

## Horizon Series: The future of livestock vaccines

White Paper Highlights with Dr. Shayan Sharif,  
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As part of its Horizon Series, Livestock Research Innovation Corporation (LRIC) has written a series of white papers on issues impacting livestock producers and the entire livestock value chain. In this issue, Dr. Shayan Sharif reviews the types of vaccines available and ideas on the innovations needed for future livestock vaccines. Sharif is a professor of poultry immunology and associate dean of research graduate studies at the Ontario Veterinary College at the University of Guelph. He leads the U of G's Poultry Health Research Network and co-authored LRIC's white paper *The Future of Livestock Vaccines*.

*"We need to understand history because it informs our future."* Dr. Shayan Sharif

Vaccination is not a new concept. Sharif reviewed a brief history of vaccines starting in 900 AD with the Chinese, and up to the late 1800s when Louis Pasteur—the father of vaccinology—developed a vaccine to protect against chicken cholera, and one for anthrax in sheep and cattle. Despite all the work done on vaccines since, there are still some diseases where effective vaccines have not yet been developed.

*"There are about a dozen different types of vaccines currently available for human or veterinary medicine."* Dr. Shayan Sharif

The mostly widely used vaccines fall into three types—live attenuated, killed and toxoids. Some may be familiar with subunit vaccines or protein conjugate vaccines. And up until the COVID-19 pandemic, Sharif suggests most people were unaware of nucleic acid or viral vector types of vaccines. The mRNA COVID vaccine is one type of nucleic acid vaccine. And there are also DNA vaccines used in human and veterinary medicine.

*"What should we look for in livestock vaccines?"* Dr. Shayan Sharif

Sharif outlined the key elements of a good vaccine, which must first and foremost be safe. Vaccines must have some level of threshold to be able to give sustained protection. Some vaccines provide several months or even several years of protection, and to do that, vaccines must be able to produce different types of immune responses. Other considerations for livestock vaccines are cost and administration. Vaccines must be inexpensive and be easy to administer

and deploy. Sharif believes that veterinary medicine has done something that human medicine needs to learn from: to make commercial vaccines at a fraction of the cost of conventional vaccines that are effective against a phlethora of pathogens.

*“For vaccines, we are focused on the adaptive immune response.”* Dr. Shayan Sharif

With a simplified immunology lesson, Sharif described the two types of responses at work in the immune system. Innate responses are generated or induced within a few minutes after exposure to antigens, vaccines or pathogens. Adaptive immune responses are generated within a few hours, a few days or sometimes a few weeks after exposure to a pathogen or an antigen derived from a vaccine. Livestock vaccines are focused on adaptive immune responses that are mediated by B cells (that produce antibodies) and T cells (that help B cells) and a kill infected cells that have been exposed to an antigen.

*“There is a wide variety of methods for delivering vaccines.”* Dr. Shayan Sharif

Sharif outlined five main routes of vaccine administration, noting that veterinary medicine has come a long way in this area and is more advanced than human vaccinology.

- Intramuscular or intradermal—most human vaccines
- Mucosal—oral, nasal, rectal, vaginal and ocular (in the eye, used in chickens)
- In ovo—immunizing the chick embryo on about day 18 in incubation to give hatched chicks partial immunization and accelerate the immune response to pathogens
- Epidermal and transcutaneous

*“What do we need now to fight emerging livestock diseases?”* Dr. Shayan Sharif

Influenza viruses and corona viruses are two virus families at the top of the list for causing some sort of future pandemic in humans or animals. The COVID-19 pandemic has demonstrated that in just about a year, a vaccine for human medicine was developed, commercialized and shepherded through the regulatory process with billions of doses produced. But Sharif knows that's not as easy to do for veterinary vaccines. Here's his comprehensive list of what needs to happen to prepare for future diseases in veterinary medicine:

- Cost-effective vaccines that are less than a penny per dose
- Novel platforms for antigen discovery including big data machine learning and artificial intelligence
- Better and more effective methods of administration including site-specific (mucosal) and needle-less
- Novel adjuvants that are potent, safe and efficacious



- Vaccines that can reduce the transmission of viruses
- Thermostable vaccines that can withstand heat
- Systems for rapid development, approval and deployment
- Global infrastructure for manufacturing and distribution
- Improved system for data collection and analysis

Then the task, according to Sharif, is how to effectively integrate all these factors into a robust system with strategies to control future pandemics and emerging livestock diseases.

Watch the full webinar or review the white paper at [livestockresearch.ca/white\\_papers](http://livestockresearch.ca/white_papers).

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