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# Gaining a better understanding of persistent environmental pollutants in livestock and food derived from livestock

*Birgit Puschner[A], Xiaopeng Chen[B], Katherine Dang[B], Phil Kass[C], Sunjay Sethi[B], Yanping Lin[B]*

*[A]UC Davis School of Veterinary Medicine, UC ANR Cooperative Extension*
*[B]UC Davis School of Veterinary Medicine, Department of Molecular Biosciences*
*[C]UC Davis School of Veterinary Medicine, Department of Population Health and Reproduction*

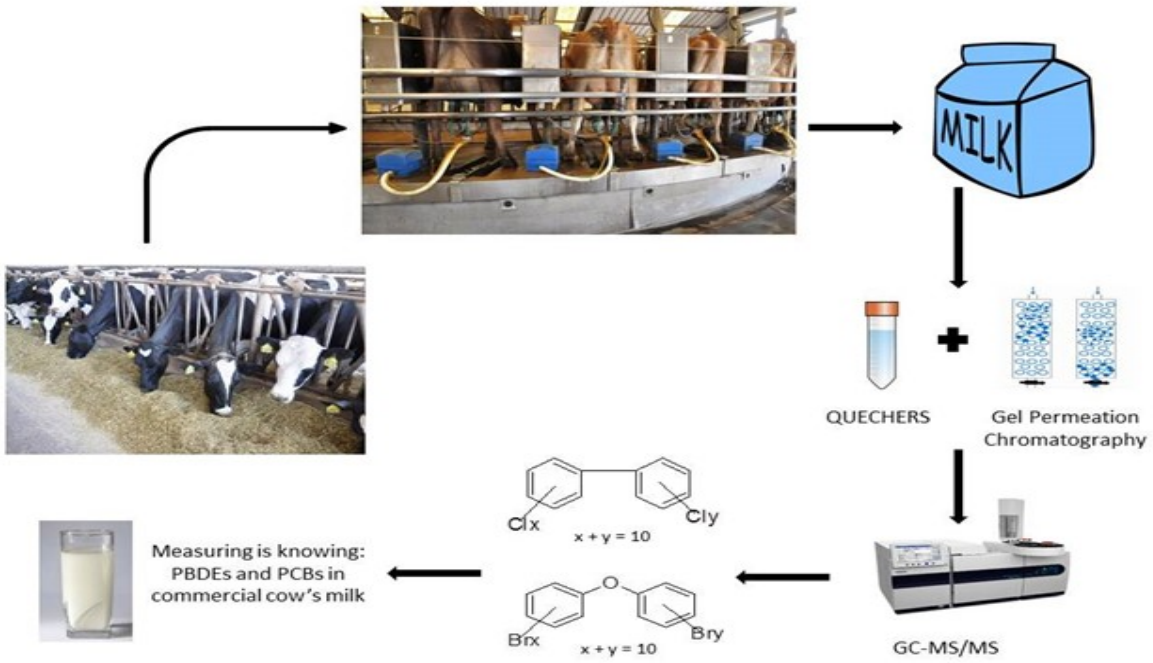
**Inside this issue:**



Polychlorinated biphenyls (PCBs) and polybrominated diphenyl ethers (PBDEs) are synthetic industrial chemicals that have become widespread persistent organic pollutants (POPs) and are resistant to biodegradation leading to their persistence in our environment. PCBs and PBDEs are contaminants of particular concern because they are endocrine disruptors and neurotoxicants that persist and bioaccumulate due to their inherent high lipophilicity. The chemical families of PBDEs and PCBs each consist of 209 congeners, many of which have been detected in human samples, raising concerns about their impacts on human health.

Beginning in the 1920s PCBs were widely used, as electrical insulators in transformers, capacitors, and heat exchangers, and as stabilizers in paints, plastics, and rubber products. PCBs are categorized into dioxin-like (DL) and non-dioxin-like (NDL) compounds. DL PCBs are potent activators of the aryl hydrocarbon receptor. Previous assessment of POP contamination of dairy products has primarily evaluated DL-compounds because, in the past, these compounds were considered to be the most toxic. However, NDL-PCBs dominate over DL-PCBs in biological and environmental samples, and specifically multiple NDL-PCBs have been shown to be potent neurodevelopmental toxicants. Major production of PBDEs began in the early 1970s for use as flame retardants in electronics, home furnishings, and foam products, including pet toys and bedding. PBDE mixtures were produced commercially at three different levels of bromination, leading to the terms penta-, octa- and deca-BDEs. BDE-99, BDE-47, BDE-100, BDE-153 and BDE-154 are most commonly added to polyurethane foam used for furniture cushions as commercial penta-BDEs mixtures. In 2004,

two commercial formulations, penta-BDE and octa-BDE, were banned or phased out of production in some U.S. states after a voluntary agreement between the U.S. EPA and the sole manufacturer of these products. Despite the phase out of many PBDEs used in industry, these compounds persist in our environment due to their resistance to biodegradation.




We determined PCB and PBDE concentrations in store-bought bovine milk distributed in the state of California. Based on the proportions in commercial mixtures and toxicity data, we selected and quantified 19 PCB congeners including indicator PCBs 101, 138, 153 and 180 and 12 PBDE congeners, mainly penta- and octa- BDEs. The region-specific evaluation of PCBs and PBDEs in cows' milk is critical for identifying potential non-point sources and for establishing and mitigation strategies for these persistent, organic pollutants in important food sources. The results of this study were recently published in PLOS ONE http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0170129 The results of this study bring attention to the lack of knowledge regarding the exposure to these pollutants in livestock and the unknown associated risk factor to humans through the consumption of animal-derived product.

## Trivia—Science at its Finest

**What are the two most efficient animals with respect to Feed Conversion Ratio?**

**Answer will be posted in the next issue of *Vet Med Extension Digest***

# Methods of selenium supplementation for beef cattle and associated weight gains

*Josh Davy, UC Farm Advisor — Tehama, Glenn, Colusa*
*Larry Forero, UC Farm Advisor — Shasta, Trinity*

Selenium (Se) deficiency in California livestock species is widespread, having been estimated to exist in excess of 60% of herds in the state. Selenium is an essential nutrient for all animals, including cattle. The importance of correcting Se deficiencies is well documented. Adequate Se levels have been found to bolster immunity, thereby reducing mortality, diarrhea, and increasing disease resistance in cattle. We completed two trials to determine how commonly used Se supplement products corrected Se deficiency and monitored the resulting weight gains in yearling cattle.

The first trial included 80 hd with 20 steers in four treatments of:

1) 3 cc of a 5 mg/ml injection of sodium selenite[1] (15 mg Se/head, Muse)
2) 5 cc injection of a 5 mg/ml sodium selenite in a mixture of zinc oxide, manganese carbonate, and copper carbonate[2] (25 mg Se/head, Multimin)
3) Se oral bolus designed to release not more than 3 mg/head/day
4) Control

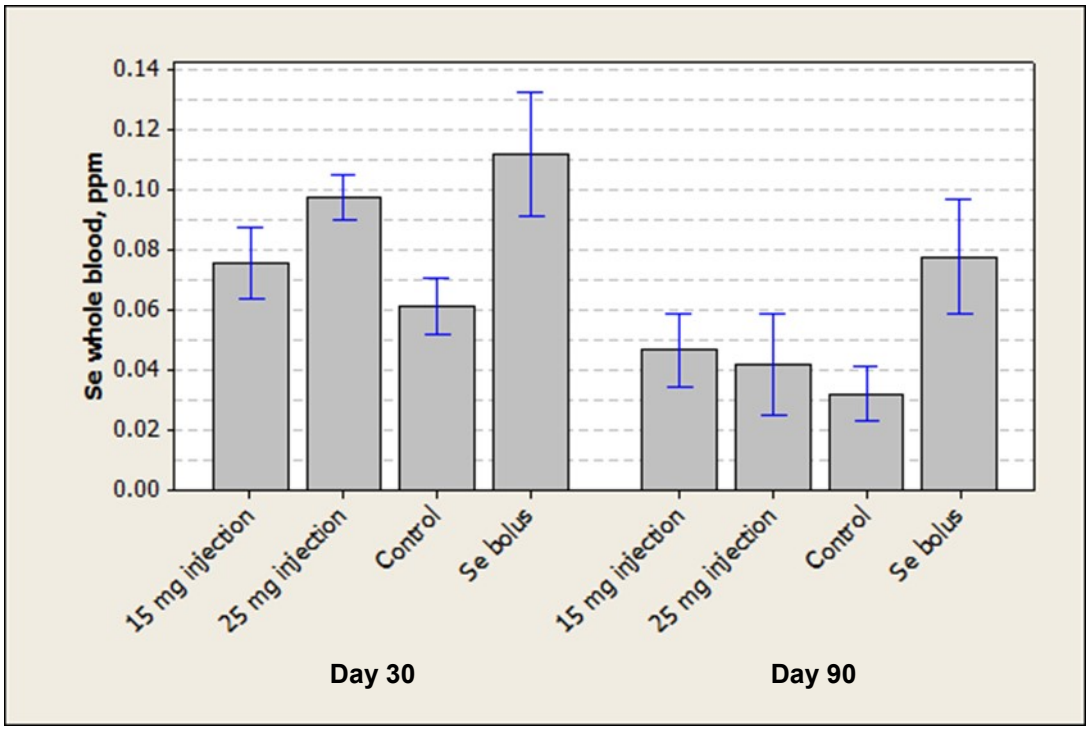



**Figure 1. Selenium whole blood levels (ppm) based on treatment and sample date for trial 1. Adequate is considered 0.08 ppm**

The cattle in the first trial were weighed every 30 days for 90 days and sampled for whole blood Se at day 30 and 90. At sampling 30 days after initiating the treatments (**Figure 1**) all of the Se treatments had increased Se whole blood levels on a herd average to within an adequate range of 0.08 ppm. However, at 90 days after treatment only the Se bolus managed to maintain levels at or above the adequate level.



[1]Muse injection, Merck Animal Health
[2]Multimin 90 injection, Multimin USA

The second trial built on the first one by testing the ability of a salt based supplement with 120 ppm of Se to raise whole blood levels of cattle (48 hd treatment 1). A small subset of cattle were separated as a positive control with a bolus (6 hd treatment 2) and a true control with no treatments (6 hd treatment 3) so that we could determine any relationships between Se levels and cattle weight gain. We weighed and collected whole blood Se samples of all 60 hd every 21 days for 85 days.

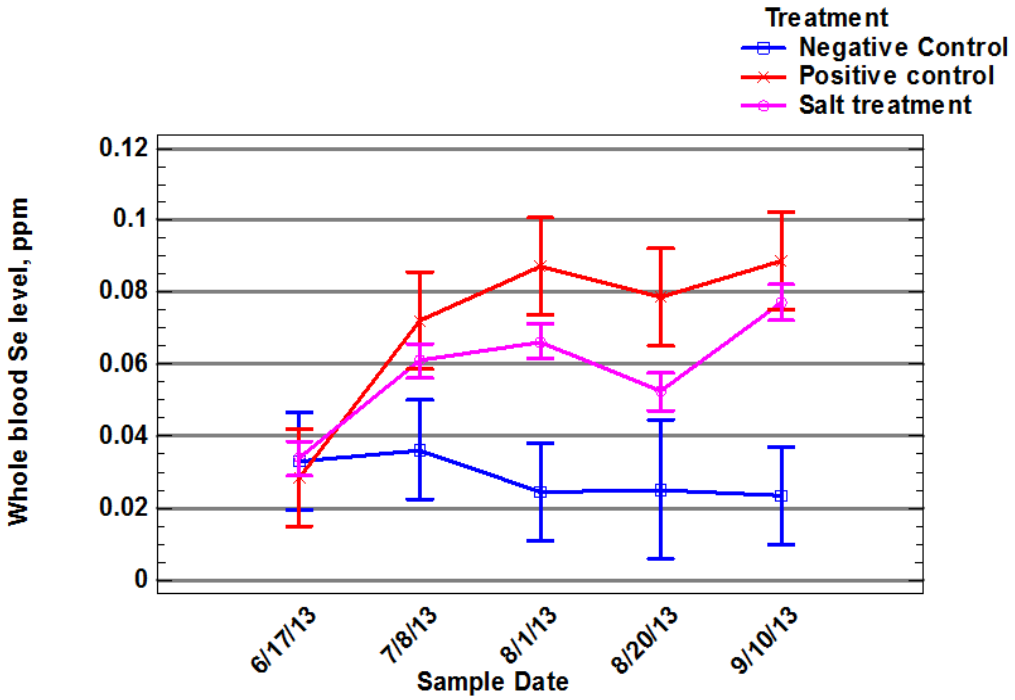



**Figure 2. Whole blood selenium response by treatment and date for trial 2. Adequate is considered 0.08 ppm**

As seen in the first trial the control cattle started and remained deficient in Se, and the bolus treated cattle reached adequate levels rapidly and remained around adequate. The salt supplement was successful in raising Se levels within the first 21 days, but took 90 days to fully produce herd average adequate levels of Se (Figure 2).

## Correcting Se deficiency

Our data showed the rumen bolus method of supplementation appears to be a very dependable method of supplementation, particularly if Se is the only deficient mineral.

The injections do elevate Se levels. In our trial, the higher injection dose at 25 (Multimin) vs. 15 (Muse) mg Se/hd provided significantly higher whole blood Se levels than the lower dose at 30 days post treatment. In this time frame, the higher dose was equal to the Se bolus treated cattle, however the benefits didn't last as long. Our results suggest that at 90 days, an injection of Se should not be expected to provide any supplemental benefit regardless of dose. However, this method may be a practical consideration when combined with the salt based supplemental method.

The greatest benefit of a salt based supplement is that it allows multiple minerals to be supplemented at the same time. Our second trial found that it was possible for the herd to reach an adequate level of selenium with this supplemental method. The difference between this method and the others is that it takes a longer time period to bring deficient cattle to adequate levels. This treatment did increase whole blood Se levels soon after the supplement was placed into the treatment pasture, but remained at a

marginally deficient level until the final sampling.

Whole blood selenium levels corresponded to consumption of the loose mineral supplement. Intake levels were high when the supplement was first placed in the pasture (**Table 1**). At 5.6 oz/hd/d consumption, the corresponding Se intake was 19 mg/hd/d, which is similar to levels administered through Se injection. With Se intake of 9 and then 8 mg/hd/d average whole blood Se levels remained the same and then declined. Yet again, when the herd average intake increased (15 mg/hd/d) the corresponding Se whole blood levels again increased significantly. This data indicates the importance of continued consumption of the supplement in known deficient areas. Seasonal supplementation, such as only during the breeding season, does not appear to be a method to adequately maintain Se levels.

| Sample dates | Loose salt consumed, oz/head/day | Actual Se consumed, mg/head/day | Herd average Se blood level, ppm |
|---|---|---|---|
| 7/10/2013 | 5.63 | 19 | 0.06 |
| 8/1/2013 | 2.76 | 9 | 0.07 |
| 8/20/2013 | 2.26 | 8 | 0.05 |
| 9/10/2013 | 4.43 | 15 | 0.08 |

**Table 1. Period average consumption of the loose salt mineral and associated Se uptake of the whole herd**

Though they did very well at a herd average, no supplemental method, including the bolus, brought all animals to adequate levels. **Table 2** depicts the percentage of the salt treatment cattle that were still deficient or severely deficient as compared to the herd average Se level at each sampling. Surprisingly all treatments were similar in this effect. Though the salt treatment reduced the percentage of cattle that were severely deficient by four times, there were still 21% of cattle that were severely deficient when the

**Table 2. Average herd whole blood level and corresponding percentage of cattle below adequate and severely deficient in the salt supplemented group of trial 2.**

| Date | Average Se blood level, ppm | % below 0.08 ppm | % below 0.05 ppm |
|---|---|---|---|
| 6/17/13 | 0.03 | 100% | 88% |
| 7/8/13 | 0.06 | 73% | 33% |
| 8/1/13 | 0.07 | 69% | 29% |
| 8/20/13 | 0.05 | 88% | 58% |
| 9/10/13 | 0.08 | 54% | 21% |

herd average was adequate. Even the bolus, which was considered a reliable long term treatment, left 23% and 17% of animals severely deficient in trials one and two, respectively. Combining supplementation methods may decrease the overall number of deficient cattle. This may include practices such as administering Se injections at the beginning of the supplementation period and then providing salt supplement as a means to maintain Se levels.

### The influence of Se on weight gain

Weight gain was surprisingly not a function of Se whole blood level. Both trials had significant variance in animal Se levels and neither proved significantly attributed nor correlated with gain differences based on Se. This does not infer that correction of low Se levels is not important. Previous Se supplementation studies have found significantly increases in immune response in calves, antibodies in yearling cattle, and vaccine antibody response. It appears that Se may not directly influence weight gain as do factors such as energy (TDN) in a ration, but rather indirectly with factors such as health. Reductions in weight gain may only be noticed in Se deficient cattle that experience some sort of immune challenge, which secondarily reduces weight gain. The possibilities for this type of challenge could be numerous including parasite and disease infections which are commonly faced by beef cattle. It is likely in our two controlled trials that these challenges were minimal due to many factors such as contained herds with little exposure to outside cattle or off ranch forage sources. However, it could be speculated that at some time an immune challenge would occur resulting in any number of animal health problems of a Se deficient group of cattle.

## Detecting pesticides and herbicides in the Sacramento-San Joaquin Delta

*Pramod Pandey, UC Davis School of Veterinary Medicine, UCANR Co-operative Extension*


Pramod Pandey, Assistant Specialist in Cooperative Extension/Assistant Microbiologist in Agriculture Experiment Station (AES) received approximately $500,000 for a project for two years (2017-2018) from the California Department of Parks and Recreation, Division of Boating and Waterways (DBW) to develop advanced methods for testing emerging contaminants such as pesticides/herbicides in the water column of the Sacramento-San Joaquin Delta. The project is focused on using Liquid Chromatography-Mass Spectrometry (LC-MS/MS) and Gas Chromatography-Mass Spectrometry (GC-MS) based methods for quantifying the low level pesticides with accuracy and reliability. DBW, project sponsor, is the lead agency to implement control measures of Floating and Submerged Aquatic Vegetation in the Sacramento-San Joaquin Delta, its tributaries, and the Suisun Marsh. The project will support DBW aquatic weed control programs, which operate according to the National Pollution Discharge Elimination System (NPDES) General Permit for Aquatic Pesticide Use and Biological Opinions from United States Fish and Wildlife Service and National Marine Fisheries (NMFS).

# Building foundations: a veterinary student at the VMTRC

*Jasmin Bardales, UC Davis School of Veterinary Medicine*

When I arrived at my first dairy in Tulare, California, the magnitude of the operation is what struck me first. I was standing on a piece of land surrounded by approximately 2,800 cows, and we had passed numerous dairies of similar scale on the way here. Tulare County has the highest milk production of any county in California, a fact made apparent by the sheer concentration of dairies in this area. This is what makes the UC Davis Veterinary Medicine Teaching and Research Center (VMTRC) so ideally-located and so vital in the integrative function that it serves in Tulare and the surrounding region. The research conducted here spans the gamut from field-based studies to laboratory-based studies, and it is coupled with extensive outreach and education programs. For a first-year veterinary student such as myself, the VMTRC represented an enticing opportunity to learn about the dairy industry up close. So, when I was given the incredible opportunity to spend a week at the VMTRC and get a glimpse into the research and other services performed there, I gladly took it.

During this time, I followed the work on lameness being conducted by Drs. Noelia Silva del Rio and Joaquin Chiozza Logroño. The magnitude that had impressed me so much upon my arrival also turned out to be one of the factors that may contribute to lameness. On such large farms, cows must walk long distances on often wet, abrasive concrete floors two or three times per day to the milking parlor. The moisture and the abrasion both serve to soften and wear down the claws. Coupled with other complex risk factors for lameness such as overtrimming, high milk production, and low

Figure 1: measuring claw length

body condition score (BCS), this can prove highly detrimental to hoof health. Thin soles can leave a cow vulnerably predisposed to developing lesions, especially on the lateral hind claw, which normally bears 70-80% of the animal's weight.

Dr. Silva del Rio is performing an ongoing study to determine if thin hoof blocks can be used as a preventive measure for at-risk cows. We visited multiple dairies to collect data. Shown in Figure 1, we measured the dorsal wall length of the claw, which has been shown to correspond proportionally to the sole thickness. We selected a group of cows that we identified as at-risk for developing thin soles based on their low BCS, days in milk, and locomotion score. By placing blocks on the medial hind claws, Dr. Silva del Rio's lab is attempting to even the weight balance by allowing more weight bearing on the medial claw and give the claws a chance to grow and develop a thicker sole.

When I was not working with Dr. Silva del Rio, I was back at the VMTRC talking with faculty, on the CAHFS necropsy floor getting bloody with the pathologists, or going out on calls with the clinicians. They showed me Clostridial diseases, the histologic appearance of rabies, proper euthanasia protocols, and the importance of monitoring nutrition. Each faculty member I spoke with had a different background, a different idea about which problems were most important to tackle, and a different perspective on what it means to be a veterinarian. However, although everyone at the VMTRC was working from a different angle, they were all working toward a common goal. Veterinary medicine, especially food animal medicine, is a complex balance between animal health and welfare, human food safety, economics, and legislation. No single aspect can be ignored if we are to do justice not only by our patients and clients, but by our communities at large.

Figure 2: protective blocks being glued to the medial hind claws

# Tackling antimicrobial use on the farm: reviewing concepts and preparing for the future

*Richard Van Vleck Pereira, UC Davis School of Veterinary Medicine, UC ANR Cooperative Extension*

Antimicrobials are an important shared resource for treating disease in both humans and animals. Antimicrobials have customarily been used in livestock for four purposes: treatment, control, and prevention of disease and low-level feeding to improve growth promotion. With the new federal legislation related to the veterinary feed directive (VFD), antimicrobials that require a VFD cannot be used for improving growth promotion. One other limitation of the new VFD legislation is that extra-label drug use (ELDU) of antimicrobials in the feed is not allowed. ELDU is defined by federal law as "use in species not listed in the labeling, use for indications (disease or other conditions) not listed in the labeling, use at dosage levels, frequencies, or routes of administration other than those stated in the labeling, and deviation from the labeled withdrawal time based on these different uses" (21CFR530.3).

This highlights the important of being aware of the limitation imposed by a drug label, and is a good time for producers and veterinarian to review how and where drugs are used on the farm, especially drugs that require a VFD. Understanding the terminology for drug use is therefore important, and to provide some clarity here are some definitions related to drug use:

**Disease Prevention**: antimicrobial use when a known disease risk is present. Drug can be administered even if none of the animals in the herd are exhibiting clinical signs of the disease.

**Disease Control**: antimicrobial use to decrease the spread of disease when a portion of the animals in the herd have shown signs of disease and the clinically sick are being treated (usually individually).

**Disease Treatment**: antimicrobial use to treat animals that are exhibiting signs of disease.

VFD can only be ordered by a licensed veterinarian through a valid veterinarian-client-patient relationship. Although the VFD has generated changes on how drugs are used, it has also created an occasion for improving communication in the farm. This includes communication between farm employees and owner, veterinarians and other parties involved with animal health on topics related to health management alternatives that could reduce the dependence on antimicrobial use to manage disease on the farm. This could reduce direct and indirect expenses that come with the use of antimicrobials, as well as decrease unwanted impacts from drug use on the farm.

Additionally, these efforts will aid in preparation for future changes in legislation affecting drug use in livestock, such as the California Senate Bill 28 (which resulted in the California Food and Agriculture Code 14400-14408). This California law dictates that starting January 1, 2018, all medically important antimicrobial

**Resource for antimicrobial drug use in livestock in California:**

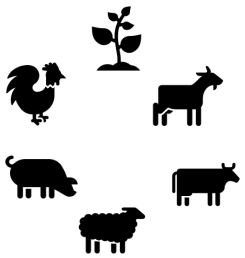
**cdfa.ca.gov/ahfss/AUS/**

drug shall not be administered to livestock unless ordered by a licensed veterinarian through a prescription or veterinary feed directive. This legislation affect the use of drugs such as penicillin and tetracycline, for which the injectable form can currently still be obtained over-the-counter without the need of a veterinary prescription. As part of the efforts to support livestock producers on approaches to improved drug use on the farm, workshops, talks and other materials are being produced and offered by different institutions, including the California Department of Food and Agriculture and UC Cooperative Extension. Using this information and added to efforts to adapt to the current and future changes to come related to antimicrobial use on the farm is a good way to reduce abrupt changes in the farm that could affect animal health and production.

**FDA Guidance for Industry #233 Veterinary Feed Directive Common Format Questions and Answers:**

**www.fda.gov/downloads/AnimalVeterinary/GuidanceComplianceEnforcement/GuidanceforIndustry/UCM474640.pdf**

# Diversified crops and livestock farming



*Laura Patterson, Graduate Group in Epidemiology, University of California Davis*
*Alda Pires, UC Davis School of Veterinary Medicine, UC ANR Cooperative Extension*

Drs. Alda Pires and Maurice Pitesky, along with PhD epidemiology student Laura Patterson from UC Davis, joined with Dr. Stephanie Larson, Director of University of California Cooperative Extension: Sonoma County, to present a seminar titled “Farming 101: Diversified Crop and Livestock Farming” at the UCCE office in Santa Rosa, CA on February 21, 2017. About 30 small-scale diversified farmers with diverse livestock (e.g., sheep, goats, poultry, pig, rabbits and cattle) and crops (e.g., vegetables, fruit trees, wine grapes) attended the event.

The seminar focused on presenting past and current research regarding diversified farms - those that raise a diversity of crops or integrate pasture-raised livestock and crop production. Dr. Pitesky provided information on pastured poultry and biosecurity practices that are important to reduce the risk of avian influenza outbreaks. Dr. Larson discussed pastured swine practices and opportunities for NRCS funding. Dr. Pires gave a presentation on food safety risks and animal health considerations for integrated crop-livestock and diversified farms, including information about specific foodborne pathogens (e.g., Salmonella and E. coli O157:H7) and parasite management and PhD student Laura Patterson discussed research updates about a small-scale farm study as well as current opportunities for famers to engage in research studies at UC Davis. More information about research and outreach opportunities can be found in the Small Farm & Urban Agriculture website.

UCCE Sonoma County presents monthly workshops. Information about upcoming workshops can be found at: http://ucanr.edu/sites/BFRSOCO/Farming_101/