as short, direct meetings, may be an effective method to improve employee well-being and engagement on dairies.

Keywords: Community of Practice, antimicrobial stewardship

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Latack, B. C., Carvalho, P. H. V., and Zinn, R. A. (2022). The interaction of feeding an eubiotic blend of essential oils plus 25-hydroxy-vit-D3 on performance, carcass characteristics, and dietary energetics of calf-fed Holstein steers. Frontiers in Veterinary Science, Volume 9.
https://www.frontiersin.org/articles/10.3389/fvets.2022.1032532

Description: Bans on ionophores in several regions of the world have led to a need to identify alternative feed additives to support feed efficiency in cattle. Essential oil blends have been identified as a potential alternative to ionophores in feedlot diets. This study evaluated the effects of a supplemental blend of essential oils and 25-hydroxyvitamin D3 on growth performance, energetic efficiency, and carcass characteristics in calf-fed Holstein steers. Ninety Holstein steer calves (123 ± 7 kg; 4 months old) were randomly assigned to 18 pens (5 steers/pen; 6 pens/treatment). Dietary treatments consisted of a steam-flaked corn-based diet supplemented with (DM basis): (1) no additives (CON); (2) 30 mg/kg of monensin (MON); (3) 200 mg/kg mixture of essential oils plus 25-hydroxyvitamin D3 (EO+HYD). There were no treatment effects ($P > 0.05$) on initial, intermediate, and final cattle live weight; moreover, cattle had similar average daily gain (ADG) and dry matter intake (DMI) among dietary treatments. Study results suggest that supplementing calf-fed Holstein steer diets with MON or EO+HYD for over 285 days increases dietary net energy utilization for maintenance and gain by 3 and 4%, respectively.

Keywords: cattle, ionophores, monensin, antibiotic alternative

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Lee, K., Pereira, R.V., Martínez-López, B., Busch, R.C., and Pires, A.F.A. (2022). Assessment of the knowledge and behavior of backyard and small-scale producers in California regarding disease prevention, biosecurity practices and antibiotics use. PLoS ONE 17(11): e0277897.
https://doi.org/10.1371/journal.pone.0277897

Description: The number and popularity of backyard poultry and livestock farming have rapidly increased in California and other states in the United States, following consumers' preference for local and organic products in the last few years. This study aimed to investigate current on-farm management and farmers' understanding of the Veterinary Feed Directive (VFD) and California Senate Bill 27 (SB 27) implications for disease prevention, biosecurity procedures, and antimicrobial use in small-scale and backyard farms in California. The survey consisted of 38 questions. The responses of 242 backyard and small-scale livestock owners were investigated in this study. Descriptive statistics summarized survey responses, and multivariable logistic regression evaluated the association of antibiotics purchase and use, and the impact of VFD and SB 27 on antibiotic use with demographics and on-farm management. Backyard and small-scale farmers in California mostly raised chickens or small ruminants with small herd sizes kept for personal use. Antibiotics were generally used for individual treatment of a sick animal with the guidance of a veterinarian. VFD and SB 27 implementation promoted the judicious use of antibiotics, specifically, by enhancing the relationship between backyard and small-scale farmers with veterinarians and treating fewer animals with antibiotics under veterinary oversight. Therefore, better access to veterinary services in backyard and small-scale farms will improve the farmer's knowledge of good husbandry practices with judicious antimicrobial use in livestock and finally contribute to reducing the risk of antimicrobial resistance in California.

Keywords: backyard livestock producers, antimicrobial use, biosecurity, disease prevention, SB 27, veterinary feed directives

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Marshall, E., Lorenz, C. Fritz, H., Silva, M., Stratton-Phelps, M. and Jackson, W. (August, 2022). California livestock antibiograms. Presented at the 16th International Symposium of Veterinary Epidemiology and Economics, Halifax, Nova Scotia.

Description: This project provided antibiogram access and education to veterinarians to support a One Health approach for antimicrobial stewardship. Antibiograms may be used to guide initial antibiotic therapy and to assess trends in antibiotic resistance, therefore maximizing treatment success and preserving the efficacy of currently available drugs by reducing unnecessary exposure of bacteria. Antibiograms focusing on bovine respiratory pathogens (*Mannheimia haemolytica, Pasteurella multocida, Histophilus somni*), sheep and goat respiratory pathogens (*Mannheimia haemolytica, Pasteurella multocida*), and equine *Streptococcus equi* ssp. *zooepidemicus* were created and distributed to over 30 veterinarians.

Keywords: Antibiogram, antimicrobial resistance, antimicrobial stewardship, judicious use, livestock

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Wright, A., Li, X., Yang, X., Soto, E., and Gross, J. (2023). Disease prevention and mitigation in US finfish aquaculture: A review of current approaches and new strategies. Reviews in Aquaculture. 2023;1-16.
https://doi:10.1111/raq.12807

Description: This review discusses how various strategies used by the aquaculture industry contribute to the overall protection of fish from pathogens in the aquaculture industries. In the era of antimicrobial resistance, this review also highlights current and emerging alternative strategies that do not rely on traditional antimicrobial products (e.g., vaccines, dietary supplements, novel antimicrobials, stock selection) for disease prevention and mitigation.

Keywords: antimicrobial resistance, aquaculture, disease management, immunocompetence

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Wright, A. and Gross, J. (2023, April). Tips for reducing disease in aquaculture. Poster presentation at Science Talk ’23 meeting hosted by the Association of Science Communicators. Portland, Oregon.

Description: Posters were designed to illustrate the three levels of disease prevention in finfish aquaculture. The posters describe the importance of facility-wide protocols, good-husbandry strategies, and antimicrobial products for optimizing animal health and disease management practices. There is a set of five posters with unique aquaculture fish featured, representing the major fish species in California aquaculture. These posters are intended for display at any aquaculture facility and provide information to on-site personnel.

Keywords: aquaculture, disease management, extension resource

Looking Ahead

What's next?

AUS has accomplished much in FY 22 - 23 and is looking forward to continuing this success in FY 23 - 24. 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.

NAHMS Sheep 2024

Assist USDA NAHMS staff in this two-phase study that will provide important information about management practices used on United States sheep operations and will take an in-depth look at the most pressing health issues facing the industry

Antibiograms

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

Best Management Practices for Neonatal Beef Calves

Develop science-based extension materials for cow-calf beef producers on stewardship practices and best management of neonatal beef calves that will enhance animal health, welfare, and economics by promoting timely colostrum management

Collaboration with UC Davis CLEAR Center

Investigate the effects of dietary *Bacillus subtilis* and carbadox on the antimicrobial resistance gene profiles of weaned pigs

Above is a selection of highlights from the work AUS completed over FY 22 - 23; it is not comprehensive. Ongoing studies report results over a number of years; results presented here were compiled in FY 22 - 23.

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 is confidential and 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 subject matter experts 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:

Dr. Essam Abdelfattah	*University of California, Davis*
Dr. Naif Alhawiti	*California Animal Health and Food Safety Laboratory System*
Dr. Rosie Busch	*University of California, Davis*
Dr. Pedro Carvalho	*Colorado State University – AgNext*
Dr. Munashe Chigerwe	*University of California, Davis*
Dr. Kris Clothier	*retired with California Animal Health and Food Safety Laboratory System*
Dr. Fernanda Ferreira	*formerly with 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. Ashley Hill	*California Animal Health and Food Safety Laboratory System*
Betsy Karle	*University of California, Davis – Cooperative Extension*
Dr. Terry Lehenbauer	*University of California, Davis*
Dr. Yanhong Liu	*University of California, Davis – CLEAR Center*
Dr. Gaby 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*
Project Staff	*NAHMS Goat 2019 study*

APPENDIX

The following pages represent high-level summaries of a selection of the studies and projects supported by AUS during FY 22 - 23. 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. Effects of extended colostrum feeding to calf-fed beef-on-dairy cross steers on health, performance, fecal resistome, and carcass characteristics

Quantify and determine the effect of extended colostrum feeding during the production cycle of calf-fed beef-on-dairy cross steers

Questions: What are the effects of extended colostrum feeding (up to 14 days after birth) on disease incidence, performance, and carcass characteristics during the production cycle of calf-fed dairy-beef cross steers in California?

Significance to CA: California's Imperial Valley is home to a number of feedlots, which raise over 400,000 head of cattle on feed. Breeding dairy cows with beef semen (beef-on-dairy) has been used as a reproductive strategy on dairy farms in recent years to increase farm profitability. Crossbred calves may be an option to improve profitability on commercial dairy farms and an option to adjust heifer inventory. Therefore, management practices developed to enhance health and growth performance, while reducing antimicrobial usage in the calf-fed beef-on-dairy industry, are needed for a specific production system that provides cattle for approximately one fifth of beef produced in this country.

Research Team: University of California, Davis and Colorado State University researchers and Cooperative Extension specialists with extensive experience with beef cattle production systems, management practices, and antibiotic resistance.

Summary: Phase 1: Beef-on-dairy bull calves originating from dairy farms in the Central Valley of California will be shipped in the first 24 hours after birth to a commercial raising facility in the Central Valley and randomly assigned to one out of four treatments and housed per industry standards. Blood samples will be taken upon arrival on days 1, 7, 14, 21, 35, and 56 to measure serum IgG level and serum total protein. Health will be monitored and documented throughout. Phase 2: Bull calves from Phase 1 will be used to evaluate the effects of extended colostrum feeding on feedlot growth performance and carcass characteristics. Calves will be shipped to the Agricultural Research, Development and Education Center (ARDEC) in Colorado on day 140 of the experiment. Cattle will be monitored daily by trained personnel for signs of BRD and digestive illness. Rectal fecal materials will be collected from the steers to monitor change in their microbiome and resistome. Pooled fecal samples will be used for metagenomic analysis to determine the effect of colostrum on the change of cattle gut microbiome and resistome throughout their lifetime. Steers will be sent for processing at a nearby processing plant after they reach 320 days-on-feed. Carcass characteristics will be measured.

Study Progress: Researchers and their support staff have finalized study standards of practice. Facility preparations are completed, and steers have been acquired for the study.

How This Helps AUS: The results of this study will support and extend knowledge amongst veterinarians, nutritionists, and dairy and beef producers. The potential to demonstrate that improved colostrum management in dairy-beef bull calves impacts health, performance, and carcass characteristics may lead to a feasible alternative to decrease the need for antibiotic use across the entire industry.

Next Steps: Calves will begin receiving the colostrum treatments and health monitoring and sample collections will begin.

II. Feeding the gut and beyond for post-weaning pig health and disease mitigation

Quantify and determine the effects of Bacillus subtilis and carbadox on the antimicrobial resistance gene profiles of weaned pigs

Questions: What are the effects of dietary *Bacillus subtilis* and carbadox, a drug used for controlling swine dysentery in the U.S., on the functional antimicrobial resistance (AMR) gene composition and abundance of the microbial community in the intestine of weaned pigs experimentally infected with a pathogenic *E. coli*?

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 U.S. pork production, it accounts for 13% of the national pork consumption. This study will help explore viable alternative practices and products that could enhance intestinal health of weaned pigs to reduce post-weaning *E. coli* diarrhea; which in turn would contribute to producing healthy animals, food products, and potentially mitigate the development of antimicrobial resistance in California pigs.

Research Team: University of California, Davis' Clarity and Leadership for Environmental Awareness and Research (CLEAR) Center researchers and Cooperative Extension specialists with extensive experience with swine production systems, management practices, and antibiotic resistance.

Summary: This is a follow-up to a disease challenge study supported by National Pork Board (NPB Project #18-081) and conducted at UC Davis. Fecal samples collected from the earlier study will be used to meet the goals of this study. Fecal samples were collected from weaned pigs at day 21 after the first dose of *E. coli* inoculation as described in the preliminary experiment. Total microbial community DNA (metagenomic DNA) will be extracted from eight replicate fecal samples per treatment. Sample libraries will be constructed using the Illumina TruSeq DNA library kit. Library sequencing will be performed on the NovaSeq S4 at UC Davis Genomic Center. Richness and Shannon's diversity of both AMR genes and microbiome by treatment will be compared and the log-fold change of AMR genes among treatments will be performed.

Study Progress: Isolation of microbial community DNA from fecal samples and preparation of the DNA library NovaSeq S4 sequencing has been completed.

How This Helps AUS: Supports the advancement of young pig production and welfare and combating antibiotic-resistant bacteria selection and dissemination in agricultural animals in California.

Next Steps: Perform data analysis by assessing fecal microbial species composition profiles and functional composition profiles.

III. Developing extension interventions to address best management practices in neonatal beef calves in California

Survey literature and create outreach materials on best practices to optimize beef calf health by managing colostrum administration and other protocols during the neonatal period

Questions: What are the current best practices for colostrum feeding and ensuring transfer of passive immunity in neonatal beef calves? What other management practices can be practically implemented to reduce disease and the need for antibiotics in neonatal beef calves?

Significance to CA: A 2017 USDA beef survey of national herds showed that about 4% of all beef calves born alive did not survive to weaning. A third of these deaths occur within the first 24 hours to three weeks due to diarrhea, respiratory disease, or navel infections, which are conditions that often lead to the use of antimicrobials. Although most of the research in neonatal calf health has been conducted with dairy calves, a reduction of disease vulnerability for operations with neonatal beef calves could lead to decreased use of antibiotics and overall gains in animal health and welfare. Additionally, improved beef calf health is anticipated to benefit California's economy since cow-calf producers represent a large segment of Californian cattle operations.

Research Team: This project is led by a University of California Cooperative Extension researcher and a UC Davis researcher, both of whom study food animal management and disease epidemiology. The researchers will work through local beef cattle associations to host training opportunities for cattlemen.

Summary: The health and survival of newborn beef calves during their first month is crucial for the success of the beef cow-calf industry. As the failure of passive transfer of colostrum and, subsequently, maternal immunoglobulins are a major cause of morbidity and mortality among young calves, efforts to increase producer knowledge about ways to improve passive immunity in calves should enable them to improve calf health. The goal of this project is to provide California cow-calf producers and veterinarians with science-based knowledge on stewardship and best management practices to enhance the health, performance, and well-being of neonatal beef calves. Engagement with topics related to neonatal beef calf health management will lead to improved animal health, increased productivity and profitability, improved food safety, and enhanced sustainability.

Study Progress: The research team began an informal literature review in Spring of 2023 to identify specific areas in neonatal beef calf management that can be implemented or improved. The team aims to complete the development of educational materials and host numerous in-person and virtual training opportunities through mid-2024.

How This Helps AUS: Improved rancher understanding of neonatal beef calf management practices may help reduce disease incidence and, subsequently, reduce antimicrobial use, a cornerstone of AUS' mandate. Additionally, educational materials distributed during training workshops provide opportunities to discuss the importance of judicious use of antimicrobials with cow-calf operations across California.

Next Steps: Information collected from the literature review will be synthesized to develop outreach materials for use in the workshops and presentations. Surveys will assess the efficacy of outreach materials and training opportunities to improve future implementation. If the survey results indicate a positive development in farm staff knowledge after the training events, additional workshops may be implemented in the future with the potential for expansion to other areas of California.