RESEARCH REPORT FOR THE OREGON SHEEP COMMISSION
June 13, 2025

Proposal Title: Effect of Different Selenium Supplementation Practices in Oregon on Whole-Blood Selenium Concentrations, Naturally Acquired Parasite Infections, and Inflammatory Mediators of Subclinical Inflammation in Ewes

Principal Investigator: Jean A. Hall, DVM, PhD, Diplomate ACVIM (Internal Medicine), Professor, Department of Biomedical Sciences, Carlson College of Veterinary Medicine, Dryden Hall 206, Oregon State University, Corvallis, OR. (541) 737-6537; Jean.Hall@oregonstate.edu

Background: The focus of our selenium (Se) research is to improve health, prevent diseases, and increase productivity in sheep flocks across Oregon, where soils are deficient in Se. Deficiencies in the Se content of forages are reflected in whole-blood (WB) Se concentrations in sheep consuming these forages. WB-Se concentrations from 56 farms in Oregon showed that 16% had deficient WB-Se concentrations in 100% of the ewes tested, and 23% had >50% of ewes tested with WB-Se deficiency (Hasan et al. *unpublished data*). Thus, subclinical Se deficiency is quite common in Oregon flocks of sheep, even when owners are providing their animals some form of Se supplement. We have previously shown that feeding selenate-fertilized forages not only increased WB-Se concentrations in sheep and cattle, but also improved their productivity and health.

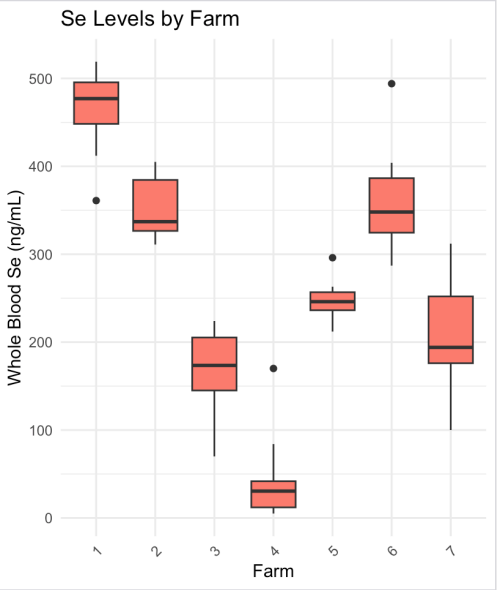
We are interested in how subclinical Se deficiency makes sheep prone to diseases, and what small molecules (i.e., cytokines) regulate these effects. A normal inflammatory response requires a balance between sufficient cytokine production to eliminate the pathogen and avoidance of a hyperinflammatory response in which an overabundance of cytokines causes clinically significant collateral tissue damage.

To better understand how Se supplementation affects inflammation and subclinical disease, we measured WB-Se concentrations from healthy ewes on seven different farms in Oregon, each of which had their own unique Se-supplementation program. We also looked at fecal egg counts thinking gastrointestinal parasitism susceptibility might be correlated to WB-Se status. Finally, we measured six different cytokines in the serum from these ewes to see if cytokine concentrations were correlated to WB-Se concentrations or GI parasite load. Our goal was to show a mechanism of how WB-Se concentrations affect inflammation and underlying health and productivity.

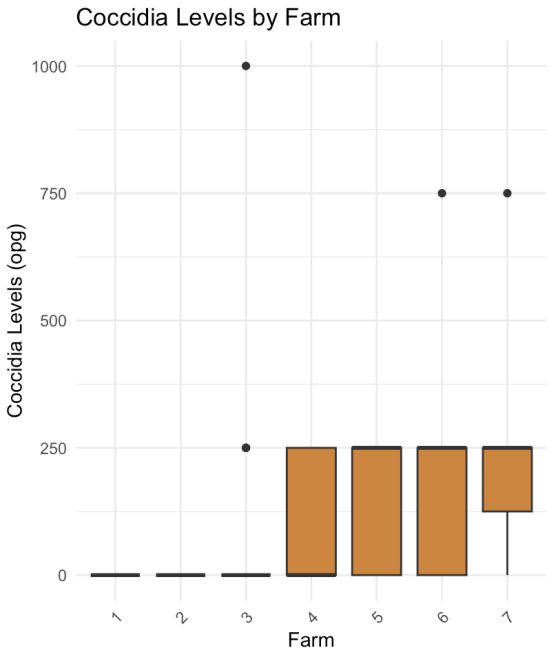
Results: Whole blood selenium levels differed depending on the individual farm Se supplementation practice. In general, higher WB-Se levels were achieved feeding organic Se supplements, without signs of Se toxicity. Although, one farm achieved higher WB-Se levels with inorganic Se supplementation, also without signs of toxicity.

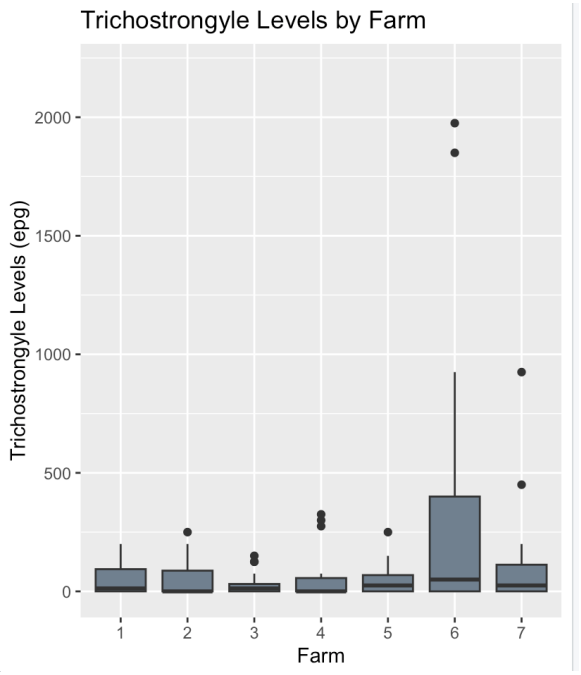
Farms differed in Se supplementation strategies: ewes from farm #1 grazed Se-biofortified pastures, were drenched biweekly with SeMet enriched yeast, and had access to free choice salt-mineral mix containing 200 ppm Na selenite. Ewes from farm #2 grazed Se-fortified pastures and received mineral mix containing ≥24.2 ppm Se from Se-yeast and selenite. Ewes from farm

#3 had access to free choice salt mineral mix containing 90 ppm Na selenite. Ewes from farm #4 had limited Se supplementation. Ewes from farm #5 had irregular Se supplementation and a diverse diet. Ewes from farms #6 and #7 had access to free choice salt mineral mix containing 165 ppm and 90 ppm Na selenite, respectively.



In general parasite levels were low in all groups of ewes. There was a significant correlation between presence of coccidia and body condition score, in that higher parasite load was associated with lower body condition scores. Ewes with lower WB-Se concentrations also had lower body condition scores.





Serum cytokine concentrations were measured via a multiplex cytokine assay and included IFNγ, TNFα, IL1β, IL-4, IL-10, and IL17α. No significant differences were found among the cytokine profiles of sheep across different farms, however a peculiar pattern of co-elevation of TNFα and IL-10 was identified. Several individuals on each farm demonstrated elevated TNFα in the 100th percentile – 6-fold higher compared to those in the 75th percentile. This dramatic elevation of TNFα corresponded closely with increased levels of IL-10. These are inflammatory and anti-inflammatory cytokines, respectively. This information was presented in Spring 2025 at the Immunology 2025 meeting, national meeting of the American Association of Immunologists. We would like to follow up with repeat testing of this subset of ewes with elevated levels of cytokines indicating chronic inflammation.

We also became interested in whether the form of Se supplement (organic SeMet from forage or Se-yeast vs inorganic selenite in salt mineral mixes) affects the type of Se species in blood. Normally, Se is incorporated into the amino acid methionine in forages and yeast to make SeMet, and when this is consumed by livestock, WB-Se appears mainly in the form of Se-Met. Conversely, consuming inorganic Se sources results in much higher concentrations of WB-SeCys. Whole blood was submitted to a lab for Se speciation. Selenium supplementation in the form of SeMet resulted in greater WB-SeMet species as a percentage of total WB-Se. Because of its organic form, SeMet is less toxic than inorganic forms. SeMet can be incorporated into body proteins and released with protein turnover providing greater body reserves of Se. In addition, the redox and antioxidant activity of SeMet-containing proteins could have major physiological consequences. This information will be presented at the 8th International Conference on Selenium in the Environment and Human Health (ICSEHH), 6-9 July 2025, Chuzhou, China.

This grant generously awarded by the Oregon Sheep Commission has helped us gain more insight into the role of Se in the inflammatory status and overall health of sheep. Moreover, it has illuminated novel research opportunities, including the exploration of Se species metabolism in sheep and the identification of biomarkers associated with persistent inflammatory states. These findings may ultimately enable earlier detection of subclinical illness, allowing producers to identify and treat sick animals before overt clinical signs appear. This work lays a critical foundation for the development of precision health strategies in sheep production systems, aligning nutritional status with immune resilience and disease prevention. We are deeply grateful for the Commission's support, which continues to drive meaningful progress in the health, productivity, and welfare of Oregon's sheep industry.